INNOVATIVE PERSPECTIVE OF TRANSPORT AND LOGISTICS

Edited by Jan Burnewicz

Wydawnictwo Uniwersytetu Gdańskiego

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About Authors
The answer to modern problems of transport and logistics is increasingly dependent on the pool of knowledge and the ability to create innovative solutions. These problems are more and more unyielding to the instruments of transport policy that we know today, used by national governments and international institutions (regulation, technical standards, funds for new projects). Traffic intensity in many areas of economic and social space has reached a level at which the capacity of the existing infrastructure and the possibility of its extension through traditional investment methods is nearing exhaustion. New-generation vehicles, alternative fuels, smart systems of traffic control and new technologies of construction and maintenance of transport infrastructure have become a necessity.

The transport and logistics sector determines how other areas of the economy and public life function and develop. Any manufacturing activity or process is connected with the need to move appropriate volumes of (raw) materials and products. The way in which these are moved is of considerable significance to business entities and consumers on the one hand, and the social and natural environments on the other. The great intensity of transport operations is a major challenge for cargo carriers and logistics providers, as well as a nuisance for most of the public. Despite significant technological progress made in transport over the decades, its efficiency and productivity remain unsatisfactory. The growing symptoms of capacity problems accompanied by rising external costs in the transport systems should incite business and research circles to intensify their search of innovative solutions that will make a qualitative leap possible in the ways distances are covered.

Trying to solve the transport problems of today by extensive infrastructure development and minute regulation is becoming relatively less and less productive. Like any other products, the means of transport that we know today have a particular life cycle and the possibilities of making upgrades or improving their use and functionality are finite. The progress made within the last 50 years in the design and propulsion of cars, planes or ships has undoubtedly been
great and has brought measurable effects in terms of unit fuel and energy consumption, improved reliability and safety and reduced emissions of fumes and noise. However, with the growing demand for transport, these state-of-the-art means of transport get stuck amidst the ailing infrastructure and chaotic traffic. Consequently, there is universal search of innovative technological and organisational ideas for the transport systems based on such solutions which will mitigate the weaknesses of the present-day systems, or eliminate them altogether.

The authors of the present study have analysed new trends in transport and logistics in order to identify and assess the most promising innovations, whether described on paper or in the Internet. The subject of the study was innovative processes of technological, organisational structural, market or sociological nature. The gathering of relevant but scattered information is time-consuming and not all important concepts, prototypes and inventions can be traced and conclusively assessed. The description of this dynamic reality may be a help in the diffusion of technological knowledge and making useful innovations widespread. The latter can prove their worth only when applied on a mass scale.

In terms of innovation, the greatest challenge for transport of the next 20-30 years will be to devise entirely new, breakthrough technologies, which will make further social and economic development possible after the world has run out of oil, on which modern transport depends so heavily. Thanks to materials engineering, large resources of energy can finally be stored in batteries, while fuel cells based on various forms of hydrogen are more and more commonly used. The prospect of a transport that is environmentally clean, safe and energy-sustainable is becoming increasingly close and realistic.

Valuable transport innovations occur owing to the tighter and tighter cooperation between the world of science, vehicle and craft manufacturers, alternative energy sector, cargo carriers and logistics providers as well as public institutions that support research and development. Owing to this cooperation, innovations and breakthrough technologies emerge, which are implemented in response to specific requirements of the market. Misconceived transport innovations are becoming rare, as are inventions made either by chance or in order to prove that something can be done, irrespective of high operating costs, heavy environmental impact or lack of public acceptance. A barrier to innovation in transport, however, is the conservative attitudes of the users of traditional means of transport, the fear of automatically controlled vehicles and distrust of vehicles propelled by hydrogen or electricity. Therefore, the success of innovations in transport will depend not only on the technological expertise of their designers, but also on innovation-oriented education and the shaping of technology-anxious, creative attitudes.
Chapter 1
INNOVATION AND INNOVATIVE PROCESSES
IN MODERN ECONOMY
(Sylwia Pangsy-Kania)

1.1. Innovation – its nature and types

The history of innovation is as old as our civilisation. However, significant develop-ment of innovation processes and their rapid diffusion started at the turn of the 20th and 21st centuries. The development of information methods and techniques is believed to be the third, after the neopolitical and industrial, epoch in our civilisation, called the epoch of information processing or the epoch of knowledge. The impor-tance of agriculture and industry among the four sectors of economy has been declining since the turn of the centuries, with the growing share of services and a still more significant and rapid growth of science and technology. Innovation is strictly linked with knowledge and available technology.

According to the dictionary, “innovation” originates from the Latin word *innovare* which means “to renew or change.” Innovation, though widely defined in literature has no uniform, accepted definition. All the definitions of innovation cannot be quoted here, thus only some are presented as an example.

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1 For more on the history of innovation see W. M. Grudzewski, I. K Hejduk, *Innowacyjność w technice i technologii źródłem przewagi konkurencyjnej małych i średnich przedsiębiorstw*, Instytut Funkcjonowania Gospodarki Narodowej SGH, Warsaw 2002, pp. 3-7.


The theory of innovation was introduced in economics by J. Schumpeter. The Austrian economist introduced the concept of innovation to global economic literature and formulated a thesis that enterprise innovation is decisive for economic development to a greater extent than capital, whereas anyone introducing new combinations is an entrepreneur. Schumpeter introduced the concept of innovation to economic literature in the sense of:
- starting the production of a new product or upgrading an existing one;
- introducing new production processes or upgrading existing ones;
- applying new sales or acquisition techniques;
- opening a new market;
- applying new materials or semi-finished goods;
- structuring the production in a new way.

In 1912, Schumpeter indicated, *inter alia*, the importance of enterprise managers and company owners. He emphasised that the role of innovation in economic development involves a profit driven shift in allocating resources within particular economic sectors. As innovations involve risk they are initially implemented by the most enterprising entities, they find followers and have an impact on prices. Schumpeter also suggested the need of conducting an in-depth analysis of the relations between innovation, the imitation of technical progress and foreign trade.

He is also the author of the so called creative destruction concept which involves continual destruction of old structures in the process of developing new, more efficient ones. Innovation disrupts economic balance, fosters optimism of investors thus contributing to development and an economic boom. Creative disruption leads to investment growth and better productivity. The development process slows down with time and results, *inter alia*, in dropping growth rates and employment rates. This results in an economic crisis, which is a kind of creative disruption because it eliminates companies that are not capable of dealing with growing competition and innovation progress. Soon the entire mechanism starts over again with the development stimulus of a new stream of innovations affecting the economy.

According to Schumpeter, the development of new structures in economy takes place as a result of: manufacturing a new product, using new production methods, finding a new market, new source of materials, structuring in a new way. An innovation must be a novelty and its practical application must have a positive economic result. The main market force is a creative entrepreneur, who aims at developing new solutions to achieve extraordinary profit, as compared with the competition. On the grounds of conducted studies, Schumpeter...
came to the conclusion that innovative changes are the work of an individual and not of a community. This led him to distinguish between:

– invention – a scientific fact providing innovative opportunities;
– innovation – the application of invention resulting in new technological solutions;
– imitation – any simplification of innovation.

Imitation as defined by Schumpeter should be understood today as the processes of innovation diffusion, which may be labelled copying or imitating. These innovation processes are often of greater significance than the innovations themselves. It should be underlined that these innovation processes are interlinked with the technology transfer processes. However, according to Schumpeter, innovation processes were not the activities connected with imitation. Furthermore, Schumpeter believed that considering innovation diffusion processes and social benefits resulting from innovation, only big corporations and imperfect competition may create innovation processes. This understanding of innovation processes has had to be revised as the highly competitive market with participation of small companies can create innovations e.g., in the area of high-tech.

According to Schumpeter, economic development is determined by the fact that innovation is erratic, complementary and forms a long chain of transformation sequences; as innovation diffuses, the economy enters the state of imbalance; innovations tend to concentrate in a specific time and place. According to Schumpeter’s theory, economic development is dependent on three factors: innovation, entrepreneur and bank credit.

In macroeconomic terms, Schumpeter analysed mutual relations between innovations and investment levels. On the basis of conducted studies, he came to the conclusion that implementing innovations connected with greater capital spending changes the allocation of production factors. According to the classical definition of innovation presented by Schumpeter, we can assume that in terms of the economy of a given country innovations mean a better allocation of resources and a positive impact on economic growth and the ability to compete in international markets. A similar opinion is expressed by P. F. Drucker who sees innovation as a characteristic tool of entrepreneurship, a measure that gives resources the drive for generating wealth. He is of the opinion that innovations have more to do with the social and economic spheres than with the technical, while at the level of an enterprise technical innovations are decisive. His studies emphasise that the greatest economic resource is the purchasing power, which is generated by entrepreneurs introducing innovations.

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According to Robert U. Ayres, who points out the economic (commercial) aspect of the issue, innovation should be understood as creativity in terms of developing new products, new technological processes and the organisation of new entities. H.G. Barnett, referring to the above, stresses the question of originality in defining innovation, a significant difference in comparison with existing solutions, and emphasizes the role of innovation in economic changes.

The theory of innovation is also discussed by many Polish economists. Special attention should be drawn to the studies by M. Kalecki, who like many other authors, believes that innovations involve more than just the technical sphere. He defines innovations as inventions applied for the first time worldwide. He considers innovation – and this should be underlined – to be the key stimulus of economic development. The view which assumes that novelty and first application worldwide are the distinguishing features of innovation was represented by, inter alia, Schumpeter, Drucker, and Solow.

Philip Kotler on the other hand states that innovations refer to any goods, services or concepts that are perceived by someone as something new.

Until the late 1970s, the term innovation was used to describe creative changes in the social system, economic structure and the natural environment. Later, the paradigm of economic theories connected with evolving models of innovative processes brought a shift from the linear to the integrated model.

Many classification systems of innovation appear in the literature of the subject, providing grounds for research on innovative capacity of economies and enterprises.

From the point of view of the economic sector in which they originate, or the sphere of activity they affect, innovations can be divided into four basic groups:

- functional – satisfying new, earlier undisclosed social needs providing new functions;
- product related – introducing new products, substituted for those currently in use, as better fitted to the task;
- process related – introducing new production methods, which facilitate manufacturing, reduce costs and improve the natural and work environment;
- structural/organisational – upgrading work and production organisation, improving occupational safety and hygiene.

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14 A. Pomykalski, Innowacje, Politechnika Łódzka, Łódź 2001, pp. 18 and on.
Table 1. Innovation criteria and types

<table>
<thead>
<tr>
<th>DIVISION CRITERIA</th>
<th>INNOVATION TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Originality of changes</td>
<td>– original, creative e.g. inventions</td>
</tr>
<tr>
<td></td>
<td>– not original, adapted, imitative</td>
</tr>
<tr>
<td>Magnitude</td>
<td>– major (strategic)</td>
</tr>
<tr>
<td></td>
<td>– minor (tactical)</td>
</tr>
<tr>
<td>Innovation source</td>
<td>– domestic</td>
</tr>
<tr>
<td></td>
<td>– international e.g. license, know-how</td>
</tr>
<tr>
<td>Degree of complexity of the innovation process</td>
<td>– interdependent</td>
</tr>
<tr>
<td></td>
<td>– discrete</td>
</tr>
<tr>
<td>Psychosocial conditions</td>
<td>– contemplated</td>
</tr>
<tr>
<td></td>
<td>– not contemplated</td>
</tr>
<tr>
<td></td>
<td>– intentional</td>
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<tr>
<td></td>
<td>– unintentional</td>
</tr>
<tr>
<td>Kind of knowledge</td>
<td>– tangible</td>
</tr>
<tr>
<td></td>
<td>– intangible</td>
</tr>
<tr>
<td>Environmental impact</td>
<td>– environment friendly</td>
</tr>
<tr>
<td>Impact scope</td>
<td>– product(s)</td>
</tr>
<tr>
<td></td>
<td>– process(es)</td>
</tr>
<tr>
<td></td>
<td>– organisation(s)</td>
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An interesting breakdown of innovations was suggested by B. Ileczko\textsuperscript{15}, also analysed by P. Niedzielski\textsuperscript{16}. Innovations were divided into the following four groups: anthropocentric (physiological, functional and morphological, neuro-psychological), social (changes accompanying social revolution and evolution, changes in economic systems, changes in social policy, changes in organisational structure and management); biotic (hybridisation of plants and animals, selective breeding of tree ecotypes, pest control); and technical (new machines and equipment, new means of transport).

In terms of the originality criterion, innovative changes may involve new solutions and thus be creative innovations or may account for diffusion, copying, dissemination and imitation and be labelled imitative and adaptation innovations. Three types of innovation may appear in economy: technological, organisational and marketing innovations where the key criterion in terms of usefulness for economic development is the induced growth in productivity. Both creative innovations that involve application of new innovations and imitative and adaptation innovations that involve copying and adapting existing solu-


\textsuperscript{16} Niedzielski, Polityka innowacyjna w transporcie, Wydawnictwo Naukowe Uniwersytetu Szczecińskiego, Szczecin 2003, pp. 19-25.
tions may be of technological, organisations or marketing nature\textsuperscript{17} (see Table 1). In professional publications the most often discussed, due to their tangible character, are technical and technological innovations. They are identified with scientific and technological progress, i.e. a stream of innovation processes taking place at a given time and place, which in the long-term perspective is of key significance for economic development.

Taking into account the definition by Ch. Freeman\textsuperscript{18}, who states that innovation is the first introduction to the market, use of a new product, process, system or device we should also note the innovations that do not satisfy the criterion of economic profitability. Rules of economy should also apply to expenditure made to reach the set objectives. This applies to innovations related to the protection of the environment, occupational safety enhancement and the reduction of work-related nuisance\textsuperscript{19}.

According to the OECD, innovation means the first application of a technology or knowledge resulting in market success. A problem remains what scale of first application should be chosen – an enterprise, a country or global economy? Furthermore, primary innovation due to feedback of various stages of the innovation process may undergo transformations that may be of greater significance than the initial innovation.

If innovation is defined as the introduction of new solutions in technology, organisation and marketing, innovative potential will be determined by internal factors resulting from the capacity to activate existing resources in the economy and external factors connected with imitation and adaptation of solutions from abroad. Innovations are developed in own R\&D projects and come from transfer of technologies and innovations as direct foreign investment, import of advanced goods, license agreements, franchising, acquisitions and strategic alliances.

Innovations cover products and processes (see Fig. 1). Product innovations play a special role in market economy as the competitiveness of a new product is an important tool in the rivalry between producers.

Generally, innovation is perceived as a change linked with progress. However, this is not always the case in practice. In the 1970s, Z. Madej\textsuperscript{20} stated that innovations mean changes in any direction, therefore they do not necessarily mean progress as they may mean neutral changes or regress. According to the classification proposed by S. Sudol\textsuperscript{21}, product innovations are a kind of produc-

\textsuperscript{18} Ch. Freeman, \textit{The Economics of Industrial Innovation}, Pinter, London 1982, p. 7.
\textsuperscript{19} E. Stawasz, \textit{op. cit.}, p. 14.
tion innovation, together with means of labour, technological innovations and innovative materials. The view according to which innovations mean changes in products and production methods is represented by Ch. Freeman.22

An interesting definition is given by D. M. Rogers, who states that everything that is perceived by an individual as a novelty is an innovation, irrespective of whether in fact the idea or object is new or not.23

To sum up, if the term is understood strictly (as in most economic theories) innovations connected with social and economic changes are discarded and focus is placed on technical innovations in economic operations.24 In practice a wider meaning of the term innovation appears resulting from the interrelations of various kinds of innovations. The narrow definition of innovations covers the process initiated by scientific research, through the concept, invention to the development of an innovation and its first application. The wide definition of the term will also embrace diffusion, copying, imitation and dissemination.

Irrespective of the adopted definition, innovations will be called “clasps” of science, technology and production. The key features of innovations result from this approach.25

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22 Ch. Freeman, op. cit., p. 7.
26 Ibid.
1.2. Innovation features

Innovation depends on more than just technological know-how. Other knowledge constitutes its important element (e.g. specific experience gained, overall educational level, contact with users and suppliers, watching the competition). This feature is connected with the necessity to develop schools and universities and to favour cooperation between scientific centres and enterprises. It is also linked with the learning process because it requires the collection of specific knowledge and information from both internal and external sources. Thus, an innovative company is able to accumulate knowledge and to run its production process efficiently and effectively.

Another feature of innovation is its interactive and multidisciplinary character. Innovation is therefore a multi-sequential process comprising, on the one hand, separate and on the other, mutually linked and interdependent phases. Therefore, the development of relations as processes integrating innovation becomes indispensable.

Innovation has its place, which means it occurs in a given space, so innovation transfer is not possible if the other location lacks the organised innovation system. Several factors must contribute to the development of an innovative system, including social factors, which is another feature of innovation.

Innovation is a social phenomenon that implies the development of an innovation friendly culture, entrepreneurship, social approval and recognition of the key significance of innovation in economic development. Additionally, innovation has its cultural roots in the historical process, thus tradition and culture must be accounted for as culture may favour or hinder or even block the introduction of innovations.

While assuming Schumpeter’s concept of innovation, we cannot forget another feature – that of creative destruction. No doubt innovations destroy existing systems. In an enterprise, the introduction of an innovative product is connected with possible structural and management changes in the organisation. Referring to features mentioned earlier – the company standards and values, i.e. the corporate culture will be assigned vital importance.

Innovations allow companies to develop competitive capacity, but they are connected with risk and costs – the greater the more trailblazing the innovation. Though, on the other hand, lack of innovation is also a risk as it does not develop competitive advantage. In the case of developing innovations the risk is greater at the initial stage of research and development. Innovations require both public and private funding, with special emphasis on the latter. As research and adapting of innovation for practical application is costly and risky, international specialization plays a major role. Import of modern technology is often the cheapest and least risky method of gaining a competitive edge and of bridging technological gaps.
The timesaving factor in reaching the same results as compared with using domestic research potential is also important. Consequently, own scientific research development is often accelerated in the given field. The right decisions on acquiring, e.g. a license, to a great extent determines success, as does the awareness of the economic and social environment in a given country. The importance of innovation for economic development is unquestionable but the appropriate (effective and efficient) pro innovation policy\(^\text{27}\) is of key significance.

Summarising, innovation should be understood as an act of qualitative change in economy when the manufacture of a new product or implementation of a new process begins as well as the product or process itself.\(^\text{28}\) Drucker states\(^\text{29}\) that the innovation discipline, which involves knowledge that provides grounds for entrepreneurship, is a diagnostic discipline, systematically studying the areas of change, usually creating business opportunities both in the organisation and in its environment.

### 1.3. Innovation source

When defining innovation as the introduction of new solutions in technology, organisation and marketing, innovation potential is identified by; internal factors resulting from the capacity to activate existing resources in the economy, and external factors connected with imitation and adaptation of solutions from abroad. Innovations will be acquired thanks to own R&D projects and transfer of technologies and innovations as direct foreign investments, import of advanced goods including license agreements, franchising, acquisitions and strategic alliances.

Regular innovation will involve objective-driven organised search for change and continuous analysis of opportunities for social and economic innovations that could make the change possible. Thus, the sources of innovation will embrace areas related to developing and acquiring knowledge.

Innovation sometimes comes with inspiration and a flare of genius; however, most often it results from regular work based on analysing the following sources of innovation\(^\text{30}\) (see Fig. 2).

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\(^\text{27}\) Cf.: S. Pangsy-Kania, *Polityka innowacyjna państwa a narodowa strategia konkurencyjnego rozwoju*, Published by the University of Gdańsk, Gdańsk 2007.


\(^\text{29}\) P. F. Drucker, *Innowacja i przedsiębiorczość* ... , p. 44 and on.

The sources of innovation embrace all areas related to developing and acquiring technical knowledge. If the processes of integrating science, technology and production, the earlier mentioned innovation “clasps” are used for innovation purposes, we can speak of a research-innovation cycle that comprises several stages, which are the source of innovation\textsuperscript{31}. The results of own research and development projects (R&D) are considered to be the most important innovation source. In terms of R&D we can differentiate basic research and application and development studies. R&D involves regular creative work undertaken to develop expertise resources, including the knowledge of man, culture and society and to find new application for that knowledge. These cover three types of R&D activity, i.e. basic research (experimental and theoretical work undertaken to acquire new knowledge without looking for practical application) and applied research (original work undertaken primarily to acquire new knowledge with a specific application in view) and experimental development (work using existing knowledge gained from research for the purpose of creating new or significantly improved products, processes or services)\textsuperscript{32}. Innovative capacity depends on the openness of the system to knowledge transfer and R&D activity.

According to Oslo methodology\textsuperscript{33}, innovation sources include the following main kinds of innovation activity: R&D, purchasing of available knowledge in the form of patents, licences, technical services, etc. (the so called intangible

\textsuperscript{31} M. Piałucha, B. Siuta, Wspieranie procesów innovacyjnych w Polsce i krajach Unii Europejskiej, ”Biblioteka Menedżera i Służby Pracowniczej” 2001, z. 205, p. 43 and on.

\textsuperscript{32} Definicje pojęć z zakresu statystyki nauki i techniki, GUS, Warsaw 1999, pp. 20-23.

technology; purchase of tangible technology, i.e. innovative machines and devices, generally featuring better technical parameters, necessary to implement new processes and production of new products. This criterion may be linked with external sources resulting from international exchange, and in-house (domestic) sources.

The diversified location of technology and knowledge as well as the degree of economic development of a country mean that the method of narrowing the technological gap is a skilful combination of innovation sources, i.e. that of imported foreign technical thought and participation in international programmes and projects.

The concept of innovation sources presented by E. von Hippel, called “functional innovation sources” underlines the mutual functional relations of enterprises and institutions. Thanks to these relations, partners achieve various economic, technical and market benefits in the process of developing and implementing new technical solutions. A network of such mutual relations appears in the new models of innovation processes.

1.4. Innovation processes – from linear to system model

An innovation process is a creative activity that leads to the development and practical application of new technical solutions.

The innovation process was divided by R. A. Webber into three stages; the creative development of the concept, followed by verification of the proposal and problem solution and implementation of the product or process as an innovation. Richard L. Daft identified five stages of the innovative process: demand, idea, design, decision on application, implementation. Peter McGowan, on the other hand, gives a wide definition of the innovation process as creative activity aimed at practical application of creative ideas by noticing opportunities to meet market demand or the necessity to solve problems. The author emphasises that innovative ideas should be generated by enterprises in all areas of their operation.

Professional literature presents several innovation process models (see Table 2).

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Table 2. Innovation processes models

<table>
<thead>
<tr>
<th>MODEL GENERATION</th>
<th>TIME OF OCCURRENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology push innovation model</td>
<td>1960s</td>
</tr>
<tr>
<td>Market pull innovation model</td>
<td>1970s</td>
</tr>
<tr>
<td>Interactive (coupling) model</td>
<td>1980s</td>
</tr>
<tr>
<td>Integrated model</td>
<td>1990s</td>
</tr>
<tr>
<td>Simultaneous, system integration model</td>
<td>turn of the 20th and 21st centuries</td>
</tr>
</tbody>
</table>

Source: own study.

The period 1960-1980 was dominated by the linear innovation model. This is a process initiated by a scientific discovery followed by a number of development stages and completed by the final product entered on the market. Research and development is considered to be the necessary discovery work preceding innovation. This model accented the technology push aspect where the development of knowledge and techniques assuming the form of inventions, discoveries and theoretical development provide the original impetus. By emphasising the supply aspects, he limited the role of know-how in the production process, this being considered to be one of its drawbacks. Feedback between particular stages of the innovation process was also neglected. The model highlighted R&D and its importance in innovation processes. As R&D is not a prerequisite for innovation processes and the sole source of ideas, the linear model was rejected.

Apart from the technology push model, which carries considerable risk of market failure, there is a market pull model of the innovation process, which appeared in the second half of the 1960s as a result of growing competition and research studies on market demand, which brought to attention the role of demand factors in the success of innovations on the market.

Excessive simplification of the linear model as compared to the innovation process caused rejection of the model and its replacement in the mid eighties by interactive models. The first was the coupled interaction model by Kline and Rosenberg called “chain linked model”. The second is the “coupling model” by R. Rothwell and W. Zegveld. This model lays emphasis on the complexity of the innovation process and the need to fall back to earlier stages. This is connected with feedback of particular elements of the innovation process at the stage of development and diffusion. The first model presented innovation activity in terms of interaction between demand and opportunities created by the market and scientific and technical capacity of the enterprise. The most important element here is accumulated knowledge. The second model embraces internal and external relations with emphasis on design engineering, mutual feedback of market and technological engineering stages of innovation, the link between R&D, production and marketing and between companies and institutions. Emphasis is laid on the need to see new market opportunities or a new product in
designing an interactive innovation model. Studies on interactive models result from the coupling, the mutual feedback of science, technology and production.

The success or failure of a given innovation product depends on the enterprise’s capacity to maintain efficient relations between the particular stages of the innovation process, e.g. the integration of marketing with the technical aspects of the innovation process.

Further studies on the essence of innovations led to the development of the network concept. The development of information science, company management methods, dynamic development of new forms of cooperation in the late 1980s and early 1990s all contributed to the concept. In the network process characterised by progressively more complex external relations, the speed and efficiency of implementing innovations are significant and become key factors of competition in the increasingly complex and global markets.

Rothwell’s model of system interaction and networking combines the networking character of innovations and changes in innovation management in the enterprise. The system interaction and networking model lays emphasis on using modern technologies, electronic engineering and information technology. Moreover, innovative companies relying on lean management move towards more efficient time/costs grids in realising a new product.

The integrated model is characterised by a parallel development cycle, team integrations of R&D staff, strong linkage with suppliers, close coupling with key clients, emphasis on integrating R&D and production, designing that accounts for production capacity, horizontal collaboration, e.g. joint ventures.

If innovation involves materialising products and services, initiation of an innovation stream will require an innovation-friendly economic, social, cultural as well as legal and administrative environment.

Contemporary innovation processes are becoming more simultaneous and system oriented. This is a fully integrated model with a parallel development cycle based on networking, therefore, this model is often referred to as the networking model. It takes advantage of specialised systems and simulation modelling in R&D projects. Another characteristic feature of contemporary innovation processes is the strong linkage with clients. The consumer is considered to be the key to the strategy and a player on the innovation scene, together with science, industry, governmental authorities and infrastructural units for transfer.

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37 E. Stawasz, op.cit., p. 29.
of techniques. Strategic integration also embraces key suppliers that may become involved in developing new products. The significance of horizontal relations, which include R&D consortia, joint ventures and common market endeavours, continues to grow. Focus is geared at quality and other non-price factors. Innovation is a continuous process and the model of innovation processes is flexible.

According to the system model not only R&D have an impact on the innovation processes but the innovation process can influence R&D (market pull). Innovations may be created in the organisation itself or by the product user (user driven innovation).

Evolution of the innovation concept from the linear to the system innovation model evokes changes in innovation policies. Adoption of the system approach means the necessity to develop and implement a comprehensive innovation policy that results in more efficient, mutually supporting instruments. Modern approach to innovation processes and development of innovation policy requires an institutional approach and points to a significantly wider spectrum of study than the relation between supply and demand. Analysis of change that does not account for the role and special nature of innovations will be worthless even in the short run. The key issue will be the understanding of innovation sources and the technological change environment as the driving force.

The distribution of innovations is not balanced, in other words there is an unequal distribution of innovations, i.e. creativity. Development of innovative economy will be possible when a given country reaches a certain level of economic development. Innovative capacity of the economy is the ability and motivation of entrepreneurs to seek and forge into practice R&D results, new ideas, concepts and inventions. Innovative capacity means modernity, the ability to create, diffuse and imitate innovations. Innovations are the effects of an innovative process, which in modern economy takes the form of a set of complex processes.

1.5. Bibliography

7. Freeman Ch., *The Economics of Industrial Innovation*, Pinter, London 1982.

2.1. Introduction

Issues concerning transport and logistics, frequently considered jointly, are of interest to economists as well as engineers, since studies related to both economic and technical sciences have nearly become the norm in transport research. Characteristically, the research is orientated towards applications serving business and policy making, as well as vocational training for the sector which now constitutes 1/10 of total workforce in developed economies. Transport is the sector which implements innovation aimed at increasing efficiency and mitigating environmental impact. These innovations change the sector by influencing its competitiveness and productivity. The scope and intensity of conducted research is reflected in the numbers of publications - specialist bibliographical databases increase by tens of thousands of titles every year. Transport research findings may also be now located in bibliographical databases of economic sciences.

The development of transport with its significance for economic integration and public life, make it an area of constant, intense economic research and study, with transport economics becoming a growing branch of science. In Po-
land, attempts were made in the early 1990s to negate the sense of developing the so called ‘branch economics’, including transport economics. This resulted in cuts in research and academic education (e.g. “transport economics” was discontinued as a discipline). Today however, interest in the studies in the area of transport (and logistics) is on the increase while the development of the TLS (Transport & Logistics Sector) and its impact on the economy is an undisputable fact. Therefore, transport research in general, and research into transport economics and logistics in particular, seem to have good prospects for development. This is confirmed when generally available Internet content is examined, as well as specialist databases of scientific bibliography throughout the world. One may also notice public support for the development of transport research (at the levels of the European Union and the governments of its members). However, it seems that much remains to be done in Poland in this respect.

2.2. Transport as a subject of publications

Transport is a subject of intensive scientific studies at the level of both natural and social sciences. These works are increasingly frequently of interdisciplinary nature (though usually classified separately within the bodies of particular branches of science). The interdisciplinary character of the research is caused by multidirectional connections and significance of transport for the functioning of other economic and social systems, as well as low substitutability of transport (as a whole). In particular, transport is the focus of interest of transport economics, equipped with operational techniques which can fill the gaps apparent in classical economic models, which barely if at all, take into account common characteristics of business activity – distance and area. Transport economics, be-

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5 If F.A. von Hayek is right that economics can be described as “a meta-theory of those theories, which were formed in order to explain how various means to reach diverse goals may be most efficiently obtained” (F.A. von Hayek, Zgubna pycha rozumu. O błędach socjalizmu, Arcana, Kraków 2004, p. 150), then one has to say without false modesty that studies in transport economics should play a leading role in the area of transport research.


5 Transport makes up 8-10% GDP of European economies, its a sector where about 15% of household spending is made and which has a decisive role in international trade - not just by having shares in it but due to the fact that without transport international trade simply does not exist: E. Quinet, R. Vickerman, Principles of Transport Economics, E.Elgar, Cheltenham (UK) – Northampton (USA) 2004, pp. 3-5.

6 Unfortunately, the so called spatial economics and classical location theory have not remedied those shortcomings, therefore the development of regional economics (alongside transport economics) – M. Blaug, Teoria ekonomii. Ujście retrospektywne, PWN, Warszawa 2000, p. 633, pp. 648-650.
cause of its applicability, cannot ignore in its research the issues of management and regulation of business activity\textsuperscript{7}.

Table 3. Occurrence of transport-related terminology on the Internet – comparison of Polish and English language pages (2007)

<table>
<thead>
<tr>
<th>Phrase</th>
<th>Pages in Polish</th>
<th>Pages in English</th>
<th>Relative rate of occurrence in Polish (in relation to the occurrence of the phrase “transport”)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport (Eng. transport)</td>
<td>1 820 000</td>
<td>235 000 000</td>
<td></td>
</tr>
<tr>
<td>Logistyka (Eng. logistics)</td>
<td>1 400 000</td>
<td>21 000 000</td>
<td>8,61</td>
</tr>
<tr>
<td>Polityka transportowa (Eng. transport policy, transportation policy)</td>
<td>66 200</td>
<td>2 160 000</td>
<td>3,96</td>
</tr>
<tr>
<td>Ekonomika transportu (Eng. transport economics, transportation economics)</td>
<td>853</td>
<td>529 000</td>
<td>0,21</td>
</tr>
<tr>
<td>Efektywność transportu (Eng. transport efficiency)</td>
<td>315</td>
<td>266 000</td>
<td>0,15</td>
</tr>
<tr>
<td>Integracja transportu i integracja systemów transportowych (Eng. transport integration, integration of transport)</td>
<td>743</td>
<td>183 000</td>
<td>0,52</td>
</tr>
<tr>
<td>Liberalizacja transportu i deregulacja transportu (Eng. transport liberalisation, transport deregulation, transport deregulation)</td>
<td>584</td>
<td>34 100</td>
<td>2,21</td>
</tr>
<tr>
<td>Konkurencyjność transportu (Eng. competitiveness of transport, competitiveness of transportation)</td>
<td>465</td>
<td>12 060</td>
<td>4,98</td>
</tr>
<tr>
<td>Ekonomika logistyki (Eng. logistics economics, economics of logistics)</td>
<td>279</td>
<td>1 618</td>
<td>22,26</td>
</tr>
</tbody>
</table>

Source: own research based on search results of selected phrases through the Google search engine (www.google.pl), the search was conducted on May 13th. and 14th, 2007.

Transport-related problems are the subject of countless publications all over the world (those of scientific nature are only a part of the whole output). Also in Poland, dozens of books and articles on the broadly defined topic of transport are published\textsuperscript{8}. The degree of interest taken in transport all over the world is illustrated by the number of websites located through the most popular search engine – Google. Table 3 presents the results of searching particular phrases related to transport and logistics, with the search limited to pages in Polish and

\textsuperscript{7} A. S. Grzelakowski, 

\textsuperscript{8} The specialist publishing house “Wydawnictwa Komunikacji i Łączności” in Warsaw alone, which specialises in publications from the fields of motoring, telecommunications, electronics, road building and aviation, has so far issued over 10,000 books with a total circulation of more than 145 million – http://www.wkl.com.pl/owydawnictwie.php?, as of 16.05.2007.
As can be seen, the phrase “transport economics” appears on English language pages much more often than on those in Polish (as a result, among the seven specific phrases, it shows second from top in English, but second from bottom in Polish). The term “logistics”, however, is used much more frequently in Poland – and probably inadequately in many cases. In analyzing the search results, one might pay attention to the significantly more frequent occurrence of the phrases “transport efficiency” and “transport integration” on pages in English than on Polish ones.

The approximate number of publications (in various languages) dealing with transport research is given by the Online Computer Library Centre (OCLC), where information about resources comes from 57,000 libraries from 112 countries. In this database, the key word “transport” gives over 41,000 results, while the key phrase “transport economics” results in 9,200 hits. The database includes numerous publications in Polish (as well as those published in Poland in other languages). In the specialist “transport” database - the Transportation Research Information Services (TRIS – USA), there are 640,000 pieces of bibliographical information available, with the base growing at the rate of 25,000 entries a year. The base is maintained with financial support of the US Government. In other databases covering various branches of science, the field of “transport economics” is noticeable as well: in the databases of EBSCO there are over 42,000 publications containing the key word “transport”. In the PROQUEST service, transport is the subject of over 21,000 publications, while

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9 In order to ensure the comparative value of the ranking, relative occurrence (C) of particular phrases was presented (calculated as the proportion of occurrences of the phrase in Polish to the occurrences in English, and referring the result to the occurrence of the word “transport” in Polish and in English): Where: \( f_p \) and \( f_a \) represent search results for a given phrase in Polish and English respectively, with \( F_p \) and \( F_a \) being the results for the word “transport” in Polish and English respectively.

10 One has to bear in mind that the word “transport” is also used by such branches of science as physics or medicine – www.oclc.org/about/default.htm, as of 06.05.2007.

11 For instance such key words as “transport economics” give 72 results and among the publications there are books by such authors as J. Burnewicz, W. Grzywacz, B. Liberdzki, P. Malek, A. Piskozub, D. Rucińska, W. Rydzewski, K. Szalucki, I. Tański, and many others. There are publications from the 1970s but also most recent ones from 2006 http://worldcat.org/search?q=ekonomika+transportu&fq=ln%3Apol+%3E&sd=desc&qt=first_page, as of 06.05.2007.

12 The system is available on-line in a freeware version – http://ntlsearch.bts.gov/tris/index.do, as of 09.05.2007.

13 Searches of databases subscribed to by the University of Economics in Katowice carried out on 05.06.2007.

14 Records contents of approximately 8000 scientific journals from the fields of humanities, social sciences, engineering, computer science, linguistics, arts, medicine, ethnic studies – www.bg.ae.katowice.pl, as of 06.05.2007.

15 Includes three bases: ABI/INFORM Dateline – offering access to complete texts of articles from over 170 local and regional business publications from the United States and Canada. The list of publications includes newspapers, journals, periodicals and agency news. ABI/INFORM Global – the base indexes over 2800 journal titles, of which 1245 contain full texts and 78 have complete archives. ABI/INFORM Trade & Industry – includes over 7000 leading journals in trade and various industries, www.bg.ae.katowice.pl, as of 06.05.2007.
in the Emerald Management Xtra\(^\text{16}\) database the key word “transport” generates 325 publications, appearing in all the fields 5494 times.

A significant proportion of publications on transport are not readily available. A major part of research in the field of transport appears in the form of various papers published in conference proceedings or bulletins of various institutions. Quite frequently, the results of research ordered by various institutions are not published at all – at least not in their entirety. These publications are difficult to obtain, frequently being referred to as “grey literature”. It may be assumed that grey literature accounts for more than 50% of all publications on transport, e.g. in 1998 reports alone made up 88% of publications on transport in Sweden, with the percentage ranging from 30 to 60% in other countries.\(^\text{17}\) The significance of grey literature is further proved by the fact that over 90% of quotations in the literature of the European countries studied come from such sources.\(^\text{18}\)

2.3. Transport research in Europe

A significant proportion of global research activity in the area of transport concentrates in Europe. The research inspiring role of the institutions of the European Union and the research programme of the British Department of Transport will be presented as examples of such activity. Research done under EU auspices (mostly framework programmes) have a relatively wide influence and bring together specialists from various countries. These programmes also represent a chance for research development in Poland. The UK government programme, on the other hand, appears to be an interesting example of public support for research in a liberal economy. This example can serve as an inspiration in Polish realities – and the heart of the matter here is by no means simply increasing research spending but rather giving proper direction to the studies and an active role of the Ministry of Transport in initiating such research and disseminating the results.

\(^\text{16}\) The service offers access to electronic versions of 125 scientific journals from the fields of accounting, finance and legal issues; economics and social policy; education and health care management; information and knowledge management; innovation and business, international business; human resources, quality, logistics and productivity management. In addition, the service contains full archives of 32 journal titles – www.bg.ae.katowice.pl, as of 06.05.2007.


\(^\text{18}\) This is probably the reason why only a small percentage of quotations in various reports on transport come from a different language than the language of the publication – ibid.
The European Union, being an area of economic (and social) integration, is for obvious reasons interested in transport development. As a result, transport research is intensive and strongly represented in framework research programmes, as well as in other projects, directly or indirectly funded by the EU. According to the information from the Transport Research Knowledge Centre (TRKC – on the Internet pages of the European Commission) out of 5,613 described research projects, 994 consist of projects funded by the EU with 28 receiving financial support from other organizations or international programmes\(^\text{19}\). The remaining ones, documented by the TRKC rely on funding provided by specific countries or public funds; however they are conducted within an area of interest to the European transport policy.

The projects financed through EU framework programmes, constitute a separate category in transport research. The Fourth EU Framework Research Programme (1994-1998) contained individual TRANSPORT programme consisting of projects in the following areas of research: strategy, integration and individual types of transport (rail, road, air, water and urban)\(^\text{20}\) with 21 (rail) to 55 (waterborne transport) projects executed within each of the sectors. Within the next Fifth Framework Research (1998-2002), research in the field of transport was also conducted. The biggest number of transport research projects was allocated to the GROWTH Programme (“Competitive and Sustainable Growth”) in the following areas of research: sustainable mobility and intermodality (52 projects), technologies of land and maritime transport (45 projects)\(^\text{21}\). The Sixth EU Framework Programme (2002-2006) lists within activity area no. 6 (“Sustainable Development, Globalization and Ecosystems”) subject priority no. 6.2 “Sustainable Land Transport”\(^\text{22}\). The following areas of research were specified within that priority\(^\text{23}\):

- new technologies and concepts of transport development;
- advanced design and production methods in transport;
- balancing and integrating various modes of transport;
- increasing safety and limiting congestion.

Apart from Priority 6.2, transport research was also conducted within Priority 4 “Aeronautics and Space”, where issues connected with air transport were placed\(^\text{24}\). Within these two priorities, in the direct field of interest of the Euro-

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\(^{19}\) Including ECMT – European Conference of Ministers of Transport, TEDIM – Telematics in Foreign Trade Logistics and Delivery Management in the Baltic Sea Region (partnership programme of Baltic countries), DEUFRAKO – bilateral Franco-German programme associated with Predit [France] and Mobility and Transport [Germany]. http://ec.europa.eu/transport/extra/web/projects_database.cfm, as of 07.05.2007.

\(^{20}\) http://cordis.europa.eu/transport/src/project.htm, as of 07.05.2007.

\(^{21}\) http://cordis.europa.eu/growth/src/proj-fp5.htm, as of 07.05.2007.

\(^{22}\) Structure of VI Framework Programme – see http://cordis.europa.eu/fp6/activities.htm, as of 08.05.2007.

\(^{23}\) http://cordis.europa.eu/fp6/sp1_wp.htm#sustdev2, as of 08.05.2007.

\(^{24}\) http://cordis.europa.eu/fp6/activities.htm, as of 08.05.2007.
Commission’s Directorate-General Energy and Transport is research concerning:

- technologies and concepts of “clean” urban transport,
- revitalization of the rail,
- intermodal transport and logistics,
- safe, efficient and interoperable water transport,
- strategies of increasing safety of road transport;
- road tolls;
- funding transport infrastructure;
- air transport management;
- airport efficiency.

Projects of the Sixth Framework Programme are in progress, while research within the Seventh Framework Programme (2007-2013) is in its organizational phase. Transport research (both land and air) is clearly marked as a separate segment within the latter, with an earmarked budget of €1,160 billion euro. The research goal is to “develop safer, greener and smarter transport systems for Europe that will benefit citizens, respect the environment, and raise the competitiveness of European industries in the global market.”

Listed as primary research areas are the following:

- aeronautics and air transport (including among others reduction of emissions, air traffic management, safety, efficiency),
- sustainable surface transport (including among others, development of clean transport technologies, reducing the negative impact of transport on climate change, intermodality of transport – also in regional aspect).

As can be seen in the presented overview, the European Union actively supports (also financially) research in the field of transport. The subject of transport is regularly represented within research priorities in successive framework programmes. It should also be added that transport research is conducted on the EU imitative also outside framework programmes – among others, within the scope of EU policy implementation (e.g. within preparatory work connected with implementation of various projects). Furthermore, the EU finances initia-

26 It is a clear increase in over VI Framework Programme – see budget http://cordis.europe.eu/fp7/budget_en.html, as of 08.05.2007.
27 http://cordis.europa.eu/fp7/cooperation/transport_en.html, as of 08.05.2007.
28 Ibid. see also the page of National Contact Point in Poland for EU Research Programmes – http://www.kpk.gov.pl/7pr/struktura/1-7.html, as of 08.05.2007.
29 For instance, research activity of the University of Economics in Katowice, working in a knowledge network, connected with the project “Silesian Cluster – Intelligent Public Transport Management System” (“Śląski Klastër – inteligentny system zarządzania transportem publicznym”), financed through the European Social Fund within IOPRD. The project is carried out by the Urban
tives of member states and associated countries in the area of EU policy implementation- the ERA-NET TRANSPORT (ENT) initiative may be given as an example – it is a scientific transport research network created in 2004, mostly by the ministries of transport of 10 European countries (not only EU members).  

Despite considerable output produced by the EU research policy, one should be aware that it represents only a segment of transport research activity in Europe. Most of the research is conducted for various public and private clients, as well as for educational purposes. In particular, it is government institutions which commission such research, especially ministries of transport. Activities of the British Department of Transport may be given as an example. The research commissioned and conducted by the DfT is to play a role in the implementation of the United Kingdom transport policy until 2030 ("The Future of Transport. A network for 2030"), including:

- congestion reduction;
- greater availability of transport;
- improved safety;
- environmental impact reduction;
- economic development.

The above mentioned research priorities are carried out with active support of DfT, which organizes, among others, information exchange between research centres, collects and provides statistics, as well as directly initiates research projects in the area of new technologies and transport processes (within the scope of various disciplines – not only technical and economic sciences but natural sciences as well. DfT also prepares reports concerning:

- transport modelling;
- economic and economic policy analyses;
- studies on the impact of regulation;
- social and operational analyses.

The activity of DfT is also noticeable in the form of public consultations, conferences and workshops, knowledge management (including databases), publications and information presented through the Internet. The DfT Internet site contains a large amount of detailed information, with even more advanced information and services available to authorized users. It seems that such activity

30 http://www.transport-era.net/about-ent.html, as of 10.05.2007.
33 Ibidem, p. 21.
34 DfT as a public institution is bound by the Freedom of Information Act 2000 – “the FOI Act”, more on the subject: http://www.dft.gov.uk/foi/, as of 09.05.2007.
may serve as an example of carrying out the transfer of knowledge requirement within the European Research Area\textsuperscript{35}.

2.4. Transport as a field of scientific research in Poland

Research in the field of transport and logistics has been conducted for many years also in Poland – as the activity of specialized research institutes, as well as higher learning institutions: universities (Gdańsk, Szczecin), technical universities (majority), economic universities (Warsaw School of Economics, University of Economics in Katowice and Poznań Economic University) as well a military academies. Transport as a field of research has also been included in theNational Framework Programme (Memorandum No 1 issued by the Minister of Science and Informatization on 21.09.2005 announcing the National Framework Programme\textsuperscript{36}), wherein “transport infrastructure” was identified as one of nine strategic research areas (next to: health, environment, agriculture and food, state and justice, security, information technology, energy and resources), with priority assigned to:
- elements of construction, operation and safety of transport systems and resources,
- transport process management systems\textsuperscript{37}.

Research in the area of transport economics is also conducted in Poland\textsuperscript{38}. In reviewing the work in the field one may risk saying that the standards are high.


\textsuperscript{36} Official Journal of the Minister of Science and Informatization No 10, 2005, Item. 47.

\textsuperscript{37} This direction “includes modern transport systems, as well as intelligent transport information and management systems. The main issue is full integration in the management of transport processes in Poland and ensuring their compatibility with the EU systems. Thanks to the studies conducted, it will be possible to increase transport interoperability and ensure compatibility and complementary character of various types of transport. The studies will allow for increase in operative- ness of various modes of transport and combining them into uniform regional and national systems” – Krajowy Programme Ramowy. Zasady, procedury i lematyka (“National Framework Programme – Procedures and Topics”), Minister Edukacji i Nauki, Warszawa 2005, http://www.nauka.gov.pl/mein/gAl- lery/15/20/15203/Krajowy_Programme_Ramowy.pdf, as of 09.05.2007.

\textsuperscript{38} Currently, according to the data of Information Processing Centre at the Ministry of Science and Higher Education (Ośrodek Przetwarzania Informacji przy Ministerstwie Nauki i Szkolnictwa Wyższego), there are 177 economists in Poland with a doctoral degree, who list transport economics among their research interests, out of this number, at least 71 have an associate professor title. In the area of technical sciences, 498 persons are active in the field of transport, with some of them listing as their area of study transport simultaneously with the term ‘economics’ or ‘organization and management’. Therefore, it may be concluded that in total there over 600 scientists active in the field of transport recorded in the databases of the Information Processing Centre – www opi.org.pl, as of 09.05.2007.
– a direct result of research which has been developing for decades – especially in the research centres of Gdańsk, Warsaw and Szczecin. However, the overall picture of modern research in transport economics in Poland remains quite complicated. Political and economic transformation resulted in initial treatment (in the 1990s) of the discipline as a relict of the former era. As a result, education in the field of transport economics was abandoned in favour of regular research activity in other fields, with the prevalent view that transport economics was not a very promising field of scientific pursuit. By contrast, the attitude abroad was completely the opposite – as a result, while so much is happening in international research on transport and transport economics, Poland is trying to make up for the wasted time and is only beginning to regain its former research dynamics.39

No research policy is conducted in Poland concerning transport or transport economics.40 While it is true that during a seminar organized by the Ministry of Science and Higher Education in November 2006, the Polish Ministry of Transport presented “The programme of Polish scientific research in transport for 2007-2013”41, these plans have not been made any more specific (especially in terms of funding) and the programme has not taken the form of an official document of the Ministry of Transport (it is not even available on the MT website). Much remains to be done also in the area of research results dissemination, the fact easily confirmed by analysing the website of the MT and comparing it with the web content of DfT: in the section “Policy Documents and Reports” most recent entries are from 06.09.2006 (occasionally some more up-to-date documents can be found on the sub-pages of the transport modes), and in the part “Analyses” only one document entitled “Study of pilotage characteristics of glider SZD-30 ‘Pirat’” is available.42 Internet access to the Ministry of Transport information has to be evaluated as very poor.43 On the other hand, activities of

39 Example of such research development is the University of Economics in Katowice where the Department of Economic Logistics (Faculty of Management) and the Department of Transport (Faculty of Economics) are among the strongest academic organisations in terms of personnel and publications. Their high level of scientific activity may be illustrated by the fact that in 2007, the employees of these units obtained two out of three grants awarded by the rector for studies following the priorities of the VII EU Framework Programme – http://www.ae.katowice.pl/?contentid=1080, as of 09.05.2007.

40 In view of public involvement in transport management and the scale of public spending on transport, it seems justified to expect a policy document with clearly-defined priorities and a programme of research projects to be commissioned.

41 Identified as research priorities were strategic planning and transport policy tools, construction and maintenance of transport infrastructure, modal split and mobility policy, environment-friendly transport solutions, sustainable urban transport, increased traffic safety, development of intelligent transport systems – http://www.nauka.gov.pl/mein/redir.jsp?place=galleryStats&id=20435, as of 09.05.2007.

42 http://www.mt.gov.pl/, as of 09.05.2007.

43 The MT website not only lacks information about research results but fails to mention the Main Transportation Library of the MT as well. The library is a collection of specialist knowledge in the
the Central Transport Library operating under the auspices of the Ministry of Transport should be appraised, since it holds and makes available specialist publications on transport. The collection has nearly 50 thousand volumes.

Transport research conducted in Poland may be classified in the following manner (apart from initiatives by individual researchers):

- research initiated within the EU Framework Programme – in cooperation with international centres – Polish centres, however, are not project leaders;
- research financed by the Ministry of Science and Higher Education (the so-called KBN grants, as well as projects initiated in research units – for example, statutory research by units of higher education institutions);
- research commissioned by both public and private sector.

It is difficult to paint a uniform picture of research activity in transport in Poland. The fact remains however, that in European scale Polish research units play the role of subcontractors. Grants from the Ministry of Science and Higher Education (the so-called KBN grants) in the field of transport’s economics are also scarce when compared with the existing research potential – according to figures from the Information Processing Centre of the Ministry of Science and Higher Education, only 11 projects of the type were undertaken.

According to Transport Research Knowledge Centre, only 29 “transport grants” were available in Poland prior to 2005 (the list makes no mention of transport economics projects).

2.5. Innovation in transport

Transport is an area of dynamic technological development, which is also accompanied by innovation in the field of organizing transport processes (as well as logistics). The innovative nature of transport is rarely questioned. Innovation

field of transport. Moreover, in comparison with the DfT page, on the day of conducting the comparison the MT portal worked much more slowly; DfT pages would open nearly instantly while MT’s required waits of at least several seconds (as long as 15-20 seconds to get to the main page and certain sub-pages) - the comparison was made on 09.05.2007 at 2:45 p.m.

45 MOTOS (Transport Modelling: Towards Operational Standards in Europe) may be an example of such a project executed within VI EU Framework Programme, its leader is a Dutch consultancy Goudappel Coffeng and one of the entities executing the project is a transport economics research centre from Warsaw (Ośrodek Badawczy Ekonomiki Transportu) – http://www.motosproject.eu/?po_id=partners, as of 05.05.2007.
46 http://nauka-polska.pl/, as of 16.05.2007.
is, in particular, the response to the needs arising where transport interacts with its environment – to reduce congestion, improve safety, provide better environmental protection. Diffusion of innovations in transport depends on (and is reinforced by) the competition on transport markets, as well as growing regulatory requirements concerning safety and the environment, in addition to growing efficiency and development potential brought on by new information and telecommunication technologies. Identification and ranking of innovations is also of interest to researchers – including the scope of projects financed within the Framework Programmes of the European Union, as well as foresight programmes, in which assessment of key technologies and innovation is made in a 20-30 years’ perspective and the methods used mitigate the uncertainty of forecasting.

In 2000, the research programmes FANTASIE (“Assessment of new technologies and environmental issues”) and RECONNECT (“Reducing congestion by introducing new concepts of transport”) recognized the following technologies as sources of innovation in transport and logistics:

- alternative propulsion, such as fuel cells and hybrid engines;
- solutions enhancing efficiency and mitigating impact of air transport development on the surroundings;
- technologies increasing intermodality;
- IT and telematic technologies improving transport safety and efficiency, particularly in:
  - on-board information and navigation systems;
  - electronic toll collection and traffic control systems;
  - accident-risk mitigation through automation of driving;
  - fleet management systems leading to higher productivity.

Similar conclusions are also reached within the framework of foresight programmes carried out by various countries, which indicate that the following technologies – sources of innovation in transport and logistics – offer a promising outlook for the future:

- development in the field of propulsion;
- telematics;

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49 Foresight – ability to think ahead, to foresee “Foresight is a systematic way of creating medium or long term vision of developing scientific and technical policy, its directions and priorities, used as a decision-making tool and rallying joint action” – http://foresight.polska2020.pl/mis/pl/oprogrammeie/idea.html, as of 05.05.2006.
51 Projects carried out in the IV EU Framework Programme were led by the German company Industrieanlagen Betriebsgesellschaft Mbh in 1997-200 and in 1998-2000, www.cordis.lu, as of 30.04.2007.
- toll-collection systems for road infrastructure;
- technologies of organizing the movement of vehicles, people and cargo (especially intermodal ones, as transport integration processes are believed to develop)

An independent regional foresight programme conducted in the Silesian Province since 2006 (entitled “Technologies of priority for sustainable development of the Silesian Province”)\textsuperscript{54}, defines key transport technologies somewhat differently, from the point of view of this rather specific region\textsuperscript{55}:
- technologies of intermodal passenger transport,
- technologies of logistics (leading to cargo transport integration, among others);
- Intelligent Transport Systems (ITS);
- alternative propulsion technologies;
- technologies of protecting transport infrastructure from mining damage (this is quite unique – usually technologies are sought protecting the surroundings from transport, not the other way round).

Elements identified by all the foregoing research programmes are innovation with a heavy impact on transportation in the following areas:
- telematics (including ITS);
- propulsion;
- protecting the surroundings from negative effects of transport operations;
- organization – especially measures enhancing transport integration and competitiveness.

Despite the fact that innovation is often associated with technology, many transport innovations are linked to organizational issues. Examples illustrating the fact may be found not only in logistics solutions, but also in those concerning urban transport policies\textsuperscript{56} or carsharing systems\textsuperscript{57}.

\textsuperscript{54} Project is financed by Sectoral Operational Programme “Improvement of Business Competitiveness 2004-2006” (Measure 1.4.5 entitled: “Research projects in technological development foresighting” (“Projekty badawcze i celowe w obszarze monitorowania i prognozowania rozwoju technologii”) http://www.roz4.woiz.polsl.pl/foresight/index.html, as of 06.05.2007.
\textsuperscript{57} An example of recognizing carsharing as this type of innovation is provided by the publication of S. Feitler, Les systèmes de voitures partagées, chaînon manquant entre le transport en commune et la voiture particulière, “Réalités Industrielles” November 2003, pp. 94-100.
2.6. Bibliography

Chapter 3
INNOVATION POLICY IN TRANSPORT
(Piotr Niedzielski)

3.1. The significance of innovation policy

The term innovation policy indicates, by the word “innovation”, the subject of operation i.e. the problems and issues we wish to affect. In macroeconomic terms it involves regulatory measures of the state towards both physical and legal persons involved in innovation processes. The aim of these measures is to influence innovation processes to ensure “competitive growth of domestic entrepreneurs and efficiency of public services and consequently to improve living standards of society especially in terms of prosperity, quality of the natural environment, healthcare and protection against extraordinary hazards”\(^1\).

A regulatory measure enacted by the government is systematic support of innovation activity mainly within the framework of innovation policy. The latter is most often defined as measures undertaken by the state and other public institutions supporting research development and implementation of scientific research results, knowledge achievements, inventions and improvements. State innovation policies integrate elements of science and technology policy and industrial policy, which have an impact on the trends and dynamics of creation processes, implementation, application and dissemination of new technical, technological and organisational solutions\(^2\). Therefore, state innovation policy

\[\text{Principles of the State’s innovation policy to the year 2002, Governmental document approved by the Council of Ministers on 6 December 1999, KBN, Warsaw 1999, p. 5.}\]

\[\text{According to S. Korenik, the concept of innovation policy is linked with science policy. He emphasizes, however, that innovation policy is part of the concept science policy: “Science policy is usually defined as measures undertaken by the state and other public institutions targeted at science which contribute to optimal economic growth and social development with optimal use of resources for scientific research”. The author notes that the term science policy, its scope and subject have not been clearly defined in literature. This definition of science policy does not embrace all innovation.}\]

41
stems from the economic policy\(^3\), or in wider terms, the socio-economic policy, of which it is a component and derivative as shown in Fig. 3.

State innovation policies, in practice, take on two forms: national and international\(^4\). The national innovation policy is generally targeted at developing and stimulating the development of the domestic innovation system. Transnational innovation policy is the consequence of global economy and the necessity of innovation processes because it focuses primarily on scientific research, neglecting or marginalising, e.g. diffusion and absorption of innovation processes. \(\)Polityka gospodarcza..., pp. 395–396.\(\)


\(^4\) Determinanty innowacyjności..., p. 54.
tegrating national economies into strong cross national economic bodies. The state innovation policy focuses mainly on:

- setting the direction and structure of research;
- educating scientific and managerial staff;
- developing research and development infrastructure;
- determining and shaping resources required to achieve specified innovation objectives, and their allocation;
- developing a friendly environment for the application and dissemination of research and development results as well as their protection against competition;
- developing international cooperation in science and technology;
- developing information and advisory systems.

At the macroeconomic level, innovation policies aim at goals of the following nature:

a) horizontal – referring to long periods, accounting for the dynamics of change; with special importance assigned to support of scientific research as well as research and development work;
b) sectoral, supporting innovation activity in economic sectors of strategic importance for social and economic development of the country in a long term perspective. Sectors impeding social and economic development in long term perspective (the so called declining industries that require more and more subsidies and show dwindling efficiency in resource management) are limited by resource allocation;
c) regional, assisting economically underdeveloped regions taking into account their resources (human, infrastructural, natural, geographical and cultural etc.).

Innovation policy is a relatively new area of social and economic policies, however, changes in development trends, goals and implementation methods are conspicuous, S. Pangsy-Kania identifies three generations of innovation policies, primarily in terms of the impact of the policy itself and its potential instruments on innovation processes (see Fig. 4). The first generation model focuses on support for scientific research units and universities, i.e. units which

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6 W. Grzywacz: Społeczno-gospodarcze problemy..., p. 106.

7 The fundamentals for developing innovation policies were made in the fifties of XX century. More in Polityka gospodarcza, op. cit., p. 395.

The second generation policy concentrates on the players of innovation processes (with reference to the chain linked model), their networking and the role of infrastructure. It also appreciates the value of assistance at the regional and local level and in consequence leads to development of regional support institutions. Decentralisation and focus on mezoeconomics result in the identification of clusters as the key factors for innovative development of regions. Growing importance is also attributed to Regional Innovation Systems (RIS).

The third generation innovation policy has not yet fully developed, but has taken the form of goals and development trends that this policy should adopt.

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9 A cluster is a geographical concentration of mutually linked companies, specialised suppliers, service providers, companies operating in related sectors and related institutions (e.g. universities, standardisation units and sectoral associations) in particular areas both competing and cooperating with each other. More in M Porter: M Porter, The Competitive Advantage of Nations, The Free Press, A Division of Macmillan, New York 1990. More on the subject of clusters in paragraph 22.3 of this study.

10 Regional Innovation Strategies are described in section 22.3.2 of this study.
The ongoing processes in contemporary economy, particularly the shift to knowledge-based economy, constitute the core that affects the shape of innovation-driven postulates. Thus, we can state that emphasis is put on the key importance of innovation in all economic sectors, science and public life, and innovation policies assume a more progressing horizontal and interdisciplinary character.

The main goal of macroeconomic innovation-oriented measures is greater competitiveness of the national economy, in practice however, this is a bundle of objectives. This classification of macroeconomic innovation policy goals has been adopted by OECD countries: It involves the following group objectives:

a) military, in terms of greater national defence capability;
b) social, in terms of better healthcare, protection of the natural environment, improved occupational safety and work hygiene as well as social protection of employees and protection of the living standards of the nation (food management, housing, etc.);
c) economic – aimed at rationalising the use of resources and competitiveness of the national economy;
d) scientific – aimed at improving efficiency of research activities and the conditions for their development.

By adopting state innovation policies, economic policies are to improve innovative capacity of the entire economy, defined as the capacity and motivation of entrepreneurs to continuously look for and apply the results of scientific research and development, new concepts, ideas, inventions, improvement and development of applied production technologies for tangible and intangible products (services), introduction of new organisational and management methods and techniques, upgrading and development of infrastructure and knowledge resources. The following should therefore be deemed as the most important:

– the development of mechanisms and structures favouring innovative measures;

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11 The main objective written, as for example, ensuring prosperity of the people and social and economic development of the country by, inter alia, growing competitiveness of the national economy, can be called a mission. Gaining competitive advantage is strictly linked to comparative advantages resulting from specialisation in the international division of labour. These advantages result from a relatively auspicious possession of production factors by a given state and the appropriate cost/demand structure, the economies of scale effects, etc. The theory of comparative costs was developed by D. Ricardo. Cf.: W. Grzywacz: Współczesne problemy..., pp. 46–47.
12 Polityka gospodarcza..., p. 397; Nowe tendencje w polityce naukowej krajów OECD. Warsaw 1972, p. 6.
14 “Thanks to an adequate innovation policy and related financial mechanisms, Poland has an opportunity to evolve from an agricultural and heavy industry country into one manufacturing highly
- the shaping and consolidation of innovative attitudes in the economy;
- the improvement of the efficiency and effectiveness of modern solutions in the entire economy.\(^{15}\)

The assumptions and goals of the innovation policy of the state are implemented by economic and financial economic policy instruments as well as by legislative and structural solutions. The state may influence directly or indirectly the achievement of adopted goals.\(^{16}\) We can identify the following three types of state innovation policies:\(^{17}\)

a) participatory – direct measures enacted by specialised institutions to finance scientific research and direct financial support for innovative processes in enterprises (covering fully or in part the cost of research, implementation, modernisation of equipment, etc.);

b) regulatory – indirect activities of the state such as adoption of legislative measures;

c) supportive – influencing entities that implement innovation processes by:
- institutional assistance, by assigning financial means to selected institutions (entity-targeted),
- support to projects, involving grants for research projects selected from amongst governmental research projects or high priority projects.

The effectiveness of implemented innovation policies can be measured by various indicators, e.g.:
- GDP per capita growth;
- growing exports, including exports of advanced technology product group;
- falling manufacturing costs,
- growing share of new and upgraded products in total sales;
- falling wear-and-tear of machinery and equipment;
- falling unemployment rate.\(^{18}\)

\(^{15}\) http://www.mg.gov.struktur/DSG/sg_innow/menu.htm.

\(^{16}\) The French model is an example of direct solutions. To implement the pro-innovation policy France established an Agency for Valuation of Research and a Fund for Scientific and Technological Research. Thanks to these institutions, inventions are implemented with partial participation in research and implementation costs, etc. The French model was also applied in the US. The indirect action of the state on innovation policies is adopted by the British and Dutch model, where innovation activity is stimulated by, \textit{inter alia}, tax rates.

\(^{17}\) Polityka gospodarcza..., p. 399.

\(^{18}\) It should also be noted that more innovative economy contributes to improved productivity and consequently, the loss of jobs. Innovation-related increase in employment is strictly connected with the growing competitiveness of the economy, both in domestic and international terms. Growing domestic competitiveness means production countering imports and development of the domestic market by the higher purchasing power of the society and their growing needs. A rise in external
3.2. European Union innovation policy

Initiatives undertaken within the European cooperation framework point to three development stages that had an impact on the EU policy regarding research and development work:

– The years 1952-1973 – research carried out on coal and steel, peaceful application of nuclear energy and agriculture-related research;
– The years 1973-2002 were the years of a common policy regarding science and technology. Initiated implementation of research programmes based on sharing costs by research centres and interested enterprises, *inter alia* FAST, ESPRIT and RACE;
– Since 2003 – further integration on scientific research endeavours and the establishing of the European Research Area (ERA). The concept was adopted at the Lisbon Council meeting in March 2000. Its essence involves the creating of the European area enabling seamless interaction and freedom of movement for researchers to share and benefit from R&D progress. The key instruments are the upgraded Framework Programmes\(^\text{19}\).

### Table 4. Key documents affecting the European Union innovation policy

<table>
<thead>
<tr>
<th>DOCUMENT TITLE</th>
<th>MAIN PRINCIPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single European Act (“Research and Development”)</td>
<td>Strengthening scientific and technical grounds for European industry and support for the development of its international competitiveness</td>
</tr>
<tr>
<td></td>
<td><em>Adoption of long term framework programme</em></td>
</tr>
<tr>
<td></td>
<td><em>Joint research and technological development</em></td>
</tr>
<tr>
<td>Treaty on European Union (Maastricht) (“Research and technology development”)</td>
<td><em>Extension of the Single European Act: Emphasis on research centres and universities as well as the transport sector, SMEs and environmental protection</em></td>
</tr>
<tr>
<td>White Paper (“Growth, Competitiveness, Employment changes and inroads to XXI century”)</td>
<td><em>Competitiveness of the European Union in the global market, Trans-European connections, research and technological development, information society and audio visual sector, as well as development of the labour market and vocational training systems</em></td>
</tr>
<tr>
<td>Green Paper on Innovation</td>
<td><em>Inter alia, increasing competitiveness of the Community in global markets, more efficient use of outlays for research, development of innovation financing systems</em></td>
</tr>
<tr>
<td>First innovation action plan in Europe</td>
<td><em>Stimulating innovation culture, setting legal and financial framework advantageous for innovations and developing closer relations of scientific research and innovative measures in the industrial and service sectors</em></td>
</tr>
</tbody>
</table>

\(^{19}\) www.ukie.gov.pl.

(international) competitiveness is connected with higher exports.
EU innovation policy was also formed by a number of documents approved by the European Council\(^{20}\) (see Table 4). The social and economic programme binding today is the Lisbon Strategy approved in 2000. The strategy is an attempt to revive the EU economy, which faces a dwindling growth rate and lags behind the US economy. The ultimate objective of the plan is to transform the EU by 2010 into the most competitive, knowledge-based economy in the world, capable of sustainable economic growth, creating more jobs and maintaining social cohesion\(^{21}\).

It is worth underlining that it is not only the drive to close the gap between the European Union and the United States (comparison of selected indicators is shown in Table 5) but also rising competition of China and other developing Asian countries, and therefore the prospect of Europe becoming marginalised that have become the key factors inducing these changes.

The strategy can be analysed in three dimensions\(^{22}\): economic, social and environmental. Measures targeted at implementing the strategy objectives concentrate on five principle areas:

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20 Conclusions adopted at the European Council meetings initiate the process of defining the general trends in EU policy.
– development of knowledge-based economy and society, including information society, support for science and research (allocating up to 3% of GDP for R&D) and for lifelong learning;
– development of an integrated internal market with efficient transposition of community law, elimination of barriers to free movement of services and liberalisation of network markets (telecommunication, energy, transport, postal and financial services);
– development of entrepreneurship and conditions for free competition by deregulation and elimination of legal and administrative barriers, establishing and developing new business, facilitating access to capital, knowledge and innovation;
– shaping of the labour market and strengthening social cohesion including an increased employment rate of 70% by 2010, more flexible labour markets, modernised social insurance models and elimination of poverty;
– implementation of sustainable development principles and protection of the natural environment by preventing climate change, setting new legislative standards on protection of the environment and reducing the dependence of economic growth on the consumption of raw materials.

Table 5. Comparison of EU-27 and US in view of implementing the Lisbon Strategy

<table>
<thead>
<tr>
<th>Item compared</th>
<th>Period</th>
<th>UE-27</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP in USD billion</td>
<td>1999</td>
<td>6.491</td>
<td>9.191</td>
</tr>
<tr>
<td></td>
<td>2008</td>
<td>18.493</td>
<td>13565</td>
</tr>
<tr>
<td>Average annual GDP growth in %</td>
<td>2001-06</td>
<td>1.6</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>2.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Population in millions (in 1999 UE-15)</td>
<td>1999</td>
<td>291.5</td>
<td>273.1</td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>500.6</td>
<td>307</td>
</tr>
<tr>
<td>GDP per capita (in PPS terms) in 2001 EU-15</td>
<td>2001</td>
<td>100.0</td>
<td>144.9</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>100.0</td>
<td>154.3</td>
</tr>
<tr>
<td>Average annual productivity growth per capita in %</td>
<td>2001-06</td>
<td>1.4</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>2008</td>
<td>1.3</td>
<td>1.0</td>
</tr>
</tbody>
</table>


23 The environmental protection aspect was added to the Strategy during the Göteborg summit in 2001.

Unfortunately, the first period of implementing the Lisbon Strategy did not bring the expected results, but, what should be noted, the disparity between EU and US grew, as demonstrated by the disparity in EU and US GDP per capita (see Table 5). The poor Strategy performance is attributed to lack of any enforcement measures helping to implement the plan and the tendency of EU state leaders to focus on current issues and to marginalise issues of long-term nature. Some noted weak links in the Strategy itself, include the multitude of objectives and priorities in the final Strategy, which resulted in a very wide spectrum of reform programmes covering many objectives and areas so “the multitude of just objectives resulted in the failure to realise the most important ones”.

In response to the failure of the initial Lisbon Strategy, an updated strategy was developed and adopted by the European Council in March 2005. The new strategy concept concentrates on two leading objectives, i.e.:

– making Europe an attractive location in which to invest, work and live, primarily by creating new and better jobs;
– using knowledge and innovation for sustainable growth of European economies (the targeted 3% of GDP for R&D was not waived).

The result of the revised Lisbon Strategy also involved the assumption that member states will develop a coherent innovation policy, primarily based on:

– mechanisms supporting innovation in small and medium sized enterprises;

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26 The European Commission collected reports from member states once a year only and next produced a summary report.


28 D. Rosati, Alarm dla Europy, speech prepared for the celebrations of the Faculty of Management and Economics of Services, University of Szczecin, Szczecin 2005.


30 It is worthwhile to pay attention to the information referring to Community economy, which clearly indicates economic revival. According to the weekly “Wprost” (M. Zieliñski: Sar¿a starej szkapy, “Wprost” no 10, March 2007, p. 48-50), we should feel optimistic in view of GDP growth, which in EU countries in the year 2005 read 2.9% (in US slightly higher – 3.4%, and in Japan 2.2%). What is more, in the first half of 2006, the value of European direct investment in the United States (61 billion USD) was higher than American direct investment in Europe (51 billion USD). Another important symptom of European development is the Fortune ranking of the biggest companies worldwide, according to which sixteen European companies ranked among the biggest thirty, with only twelve American and two Japanese companies. However, other statistics on innovation and achievements in scientific research studies place the United States and China in leading positions. From among EU countries Sweden, Finland and Denmark are the leaders (based on Nauka, technologia i przemys³ w krajach OECD: Report 2005).
– promotion of joint enterprise-university research;
– better access to venture capital for entrepreneurs;
– directing public procurement at innovative products and services;
– development of partnership-for-innovation centres at the regional and local levels\textsuperscript{31}.

Table 6. General characteristics of EU framework programmes

<table>
<thead>
<tr>
<th>Period</th>
<th>Framework Programme</th>
<th>Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984–1987</td>
<td>I FP</td>
<td>Priorities: agriculture, industry, raw materials, energy, development, improving living conditions, the environment</td>
</tr>
<tr>
<td>1990–1994</td>
<td>III FP</td>
<td>Continuation of the two earlier priorities with emphasis on disseminating research results, support of scientific and research work on information technology, communication, medicine and the natural environment.</td>
</tr>
<tr>
<td>1998–2002</td>
<td>V FP</td>
<td>Opening new prospects for living resources and ecosystems, maintaining international status of European science, innovation measures of small and medium sized enterprises, human potential enhancement</td>
</tr>
<tr>
<td>2002–2006</td>
<td>VI FP</td>
<td>Concentration and integration of European research on: genomics, biotechnology, information society technology, nanotechnology and nanoscience, aeronautics, food safety, sustainable technology, ecosystems, knowledge society.</td>
</tr>
<tr>
<td>2007–2013</td>
<td>VII FP</td>
<td>The programme will support international research work through joint projects and research networks, coordination of national and regional research programmes and cooperation with third countries. Joint research projects will be implemented under 10 priority themes: health, food, agriculture and biotechnology, information and communication technology, nanoscience, nanomaterials, materials and new production technologies, energy, environment (including climate change), transport (including aeronautics), socio-economic and humanistic sciences, safety and outer space.</td>
</tr>
</tbody>
</table>

Source: own study based on European Union brochures promoting particular framework programmes and http://www.cordis.lu/guidance/pl/thematic_index.htm#eu.

The key instruments of European Union science and technology policy are Framework Programmes. A framework programme is a set of scientific research

\textsuperscript{31} U. Płowiec: \textit{Strategia lizbońska...}, op. cit., p. 91.
and technical subjects in several areas to be realised within a specified time frame. Programmes are financed by the European Union and managed by the Commission. Framework programmes comprise detailed action plans which cover a diversified subject area.

The first EU Framework Programme was implemented in the years 1984-1987 and was to coordinate and concentrate Community research activity. Six Framework Programmes have since then been implemented (general programme characteristics are presented in Table 6). In the next seven years (2007-2013), two framework programmes will function in the area of technology development and innovation, i.e. 7 Technological Development and Demonstration Framework Programme and Competitiveness and Innovation Programme (CIP).

The 7 Framework Programme (7FP) is the biggest instrument for financing and shaping scientific research at the European level. This seven-year long programme, with a budget of nearly 54 billion euros, is the key instrument for implementing the Lisbon Strategy targeted at transforming EU into the most competitive and knowledge-based economy. The 7FP, as a program targeted at creating the European Research Area (ERA) at the European level, is also addressed to the research potential in the regional dimension, thus we can state that it is complementary to the activities undertaken by Member States under the Lisbon Strategy, with Structural Funds financing. The main challenges of the 7FP include:

- support for transnational cooperation in all areas of research and technological development;
- boosting the dynamics, creativity and excellence of European research in pioneering areas;
- strengthening human potential in research and technology by ensuring better education and training, easier access to research potential and infra-

33 The budget growth was approximately 63% as compared with 6PR, more at http://www.kpk.gov.pl/.
35 Structural funds are funds created in the European Community budget (Council Regulation no 1260 dated 21 June 1999, introducing general provisions on structural funds, Official Journal of the European Union no OJ L 161 z 1999 r., which enable aid in restructuring and modernisation of the economy in Member States in key sectors and regions (improving the structure). We can single out the following structural funds: European Regional Development Fund, European Social Fund, European Agriculture Guidance and Guarantee Funds Section and Financial Instrument for Fisheries Guidance More at http://www.funduszestrukturalne.gov.pl/.
structure, growing recognition for the researcher’s profession and encouragement for greater mobility and career development of researchers;
– intensifying the dialogue between the research community and the European public to enhance public trust in education;
– upgrading research and innovation potential taking into account the needs of regional convergence.

A programme complementary to the 7 Framework Programme is the Framework Competitiveness and Innovation Programme targeted at enhancing the innovation and competitiveness potential of EU economy, with special emphasis on enterprises. The programme is also to support the development of advanced-knowledge society and economic growth based on improved environmental security and quality. The basic CIP objectives are:
– to increase competitiveness of enterprises with special attention paid to SMEs;
– to promote all forms of innovation, including technological innovations;
– to accelerate the development of a sustainable, competitive, innovative and inclusive information society;
– to foster energy efficiency and renewable energy sources in all economic sectors, including transport.

The key data (budget, time period and sub-programme types) of both framework programmes, i.e. the 7 Framework Programme and the Framework Programme for Competitiveness and Innovation are shown in Table 7.

Table 7. Community programmes for the years 2007-2013

<table>
<thead>
<tr>
<th>Programme</th>
<th>Time period</th>
<th>Budget [billion euro]</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 Framework Programme</td>
<td>2007-2013</td>
<td>54,6</td>
<td>– Cooperation&lt;br&gt;– Ideas&lt;br&gt;– People&lt;br&gt;– Capacities&lt;br&gt;– Joint Research Centre&lt;br&gt;– EURATOM</td>
</tr>
<tr>
<td>Framework Programme for Competitiveness and Innovation</td>
<td>2007-2013</td>
<td>3,6</td>
<td>– entrepreneurship and innovation programme&lt;br&gt;– ICT support programme&lt;br&gt;– Intelligent energy for Europe programme</td>
</tr>
</tbody>
</table>


Structural Funds and community programmes are complementary financing sources for research and innovations, making synergy effect possible (see

37 Convergence – the process of reducing divergence among European Union countries and strengthening socio-economic convergence.
In modern economy, the competitive position of a country internationally depends primarily on its innovative capacity. Therefore, the importance of defining a valuation measure for innovation performance that makes comparison possible of innovation performance of other countries. In EU countries, the European Innovation Scoreboard (EIS) is applied to evaluate and compare the innovation performance of member states of the European Union.

EIS is an instrument developed under the Lisbon Strategy. Data is collected according to a uniform methodology and reported annually in the form of indicators, which reflect the innovation performance in EU states. EIS methodology is based on 25 indicators in five categories:

- **innovation drivers**: the number of S&E graduates per 1000 population aged 20-29, share in (%) of population with tertiary education per 100 population aged 25-64, broadband penetration rate (number of broadband

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58 Compare A. Bąkowski, A. Siemaszko, M. Snarska-Świderska, Jak zostać regionem wiedzy i innowacji, Twigger, Warsaw 2007, p. 25.

59 http://www.proinno-europe.eu and Innowacje i transfer technologii, op. cit., p. 44.

40 The system of innovation indicators developed by the European Commission and the University of Maastricht covers 27 EU countries, Turkey, Iceland, Norway and Switzerland and comparisons with the US and Japan. More in St. Łobejko: Eksperdyza wykonana na zlecenie Zachodniopomorskiej Agencji Rozwoju Regionalnego, Warsaw, December 2006.

41 On the basis of: European Innovation Scoreboard 2006, Comparative Analysis of Innovation Performance, Maastricht Economic Research Institute on Innovation and Technology (MERIT) and the Joint Research Centre (Institute for the Protection and Security of the Citizen) of the European Commission, p. 7.
lines per 100 population), participation in life-long learning per 100 popu-
lation aged 25-64, youth education attainment level (% of population aged
20-24 having completed at least upper secondary education);

- **knowledge creation**: public R&D expenditures (% of GDP), business R&D expenditure (% of GDP), share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditure), share (%) of enterprises receiving public funding for innovation;

- **innovation and entrepreneurship**: share of SMEs innovating in-house (% of all SMEs), share of innovative SMEs co-operating with others (% of all SMEs), share of innovation expenditure (% of total turnover), share of venture capital in early-stage enterprise (% of GDP), ICT share of expenditure (% of GDP), share of SMEs using organisational innovation (% of all SMEs);

- **application**: share in employment in high-tech services (% of total workforce), exports of high technology products as a share of total exports, share in sales of new-to-market products (% of total turnover), share in sales of new-to-firm products (% of total turnover), share of employment in medium-high and high-tech manufacturing (% of total workforce);

- **intellectual property**: number of EPO\(^\text{42}\) patents per million population, USPTO\(^\text{43}\) number of patents per million population, number of triadic patent families\(^\text{44}\) per million population, number of new community trademarks per million population, number of new Community industrial designs per million population.

The indicators given above are additionally divided into Input Indicators, which embrace the first three groups, whereas the remaining indicators belong to Output Indicators. Summary Innovation Index in 2008 is shown in Fig. 6.

It is worth emphasising that Poland enjoys one of the highest gross enrolment ratios (GER). 91.6% of young Poles\(^\text{45}\) have completed at least secondary education. In Norway, this ratio reads 93.3% whereas the EU average is 78.1%. The number of S&E graduates grows as does the share of population with tertiary education. It should also be noted that the material and energy consumption indicator in Poland is higher (11.6) than the EU-27 average (9.6) – see Table 8.

\(^{42}\) European Patent Office.

\(^{43}\) The United States Patent and Trademark Office.

\(^{44}\) Triadic patents families – the term refers to an invention registered with the European Patent Office (EPO), Japanese Patent Office (JPO) and The United States Patent and Trademark Office (USPTO).

\(^{45}\) In the age group 20 to 24.
### Table 8. Innovation performance of Poland against European Union and European leaders in 2008

<table>
<thead>
<tr>
<th>ENABLERS</th>
<th>EU-27 average</th>
<th>EU Leader</th>
<th>Poland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human resources</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.1 S&amp;E and SSH graduates</td>
<td>40.3</td>
<td>France (62.0)</td>
<td>52.9</td>
</tr>
<tr>
<td>1.1.2 S&amp;E and SSH doctorate graduates</td>
<td>1.11</td>
<td>Portugal (2.75)</td>
<td>0.86</td>
</tr>
<tr>
<td>1.1.3 Tertiary education</td>
<td>23.5</td>
<td>Finland (36.4)</td>
<td>18.7</td>
</tr>
<tr>
<td>1.1.4 Life-long learning</td>
<td>9.7</td>
<td>Sweden (32.0)</td>
<td>5.1</td>
</tr>
<tr>
<td>1.1.5 Youth education</td>
<td>78.1</td>
<td>Czech Rep. (91.8)</td>
<td>91.6</td>
</tr>
<tr>
<td><strong>Finance and support</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2.1 Public R&amp;D expenditures</td>
<td>0.65</td>
<td>Sweden (0.99)</td>
<td>0.38</td>
</tr>
<tr>
<td>1.2.2 Venture capital</td>
<td>0.107</td>
<td>United Kingdom (0.483)</td>
<td>0.017</td>
</tr>
<tr>
<td>1.2.3 Private credit</td>
<td>1.31</td>
<td>Ireland (2.47)</td>
<td>0.40</td>
</tr>
<tr>
<td>1.2.4 Broadband access by firms</td>
<td>77.0</td>
<td>Finland (91.0)</td>
<td>53.0</td>
</tr>
<tr>
<td><strong>FIRM ACTIVITIES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Firm investments</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.1 Business R&amp;D expenditures</td>
<td>1.17</td>
<td>Sweden (2.64)</td>
<td>0.18</td>
</tr>
<tr>
<td>2.1.2 IT expenditures</td>
<td>2.7</td>
<td>Sweden (3.8)</td>
<td>2.6</td>
</tr>
<tr>
<td>2.1.3 Non-R&amp;D innovation expenditures</td>
<td>1.03</td>
<td>Estonia (3.36)</td>
<td>1.03</td>
</tr>
<tr>
<td><strong>Linkages &amp; entrepreneurship</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2.1 SMEs innovating in-house</td>
<td>30.0</td>
<td>Germany (46.3)</td>
<td>17.2</td>
</tr>
<tr>
<td>2.2.2 Innovative SM Es collaborating with others</td>
<td>9.5</td>
<td>Finland (27.5)</td>
<td>9.3</td>
</tr>
</tbody>
</table>

**Fig. 6. Summary Innovation Index in 2008 and trends**

### Throughputs

<table>
<thead>
<tr>
<th>Throughputs</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.1 EPO patents</td>
<td>105.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3.2 Community trademarks</td>
<td>124.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3.3 Community designs</td>
<td>121.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3.4 Technology Balance of Payments flows</td>
<td>1.07</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Outputs Balance of Payments Flows

<table>
<thead>
<tr>
<th>Throughputs</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.1 EPO patents</td>
<td>105.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3.2 Community trademarks</td>
<td>124.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3.3 Community designs</td>
<td>121.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3.4 Technology Balance of Payments flows</td>
<td>1.07</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Innovators

<table>
<thead>
<tr>
<th>Innovators</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.1 SM Es introducing product or process</td>
<td>33.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>innovations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.2 SM Es introducing marketing</td>
<td>40.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>or organisational innovations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.3 Resource efficiency innovators</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.3a Reduced labour costs</td>
<td>18.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.3b Reduced use of materials and energy</td>
<td>9.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Economic effects

<table>
<thead>
<tr>
<th>Economic effects</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2.1 Employment in medium-high &amp; high-tech</td>
<td>6.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>manufacturing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2.2 Employment in knowledge-intensive services</td>
<td>14.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2.3 Medium-tech and high-tech manufacturing</td>
<td>48.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>exports</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2.4 Knowledge-intensive services exports</td>
<td>48.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2.5 New-to-market sales</td>
<td>8.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2.6 New-to-firm sales</td>
<td>6.28</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Unfortunately, though some indicators show a rising trend, Poland rates fifth last in terms of the Summary Innovation Index (Fig. 7), before Romania, Bulgaria and Greece. In the group of countries covered by the European Innovation Scoreboard, Sweden is the leader, rating first. Leading positions among EU states are also held by Switzerland, Finland, Denmark and Germany. SII indicates the gap between EU states (average SII for EU-25) and the United States and Japan.

The weak position of Poland results from low EIS indicators, which show an increase over the previous year but continue to lag behind EU average. Research funding continues to be a problem for Poland. R&D expenditure in 2008 amounted to a mere 0.56% GDP, whereas the European average stands at 1.82%. We should also remember that the Lisbon Strategy assumed that by 2010 expenditure for R&D were to reach 3% GDP in all member states. Taking into account
the low share of expenditure on R&D, which are lower today than in the 1990s (see Table 9), Poland’s achievement of this Strategy objective is questionable.

Table 9. Expenditure on R&D in Poland in 1995-2005

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D expenditure in GDP (%)</td>
<td>0.65</td>
<td>0.68</td>
<td>0.69</td>
<td>0.71</td>
<td>0.72</td>
<td>0.64</td>
<td>0.62</td>
<td>0.56</td>
<td>0.54</td>
<td>0.56</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Source: own study based on GUS (Main Statistical Office) and Eurostat.

Furthermore, the R&D expenditure structure gives rise to concern. It is dominated by financing from the state budget (68%), whereas in top rating countries R&D is financed by the private sector (on the average three quarters is covered by private funds).

Poland’s performance is also low because of SME’s implementing own innovations ratio, which is three times lower than in Germany (17.2% and 46.3%, respectively). A significant gap is also visible in broadband penetration rate (per 100 inhabitants), which in Poland reads 1.9 and in EU 10.6 on average. Attention is also due to the gap between Poland and EU States in protection of intellectual property envisaged by the number of patents and registered designs in Poland and the EU (e.g. number of EPO per million for Poland reads 3.0 whereas for EU countries it reads 105.7).
Even more pessimistic is Poland’s performance in global terms. Poland appears in a bad light in the results published in the Global Innovation Scoreboard (GIS), which compares European Union countries with other strong economies. According to the Global Summary Innovation Index – GSII, Poland belongs to the group of lagging countries rating eighth from the bottom – see Fig. 8.

Summarising, we can note that Poland’s innovation performance is low compared to EU countries and selected countries worldwide. In the long-term perspective, Poland’s performance affects the competitiveness of the Polish economy in the European and global markets. Therefore, it is important for the government to undertake relevant measures to support, above all, the research and development activities and innovation potential of the private sector.

Fig. 8. Global Innovation Scoreboard (selected countries)

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46 Argentina, Brazil, Hong Kong, India, Japan, Canada, South Korea, Mexico, New Zealand, Republic of South Africa, Singapore and the United States.
47 SII comprises 25 indicators, whereas GSII provides only 12 indicators.
3.3. Polish innovation policy

In Poland, innovation policy in macro terms is limited due to the financial difficulties of the State and stalling tactics in restructuring budget expenditure on development activities. Everyday social and structural needs, backwardness in many economic sectors (agriculture, mining industry and others) mean that R&D funding including innovation activity remains low. This situation is presented in Table 10 and Table 11.

Table 10. Outlays and employment in research and development activity in chosen countries in 1999

<table>
<thead>
<tr>
<th>Country</th>
<th>Outlays (current prices)</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>total (million USD)</td>
<td>GDP share (%)</td>
</tr>
<tr>
<td>Poland</td>
<td>2 493.4</td>
<td>0.75</td>
</tr>
<tr>
<td>Germany</td>
<td>47 625.2</td>
<td>2.44</td>
</tr>
<tr>
<td>Spain</td>
<td>6 369.4</td>
<td>0.89</td>
</tr>
<tr>
<td>Finland</td>
<td>37 490</td>
<td>3.19</td>
</tr>
<tr>
<td>Japan</td>
<td>94 722.7</td>
<td>3.04</td>
</tr>
<tr>
<td>Italy (1997)</td>
<td>13 866.8</td>
<td>1.04</td>
</tr>
<tr>
<td>United States</td>
<td>243 548</td>
<td>2.64</td>
</tr>
<tr>
<td>Russia</td>
<td>8 053.7</td>
<td>0.93</td>
</tr>
<tr>
<td>Hungary</td>
<td>776.1</td>
<td>0.68</td>
</tr>
<tr>
<td>Slovakia</td>
<td>402.2</td>
<td>0.68</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>1 769.9</td>
<td>1.29</td>
</tr>
<tr>
<td>South Korea</td>
<td>18 543.7</td>
<td>2.46</td>
</tr>
<tr>
<td>Turkey (1997)</td>
<td>1 996.9</td>
<td>0.49</td>
</tr>
<tr>
<td>Mexico (1997)</td>
<td>3 299.8</td>
<td>0.40</td>
</tr>
</tbody>
</table>

* Without depreciation and fixed assets.

b In equivalent to full time employment.

Purchasing power parity.


Table 11. Basic indicators in research and development activity in Poland in the years 1995–2000

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Outlays* for R&amp;D (current prices)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of Gross Domestic Expenditure on R&amp;D (GERD) in GDP (%):</td>
<td>0.69</td>
<td>0.72</td>
<td>0.75</td>
<td>0.70</td>
</tr>
<tr>
<td>Per capita (PLN)</td>
<td>55</td>
<td>104</td>
<td>119</td>
<td>124</td>
</tr>
<tr>
<td>Employment in research and development activity per 1000 employable</td>
<td>4.9</td>
<td>4.9</td>
<td>4.8</td>
<td>4.6</td>
</tr>
<tr>
<td>Including R&amp;D employees</td>
<td>2.9</td>
<td>3.3</td>
<td>3.3</td>
<td>3.2</td>
</tr>
</tbody>
</table>
Without depreciation and fixed assets.

Preliminary data.

Employment in R&D in full time equivalent, employable (all persons deemed employed and unemployed) on the grounds of Economic Activity of the Population Studies (BAEL) in the years 1995 and 1998, and in the years 1999 and 2000 from 4th quarter.

NB: In 1999 GERD to GDP in the European Union read 1.8%, and in OECD – 2.0 %.


### Table 12. Outlays for R&D by type (current prices, million PLN)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Total</th>
<th>Type of research</th>
<th>Development works</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Basic</td>
<td>Applied</td>
</tr>
<tr>
<td><strong>Total in 1995</strong></td>
<td>1834.8</td>
<td>668.0</td>
<td>491.5</td>
</tr>
<tr>
<td>1998</td>
<td>3219.8</td>
<td>1111.3</td>
<td>830.5</td>
</tr>
<tr>
<td>1999</td>
<td>3694.9</td>
<td>1339.2</td>
<td>904.8</td>
</tr>
<tr>
<td>2000</td>
<td>3981.5</td>
<td>1534.2</td>
<td>991.7</td>
</tr>
<tr>
<td><strong>Scientific and research units</strong></td>
<td>2175.3</td>
<td>821.1</td>
<td>592.5</td>
</tr>
<tr>
<td><strong>Polish Academy of Sciences – Branches</strong></td>
<td>477.1</td>
<td>433.7</td>
<td>36.5</td>
</tr>
<tr>
<td><strong>Scientific and research units</strong></td>
<td>1666.4</td>
<td>387.4</td>
<td>539.7</td>
</tr>
<tr>
<td><strong>Service providing units</strong></td>
<td>31.8</td>
<td>–</td>
<td>16.3</td>
</tr>
<tr>
<td><strong>Development units</strong></td>
<td>604.8</td>
<td>5.8</td>
<td>54.7</td>
</tr>
<tr>
<td><strong>Tertiary Education Units</strong></td>
<td>1201.4</td>
<td>707.3</td>
<td>344.5</td>
</tr>
</tbody>
</table>

* Without depreciation and fixed assets, including outlays for specialised apparatus.

Source: *Nauka i Technika (Science and Engineering)* ..., p. 11.

### Table 13. Structure of outlays for R&D by sources of funding (current prices)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Including resources from:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State budget</td>
<td>60.2</td>
<td>59.0</td>
<td>58.5</td>
<td>63.4</td>
</tr>
<tr>
<td>Economic entities</td>
<td>24.1</td>
<td>29.7</td>
<td>30.6</td>
<td>24.5</td>
</tr>
<tr>
<td>Scientific Branches of the Polish Academy of Sciences and research and development centres</td>
<td>11.9</td>
<td>8.3</td>
<td>7.5</td>
<td>8.1</td>
</tr>
<tr>
<td>International organisations and foreign institutions</td>
<td>1.7</td>
<td>1.5</td>
<td>1.7</td>
<td>1.8</td>
</tr>
</tbody>
</table>

* Without depreciation and fixed assets.

Source: *Nauka i Technika (Science and Engineering)* ..., p. 11.

The data presented indicate that countries investing in generally understood knowledge are the leaders of social and economic development. The example of Finland, which assigns a considerable share of GDP to research and development (3.19% – the biggest share) shows how such investments pay off in the future. Countries which neglect investments in knowledge, though have the potential, lack relevant knowledge resources and fail to secure dynamic deve-
velopment in the future, e.g. Turkey, Mexico. By assigning a small proportion of GDP to knowledge, Poland diminishes its development opportunities. Furthermore, Poland has a faulty structure of funding the knowledge sector because most of the resources for this kind of activity come from the state budget. Under the innovation policy, the State makes efforts to change this negative structure by applying various instruments. Today, the most often applied instruments in Poland for innovation and science policy can be divided into two groups. The first group covers instruments related to fiscal policies:

- acknowledging the taxpayer’s spending on scientific research or development work as cost;
- acknowledging the taxpayer’s spending on the results of scientific research or development work as cost (provided they are linked with property rights acquisition);
- making innovation spending deductible from taxable income for a longer period than one fiscal year;
- providing tax allowance for individuals who are authors of new innovative solutions.

The next group covers financial and organisational instruments like:

- accelerated depreciation;
- allowances and credit preferences (linked with state guarantees) for modernisation of production by implementing new domestic technologies;
- new legislative and institutional solutions for the capital market;
- investor insurance for implementing new technologies;
- licence and science policies coordination;
- regulation covering inventions.

The significance of innovation policy for modern economy is exceptionally great because well defined and efficiently performed invention policies contribute to economic growth and improvement of the competitive advantage in the international arena. Additionally, skilful support by the state of innovative processes in the free market involving private and state institutions is advisable as it should lead to greater competitiveness in both social and economic terms as well as in terms of regional development.

The first stage of the development of Polish innovation policy under examination was connected with the beginnings of free market economy in Poland and economic transition processes. The next stage started with Poland’s accession to the European Union in 2004 when, as a Community member, Poland was obliged to adapt its policy to Lisbon Strategy principles.

Since the 1990s, many documents referring to the innovation policy were adopted, which are presented in Table 14. According to Jasiński[48], Polish innovation policy in the years 1989-2004 depended on the economic development cycle

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and lack of long-term development strategy. As a result, the pro-innovation measures undertaken by the government, as Jasiński underlines, were usually delayed (drifting with the cycle or were run parallel to economic reality (with the cycle). Moreover, the support was not of a long-term nature to face such difficulties as the slowing down of the economy – see Fig. 9.

Table 14. Key documents of Polish innovation policy in the period 1998-2005

<table>
<thead>
<tr>
<th>Document title</th>
<th>Organisation responsible</th>
<th>Document status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principles of Scientific and Engineering Policy of the State</td>
<td>Scientific Research Committee</td>
<td>Governmental document approved by the Council of Ministers on July 20, 1993</td>
</tr>
<tr>
<td>Principles of the State’s Pro-innovation Policy</td>
<td>Scientific Research Committee</td>
<td>Governmental document approved by the Council of Ministers on 22 November, 1994</td>
</tr>
<tr>
<td>International Competitiveness of the Polish Industry</td>
<td>Ministry of Industry and Commerce</td>
<td>Governmental document approved by the Council of Ministers on 16 May, 1995</td>
</tr>
<tr>
<td>Principles of the State’s Scientific and Technological Policy Preferential Scientific Research Areas and Development Projects Raising Innovative Capacity of Polish Economy</td>
<td>Scientific Research Committee</td>
<td>Governmental document approved by the Council of Ministers on 16 January, 1996</td>
</tr>
<tr>
<td>Programme Assisting the Development of Regional Institutions Involved in Technology Transfer</td>
<td>Project Team for Regional Development</td>
<td>Governmental document approved by the Council of Ministers in 1997</td>
</tr>
<tr>
<td>Principles of the State’s Innovation Policy until 2002</td>
<td>Scientific Research Committee</td>
<td>Governmental document approved by the Council of Ministers on 6 December, 1999</td>
</tr>
<tr>
<td>Increasing Innovative Capacity of Economy in Poland until 2006</td>
<td>Ministry of Economy, Industry Strategy Department</td>
<td>Governmental document approved by the Council of Ministers on 11 December, 2000</td>
</tr>
<tr>
<td>Strategy for Increasing outlays for R&amp;D to Meet the Lisbon Strategy Objectives</td>
<td>Ministry of Science and Information Technology</td>
<td>Governmental document of March 2004</td>
</tr>
<tr>
<td>National Reform Programme for the Years 2005-2008</td>
<td>Ministry of Economy and Labour</td>
<td>Governmental document approved by the Council of Ministers on 27 December, 2005</td>
</tr>
</tbody>
</table>

Attention is due to the document “Principles of the State’s Pro-innovation Policy” which identified three main objectives:
– stimulation and promotion of innovative attitudes in society and business entities;
– assisting the development of institutions involved in innovations;
– building legal foundations of ownership transformations of science and research organisations

Furthermore, the principles laid down in the document “Principles of the State’s Pro-innovation Policy” resulted in implementing a number of financial instruments, \textit{inter alia}, acknowledgement of a wider range of R&D related expenses as revenue costs\(^{50}\); like investment expenditure on patents, licenses, know-how, results of domestic scientific and research and development results, insurance of innovation export contracts and accelerated depreciation of fixed assets for R&D\(^{51}\).

Also the programme “Increasing Innovative Capacity of Economy in Poland until 2006,” which paved the way for the innovation part of the “National Development Plan for the years 2004-2006,” is worth noting. The programme assumes, \textit{inter alia}:
– the development of mechanisms and structures favouring innovative activities;
– the shaping of innovative attitudes in the economy;
– improvements in implementing advanced solutions in the economy;

\textbf{Fig. 9. Macroeconomic dynamics and innovation policy}

\(^{49}\) \textit{Ibid.} p. 196.
\(^{50}\) Up to 50\% of the income.
\(^{51}\) \textit{Ibid.}
– greater effectiveness of applied research and development works, in particular result application in economic and social practice, support for the existing and establishing new centres of excellence;
– a shift to consumption and production patterns in Poland which foster sustainable development.

The “National Development Plan for the years 2004-2006” by specifying key structural measures co-financed by the European Union, which Poland was to implement in the initial period of its EU membership, defined the ways in which innovation objectives stipulated by the programme “Increasing Innovative Capacity of Economy in Poland until 2006” were to be achieved. Goal attainment was specified in the Sectoral Operational Programme “Improvement of the Competitiveness of Enterprises and the Sectoral Operational Programme ‘Human Capital Development.’

Achievement of the objectives formulated in the revised Lisbon Strategy is reflected in the “National Reform Programme for the years 2005-2008” (KPR), the main objective of which is maintaining high economic growth rate, favouring job creation, with due respect for the principles of sustainable development. One of the programme priorities involves innovative growth of enterprises, which comprises three sub-priorities; the development of the innovation market, the support of research and development activity and the development of institutional environment fostering cooperation between the R&D and the economy. The KPR assumes that the pillar of innovation development in Polish economy is the private sector, which if supported by adequate institutional and legislative measures, will allocate more resources to R&D.

Innovative economy is a priority underlined in many documents and strategies, which indicates activity trends in Poland in the medium- and long-term perspective. Currently, the European Union budget for the years 2007-2013 is particularly important for Poland, which will benefit from EU funds under the European Regional Development Fund (ERDF), the European Social Fund (ESF), and the Cohesion Fund.

The measures financed in the years 2007-2013 were specified in the “National Cohesion Strategy (“National Strategic Reference Framework”)”, which projects 85.6 billion euro in the oncoming financial period for Poland, where:
– 67.3 billion euro comes from the EU budget;
– 11.9 billion euro to be provided by national public funds;

54 Ibid., p. 21-24.
56 Implementation of the National Strategic Reference Framework (to the year 2015) will cost on average 9.5 billion Euro annually, which represents approximately 5% of the gross domestic product. More at http://www.funduszestrukturalne.gov.pl.
– 6.4 billion euro to be provided by private entities.

One of the National Cohesion Strategy (NSS) priorities is “Improving the competitiveness and innovative capacity of enterprises, including in particular the manufacturing sector with high added value and development of the service sector”\(^{57}\). The Strategy projects that improvement in the innovative capacity of the economy is possible through support for innovation in enterprises, especially the SME sector, for which approximately 75% of available resources under the sectoral and regional programmes have been allocated.

Innovation assistance will be provided mainly by the “Operational Programme Innovative Economy” (POIG) under which financing\(^{58}\) of innovation undertakings\(^{59}\) consistent with specific POIG objectives will be possible. These include:

- boosting innovative capacity of enterprises;
- increasing competitiveness of Polish science;
- increasing the significance of science in economic development;
- increasing the share of innovative products of Polish economy in international markets;
- creating sustainable, better jobs;
- increasing the application of information and communication technologies in the economy\(^{60}\).

To improve innovativeness of Polish economy in the years 2007-2013, other operational programmes must be performed such as: “Human Capital”, Infrastructure and the Environment,” and “Development of Eastern Poland Programme”\(^{61}\). Referring to Fig. 10, which presents correlations of programme documents for the years 2007-2013 with national and EU strategies, we can say that the key document underlying individual strategies is the “National Development Strategy 2007–2013” (SRK)\(^{62}\). One of the six strategic priorities of the SRK is “Increasing economic competitiveness and innovation”\(^{63}\), which is reflected in the priorities and objectives of other strategic documents.

Another important program affecting innovation policy for the years 2007-2013 is the document “Strategy for Increasing Innovative Capacity of the Economy in 2007-2013,” which is a continuation of the governmental pro-

\(^{57}\) National Strategic Reference Framework..., op. cit., p. 61.
\(^{58}\) Allocation of approx. 8.3 bn euro.
\(^{59}\) Only innovation products of national or global scale. Regional scale innovation projects will be supported by the 16 Regional Operational Programmes (RPOs).
\(^{61}\) For example, the allocated funds for RPO in Zachodniopomorskie Voivodship (RPO WZ) amounts to 835.42 billion euro.
\(^{62}\) Document adopted by Polish Council of Ministers on 29 November 2006.
The strategic objective in “Strategy for Increasing Innovative Capacity of the Economy in 2007-2013” was formulated as “growth of the innovative power of enterprises in order to maintain the rapid development of the economy, and to create new, better jobs”.

The strategic axis and areas of state intervention in the “Strategy for Increasing Innovative Capacity of the Economy in 2007-2013” covers:
- human Resources for modern economy;
- research for the economy;
- intellectual property for innovation;
- capital for innovation;
- infrastructure for innovation.

Provisions of the document referred to above recommend the structure of the axis aimed at increasing innovativeness of the economy (see Fig. 11) focusing on entrepreneurs and emphasising the significance of timing in development of knowledge-based economy (GOW). A drive towards innovative and
knowledge-based economy is the only development track that can ensure international competitiveness of Poland, especially in view of the fact that such factors as labour costs are slowly becoming exhausted.

The strategy axis of the “Strategy for Increasing Innovative Capacity of the Economy in 2007-2013,” and the “National Development Strategy for the years 2007-2013” were approved by the OECD. A reliable evaluation performance assessment of the programme documents referred to above will be possible from the perspective of several years, inter alia, on the grounds of concrete data on the innovativeness of Polish economy and the enterprise sector.

3.4. Innovation policy in the transport sector

The development of the innovation policy in transport should account for the specifics of innovation activity in the service sector. Though there is a clear difference in the measures undertaken by production and service companies, we can recently see convergence in performance of these sectors. On the one hand we can see the so called “servicing functions in production” and on the other, services are becoming similar to production in the sense that services and inno-

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Fig. 11. The structure of the axis aimed at increasing innovativeness of the economy


vation services are becoming determinants of innovation in production. We can identify four main aspects of innovative behaviour in services (see Fig. 12):

– new concept of services;
– new plane of cooperation with the client;
– new system of service provision;
– application of new technologies.

The shaping of innovation policy in transport should account for model solutions in innovation policy. Successful support for innovation activity of enterprises, including operation on the TL market, requires relevant instruments which facilitate the overcoming of innovation barriers faced by companies. The major factors hindering innovative measures of enterprises include barriers:

– resulting from the development level, structure and nature of the economy;

Fig. 12. Aspects of service innovation


67 Contemporary innovation policy pays considerable attention to the small enterprise sector, which does not exclude big entities from benefiting from assistance and effects of the innovation policy. However, the aid to SMEs derives from the necessity to compensate for market and regulatory imperfections, which cause many limitations and barriers diminishing the innovation capacity of companies. For this reason the innovation policy of the state focuses on building an environment of partners for small enterprises involved in innovation and in this way reducing barriers to their innovation activity. (More K.B. Matusiak (ed.): op. cit., p. 119).
– arising during business activity, *inter alia*, connected with competitiveness, e.g. advantage of international corporations;
– resulting from the social environment, attitudes and trends, including resistance to privatisation;
– resulting from activities of the government or directly from its economic policies.

**In delimiting the area of innovation policy for transport** the following relations between various policy types were considered:
– social and economic;
– macroeconomic innovation policy;
– transport policy.

The interdependence of the specified areas is presented in Fig. 13. The various social and economic policies, e.g. fiscal policy, have an impact on the operations of all businesses (the entire economy) in a specified time period, (e.g. assisting innovation processes). Sectoral policy focuses on regulating the operation of businesses in a given sector, e.g. agriculture, telecommunication or transport. The overlapping of “bars of influence” indicates the area of interest that is com-

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mon to various policy components. The characteristic objectives of both policy types coincide in terms of:

a) **The aim of innovation policy**, which is to influence innovation processes to ensure “competitive growth of domestic entrepreneurs and efficiency of public services and consequently improve the quality of life of the society, especially in terms of prosperity, quality of the natural environment, healthcare and protection against extraordinary hazards.”

b) **The key objective of transport policy**, is the definite qualitative improvement of the transport system and its expansion, in line with the principles of sustainable development in technical, spatial, economic, social and environmental terms, in a country developing market economy, while international (mostly European) cooperation and defence commitments resulting from NATO membership.

Strategic objectives of innovation and transport policies are concurrent if not identical. The strategic objective (superior) of the innovation policy in transport is the development of a sustainable transport system, contributing to ensuring efficient and rapid social and economic development of the country and taking into consideration the realities of social, economic and political life. The transport system and all its elements must contribute to increased competitiveness and productivity of the economy.

The overriding objective of innovation processes in transport companies is assurance of their development. This can be achieved through partial goals of the transport company, which are integrated with the overall operations of the company in the transport market. The first stage of the innovation processes in a transport company is making the management aware of the clearly defined objectives. These objectives are expressed in the structured creation or adaptation followed by implementation of new technologies, technical and organisational solutions. New solutions should be acquired via all transfer channels and carriers. A transport company, or more broadly – transportation, should above all respond to the needs of the economy and expectations of the public connected with the services provided. Modern economy must be based on a dynamic and creative culture regarding the application of innovative measures, ready to break the routine of all players involved. Innovative measures result from the principles specified by praxeology because innovations aim at eliminating harmful routine in the operation of transport companies, taking advantage of invention, creativity and ideas in implementing economic progress and stimulating entrepreneurship. The more immediate goals of such proceedings may include:

- adapting to the changing needs of the market in terms of size and pattern of transport services provided;
- improved quality of services;

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69 Principles of the State’s innovation policy ..., p. 5.
- the use of advanced methods and technologies;
- more rational use of resources;
- adapting company structure to the changing environment.

The key premises for their development are as follows:

a) systematic growth of outlays for innovation activity often exceeding the financial capacity of one enterprise;
b) the need to keep pace with international competition;
c) the necessity to develop methods and technologies in socio-economically important areas, i.e. telecommunication, transport, energy, healthcare, education, etc., and the need to conduct scientific research which results in new products and technologies;
d) the necessity to protect the public from negative effects of company operations, e.g. environmental hazards;
e) ensuring State security and defence;
f) the need to ensure and maintain the balance disturbed by urbanisation and industrialisation, rising costs of acquiring new raw materials, energy sources, the rise of unemployment, etc.

Shaping innovation policy in transport is undoubtedly a complex issue and researchers express various respective attitudes and opinions. Innovation processes determine the competitiveness not only of transport companies in the global market of transport/forwarding and logistic services (TL) but to a considerable extent affect competitiveness of Polish businesses using the Polish transport system or more broadly, European or global ones. An efficient transport system stimulates the economy.

Synergy of objectives, the need to harmonise and cooperate in their pursuit provide grounds for an efficiently operating transport system and transport companies, which are an important element of the entire system. Adequate shaping of innovation processes in transport is also important due to the growing integration of transport production with production processes of customers. The relevant development of innovation processes in transport allows for proper cooperation of service providers and their clients. Integration of transport with other economic operations continues to intensify.

Transport, and particularly transport enterprises should be capable of innovation and undertaking new measures involving, among others, providing services tailored to their customer’s preferences. Modern environment necessitates tailored products and services in the TL market and shows growing participation of the consumer in the preparation of transport services.

The need to harmonise all innovation processes at all levels of economic operation should be emphasised, on the macro-, mezo- and microeconomic level. Nevertheless, the objectives of particular interest groups should be taken into

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consideration. This is a task difficult to perform in practice but indispensable. A characteristic feature of knowledge-based economy is the growing role of cooperation of various interest groups, including competitors. This refers to both transport companies, their suppliers and clients as well as organisations and institutions in the regional, national and transnational dimension. Innovative capacity of an enterprise, innovation diffusion and absorption in economy are the subject of special interest of the state. The state shapes the environment for performance of innovation processes by adopting social and economic policies, by introducing legislation, financial, organisational and publication regulations, etc.

3.5. Bibliography

Chapter 4
A STUDY OF INNOVATIVE TRENDS IN TRANSPORT
(Jan Burnewicz)

4.1. Introduction

One of the oldest challenges before mankind is to be able to move efficiently in all spatial dimensions. To reach valuable and useful goods located in different places, man had to devise more advanced forms of movement than walking, carrying or dragging things. This required inventions giving man the possibility of using mechanised techniques of movement, which used such key solutions as sliding or rolling on land, sailing on or under water surface or flying or hovering in the air. Of greatest significance were inventions which made the creation of large-scale transport systems possible, and this depended on the emergence of a number of complementary inventions and innovations\(^1\) as well as on the level of funding needed to implement them, on their operating costs and on the availability of specific energy carriers.

Innovative activities in transport often fail. A commercial success is viable only if specific requirements and market demand are taken into account while new ideas are sought. Innovation projects are also likely to fail if they are based on structures which are excessively large, take a lot of resources, land and energy, and are difficult to operate.

Experience has it that innovation in the way we move in space is more difficult and less spectacular than changes in the image or production methods of consumer goods and services. Since the train, the car and the aircraft were invented, no breakthrough transport technologies have emerged. There seems to

\(^1\) The invention of the car, for instance, was not only the building of its body, but the integration of ideas for propulsion (a well-performing engine), the wheels (tyres), the steering system, the brakes, the lights, etc. The same applies to the bicycle, despite its lesser complexity.
be no substitution prospect for the technique of wheel-based movement on land, or combustion-propelled movement in the air. This pessimistic observation makes sense only if we believe that the demand for movement in space is of an objective nature and each of its forms has to be accepted. The greatest innovation prospects in transport and logistics, however, are not inherent in the way in which we try to keep up with the growing demand for transport, but in the way in which we consciously try to shape it. Unrestricted increase in the movement of people and objects in space inevitably leads to chaos, network congestion and excessive investment in traditional infrastructure. This can be prevented by innovative solutions based on information and satellite technologies, implementation of new ideas in the management of transport and logistics processes and a genuine integration of various forms of transport.

4.2. Determinants of innovation in transport

Without innovation, extensive development of transport systems means development which is limited to the boosting – within certain limits – of the parameters of the system components (the capacity of roads, terminals, junctions or vehicles). With heavily concentrated traffic, insistence on extensive methods of boosting technical capacity of transport usually leads to accelerated (exponential) increase in expenditure, raising doubts about the sensibility of purely quantitative growth. Trying to make transport system components more efficient in this way is bound to cause spatial, environmental and social conflicts.

Transport innovation of today is adopted to attain different goals than in the 19th and 20th centuries. In the past decades, progress initially meant replacing the muscles of living creatures (animals and humans) with machines and increasing the volume of cargo and passengers carried. Later, innovation was connected with the need for greater speed, safety, reliability and comfort of transport. Transport innovations of the 21st century face a different challenge – they are supposed to reduce the oil-dependence of transport, its environmental impact and the demand for transport (through advanced logistics systems and better placing of transport systems within economic and social space).

In the days when transport was not mechanised, a breakthrough was usually made by inventions or innovation made by trial-and-error method; inspired by an idea, human need or a stroke of genius in making the right associations. This is how the boat, the sail, the rudder, the water lock, the wheel, the barrow and the cart were invented. These inventions required no scientific theories, not even mathematical calculations or design schemes.\(^2\)

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In more recent centuries, though, transport inventions and innovations were more often based on earlier theoretical discoveries. The invention by Ivan Ivanovich Polzunov (1764) of a steam engine, improved by James Watt (1769) – an innovation marking the onset of motor transport – was one of the last major inventions made by practitioners without links to the world of science. The invention, however, would not have been possible if Italian scientist Evangelista Torricelli (1608-1647) had not discovered the phenomenon of atmospheric pressure before. Subsequent transport inventions have been the result of associating mobility needs of people with scientifically described theories concerning the laws of physics, mechanics, chemistry, electricity, informatics and other fields of knowledge.

Inventions are prompted by specific human needs and they are or should be made in a conscious way, whereas scientific discoveries are frequently made by chance in an effort to satisfy human curiosity, although they can now be made in a more planned way, during special-purpose research programmes. Innovations are activities and solutions whereby existing inventions and ideas are transformed and diversified. The aeroplane, invented in the early 20th century, has been the subject of numerous innovations, owing to which many models could have been designed and built. And although the nature of the aeroplane remains the same as when it was first built in 1903 by the Wright brothers, modern Airbus 380 or Boeing 787, resulting from a whole chain of innovations in the aviation industry and air traffic management, show little resemblance to their ancestor.

Modern innovative efforts in transport are of increasingly planned and coordinated nature. Transport inventions are no longer made by chance, but are ordered to satisfy an important need and a large market. In the old days, an invention could be made by a brilliant hobbyist with little resources. Transport innovation of today is so complex technologically that it can only be made by teams of cooperating research centres, supported by business community and public authority. Necessity has always been the mother of invention, but its role in innovative processes today is more conspicuous than ever. This is seen in the research priorities of major research organisations specialising in the development of transport systems. The European Rail Research Advisory Council

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3 A scientific discovery means that something previously unknown (a phenomenon, a fact, a process or a natural regularity) has been credibly proved and thus revealed, or that previously existing knowledge of such phenomenon, fact process or natural regularity has been proved to be incorrect. Examples of scientific discoveries are provided by finding the existence of specific chemical elements, laws of physics or astronomy, principles of mechanics, economic regularities, psychological processes etc. An invention means that a new apparatus, tool or item of everyday use has been created, or a completely new technology of manufacturing something has been devised. Inventions are various items used by man to satisfy hunger (bread, wine, sugar), keep safe from cold (fire, clothing, shelter), keep healthy (herbs, drugs, treatment), move (footwear, wheel, boat, vehicle), trade and communicate with others (money, writing, telephone, the Internet) and meet other needs.
(ERRAC\textsuperscript{4}) lists the following as its long-term research priorities: intelligent rail systems, energy efficiency and environmental impact, work safety and the safety of carriage, development of technologies enabling competitiveness, macroeconomic impact of the rail, rail infrastructure development. The European Road Transport Research Advisory Council (ERTRAC\textsuperscript{5}) has the following research priorities: automotive innovations for sustainable urban mobility, alternative energy sources and new kinds of propulsion, technologies for long-distance and low-environmental-impact transport of cargo and new means of improving road safety. The Advisory Council for Waterborne Transport Research in Europe (WATERBORNE\textsuperscript{6}) has planned scientific and innovation research in low-risk, efficient ship, port and inland waterway infrastructure and logistics and upgrading of the skills of waterborne personnel. The priorities of the long-term research agenda of the Advisory Council for Aeronautics Research in Europe (ACARE\textsuperscript{7}) are new generation aircraft, airports, aircraft engines, traffic management systems and avionics.

The need to create and implement innovation in transport results from the continuing low efficiency of many of its technical elements and processes, leading to unsatisfactory levels of productivity, capacity and reliability, waste of time and resources, and higher operating costs. Another reason behind the search of new solutions in transport is the necessity to improve its relations with the world outside by greater accessibility in time and space, better quality of service and lower environmental impact. Many years of observation help to identify the weaknesses of the transport systems requiring innovative action. Efforts of research centres should focus on solutions that will mitigate the permanent faults and inefficiencies or eliminate them altogether.\textsuperscript{8} By using the classical scientific method of induction, one may – on the basis of observation and analysis – formulate a list of major shortcomings of the present forms of transport. This may be used as an indicator of the direction in which innovation efforts should go in order to mitigate or eliminate the deficiencies.

In the programming of the course of innovation-oriented activities and processes in the sector of transport and logistics, the starting point is a diagnosis of the efficiency and productivity of the currently existing systems. Such a diagnosis is difficult, both in terms of methodology and information available. There is a difference between highly-developed nations and those at a lower stage of

\textsuperscript{5} ERTRAC – The European Road Transport Research Advisory Council – http://www.ertrac.org.
\textsuperscript{8} J. Burnewicz, Nowoczesna wizja transportu i jej potencjalny wpływ na zagospodarowanie przestrzenne. (in:) Koncepcja przestrzennego zagospodarowania kraju a wizje i perspektywy rozwoju przestrzennego Europy. Edited by T. Markowski. KPZK PAN, Warsaw 2008, p. 66.
economic development. In this diagnosis, the deficiencies in the development of the existing transport systems should be grouped as follows: (a) symptoms of technological stagnation (conservatism); (b) distortions in technology and attitudes (pathologies); (c) excessively ambitious innovation efforts, inconsistent with the current level of civilisation and development.

A basic reference point for the creation of transport innovation is the situation in the most economically advanced countries. For the developing nations, the large-scale replacement of traditional transport means (city rickshaws, pack or cart animals) with motor transport, commonly used in Europe, North America and Japan, does not mean innovation, but classical adaptation and modernisation. An innovative challenge is a vision of what new can be done which is different from the solutions currently considered to be most advanced in the world.

A symptom of technological stagnation in the transport of the developed nations is the excessive reliance on the internal combustion engine. Road vehicles, ships and aeroplanes alike have so far been propelled by combustion engines alone; it is only rail transport that has used stationary electric power supply to a greater extent. This could have been tolerated until the threat of global oil depletion emerged. The proven deposits of crude oil (feasible for extraction) globally amount to 160-181 bn tonnes, while average global output stands at 3.5 bn tonnes annually. This means oil will run out in a matter of 46 to 52 years.9 The economy (transport inclusive) must gradually make a shift to renewable energy sources (RES) like biomass, hydropower, wind, solar, geothermal, tidal power and others.

Another symptom of technological stagnation in transport is the heavy reliance on traffic based on the wheel. It might seem that the invention of the wheel has ultimately solved the problem of moving efficiently on a flat land surface. This efficiency, however, is ensured not only by the wheel, but also by good quality of the road on which it is rolling, and the construction of a dense network of roads is both costly and time-consuming. Cheaper transport could be provided, without the costly road infrastructure, if an efficient way of sliding, hovering or moving otherwise were invented. Or we might go towards innovative road building technologies, against the drift of accepted engineering, geological, material and environmental stereotypes.

Yet another example is the reliance on the concept that passengers or cargo should be moved in mobile, close compartments, namely the vehicles. In the worst case there is a duplication of these compartments – in intermodal technologies – leading to an increase in the material used, the weight of the loading units and in the cost involved. In many cases, getting rid of the vehicle is not possible, but a reduction in its weight would be a significant improvement. The

image of people flying without vehicles, or cargo transported automatically by pipes or cables seems too simplistic.

Technological conservatism most strongly affects spatial differentiation of transport costs. A common fault with present-day transport systems is that the technologies used ensure an acceptable unit cost level only when a high level of operational activity is reached (owing to high flow of cargo or to large numbers of vehicles in operation). These systems are unproductive in low-demand areas and lose the competition with individual forms of transport (the private car of in-house transport). This conservatism could be overcome through innovation making transport more customised\(^\text{10}\), with solutions ensuring its low cost and creating a lasting order of such traffic in time and space.

Another fault of present-day transport systems is the technological oddities that can be seen in the ways means of land transport are used. They consist in the development of autonomous modal subsystems, which render interoperability with other modal or national subsystems impossible. The original sin of these oddities in land transport was the 19th-century split in the concept of vehicles moving on iron wheels versus rubber-tyre vehicles. As a result, two commercially hostile subsystems of transport emerged – rail transport and road transport. Clumsy attempts are now made to re-integrate them within the concept of intermodal transport, nevertheless based on the need to tranship the loading unit. This disintegration of land transport would not have occurred if the concept of universal vehicle, fitted with wheels running on both rails and a flat, paved road had initially been followed. Additional technological pathology is provided by the differences between national railway systems (rail gauge, signalling systems, power supply systems), making international carriage difficult and requiring difficult and costly implementation of interoperability. In contrast, the autonomy of maritime transport and inland water transport is natural, because the two kinds of waterway are incomparable – despite the fact that they are used by vessels built on similar principles.

A challenge for researchers and transport policy makers is posed by the distorted attitudes formed over the last decades to the way in which mobility needs are satisfied. Millions of transport users do not seem to be impressed by the burden of congested roads and streets, the death toll of road accidents comparable with that of most bloody wars, or by transport-related degradation of the environment. Transport does add to the range of civic liberties, but does this mean that the freedom of movement should be exercised without any respect for its impact? Can cars, unlike aeroplanes, be used anywhere, any time and in any way? Innovations are needed to deal with the attitudinal distortions, by re-

\(^{10}\) Solutions like automated taxis could help here – see: Learning from a failed innovation process: http://www.rstrail.nl/website_nieuw/pages/downloads/Course%20ITE/Learning%20from%20a%20failed%20innovation%20Zuylen.ppt.
placing private car use with public car use (carsharing\textsuperscript{11} or carpooling\textsuperscript{12} systems, managed by competent operators) and by harmonising car traffic in time and space in most congested areas.

An important factor for transport innovations is a knowledge base of unique or abortive inventions. The history of transport technology demonstrates that inventions were a failure not only when they were not founded on a specific need, but also when based on very risky concepts (airships\textsuperscript{13}, vacuum tube train\textsuperscript{14}, supersonic plane\textsuperscript{15}, jet train\textsuperscript{16}, gravity control propulsion vehicles\textsuperscript{17}); inventions taking the form of gigantic structures (gigantic vehicles\textsuperscript{18}, superships\textsuperscript{19}, superplanes\textsuperscript{20}); inventions with innate faults that are difficult to eliminate by upgrading (pneumatic railway\textsuperscript{21}, hovercrafts\textsuperscript{22}, lighter aboard ships\textsuperscript{23}, mobile pas-

\textsuperscript{11} What is car sharing? – http://www.carplus.org.uk/carsharing/what-is.html.
\textsuperscript{13} The dire history of the zeppelins has not halted modern airship development. See: modern-airships.info – http://www moderne-airships.info info/en/home.html.
\textsuperscript{15} After the “Concord” crash, the future of supersonic jetliners looks uncertain. Supersonic aircraft, however, remain a classic of military aviation technology. Some, like Russian TU-25 (Mach 3), Russian super bomber TU-160, or US super bomber B1 Lancer form one of the foundations of the armed forces of the superpowers.
\textsuperscript{16} The jet train was the an idea of Soviet engineers, who un succeedfully tried to build it in the 1970s by mounting two JAK-40 jet engines on the roof of an aerodynamic suburban train. See: Soviet Union Jet Train – http://russianfun.net/technology/soviet-union-jet-train.
\textsuperscript{17} An alleged gravity control propulsion craft was Hauneebu, designed in the Third Reich – see: http://discliaircraft.greyfalcon.us/HAUNEBU.htm.
\textsuperscript{18} The largest motor vehicle in the world is the Liebherr T282B, It has a 20-cylinder, 90-litre, 3650 HP diesel engine, giving maximum speed of 64.4 km/h. Maximum gross weight – nearly 600 tonnes, with load capacity of 363 tonnes. See: http://www.liebherr.com/lh/en/594.asp.
\textsuperscript{19} The largest sea-going vessel today is “Knock Nevis” – 565 thousand dwt. See: http://www.knock- nevis.com.
\textsuperscript{20} The largest aeroplane today is the Russian AN-225, with maximum gross weight of nearly 600 tonnes – see: http://ram-home.com/ram-old/an-225.html.
\textsuperscript{21} Prototypes were built only in Great Britain (Crystal Palace Pneumatic Railway in 1864) and in New York (Beach Pneumatic Railway in 1870) – see: http://www.shohola.com/AlfredBeach and http://www.capsu.org/library/documents/0040.html.
\textsuperscript{22} Although hovercraft, or air-cushion vehicles – ACV can move on water and roadless land, they are damage-prone and difficult to manoeuvre. They are unable to move on slopes, use a lot of fuel and produce a lot of noise and dust. Small ACVs are made all over the world and used for leisure or in special operations – cf.: Airlift Hovercraft – http://www.airlifthovercraft.com.
\textsuperscript{23} LASH vessels were meant to transport lighters aboard sea-going vessels, to areas with no sea-ports, but they proved very expensive to build and operate. See: P. T. Leach: The end of the LASH era – http://www.accessmylibrary.com/coms2/summary_0286-33311165_ITM.
senger lounge systems\textsuperscript{24}, automated container handling terminals\textsuperscript{25}, monorail\textsuperscript{26}, gyrobus\textsuperscript{27} and the like.

The risk of creating and endorsing miscarried transport innovations is augmented by the following factors: (1) limited applicability (little demand, small market), (2) great capital intensity of the research, the implementation and related investment, (3) incurable faults (heavy environmental impact, high failure incidence, high energy consumption), (4) quick obsolescence of underlying idea (many possible substitutes), (5) low competitiveness vis-à-vis existing traditional technologies.

The need for innovation exists both within entire transport systems (of a country or city) as well as within individual modes or forms of transport. In the former case, innovation should result in giving the user a new generation service; in the latter, successful innovation is new generation means of transport, infrastructure, new traffic control methods, new ways of improving safety or reducing environmental and social impact. With the two approaches in mind, we might ask a question: What type of transport innovation does the world need?

The whole transport systems of countries or large urban areas can be made more efficient by capital spending and by innovations removing their chronic weaknesses. This goal, however, cannot be achieved by innovation alone, if it is not accompanied by the necessary investment in order to replace traditional elements of the system. Innovation becomes a must if traditional heavy spending on the existing transport systems produces no results. There may be situations, when local transport systems function well enough for efficiency to be ensured by replacement expenditure alone, without innovation\textsuperscript{28}. There are no transport systems in large urban areas, however, requiring no innovation to reduce congestion, which is not very responsive to traditional infrastructure upgrading and extension. It has to be remembered that system innovations must not bring positive effects for a small group of the chosen ones, with easy access to the new generation service or infrastructure, but must benefit all the inhabitants using the given transport system.

\textsuperscript{24} In the 1970s, F. Krupp tried, with little success, to implement the so-called “PUT-System” – using mobile lounge systems for large airliner check-in as well as travolators and passenger pod conveyors in urbanised areas.

\textsuperscript{25} COMMUTOR nodes were meant as automated container or truck body handling stations. See: Bertrand Jalard: COMMUTOR – la réponse SNCF au transport combiné. WCCR ’94 - Les Actes du Congrès. Volume I, Paris 1994, p. 130.

\textsuperscript{26} Monorail (Safege, Alweg) – see: Wikipedia: http://en.wikipedia.org/wiki/Monorail.

\textsuperscript{27} Gyrobus is a bus powered by large flywheel, charged with electricity at bus stops. See: “Buses Worldwide” – http://www.busesworldwide.org/current.php

\textsuperscript{28} Places which need no innovation are most commonly unique cities and tourist destinations, where administration has imposed access restrictions, allowing pedestrian and non-motor traffic, with car use for residents only (like in Rome, Florence and similar locations).
The prime module of modern transport systems, i.e. the car module, does need innovation due to its inherent deficiencies, like insatiable demand for road and parking infrastructure, the amount of land that road infrastructure takes, total dependence on the availability of liquid fuels and their prices, the need for the driver to concentrate at any time during the journey and disorderly traffic in roads and streets, resulting in congestion and accidents.

The deficiency of rail transport common to all countries and enforcing a search of new concepts and technologies for its operation are low spatial accessibility, determined by whether or not operable rail tracks are available in a given area, an intricate pattern of national or regional differences in rail technology, requiring interoperability efforts, the closed nature of railway network – accessible to specific rail vehicles – and low urban planning adaptability, which is seen in large urban areas.

Inland water transport is a most difficult area when it comes to seeking and implementing new technological concepts or operational innovations. The deficiencies that encourage the pursuit of innovation are low speed of navigation, making it unattractive to logistics systems, high dependence on hydrological conditions and limited spatial accessibility of waterways and ports.

Maritime transport is an element presenting a major challenge for innovative solutions. Its greatest deficiencies are the failure of even the largest ships when confronted by the dangerous element of the sea (an unsinkable vessel has not yet been conceived), the low speed of sea shipping, accessibility to the service that is limited to coastal locations fitted with technically complex and capital-intensive port infrastructure, and the onerous nature of work at sea.

Aviation, which is representative of the greatest technological advancement in transport, also has a number of intrinsic deficiencies. These are the complex and hazardous take-off and landing, great threat to the safety of aviation from

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29 Any infrastructure that permanently covers the surface of the Earth with various materials (concrete, asphalt, composites or metals) is not environment friendly, but is the necessary evil. Covering the globe with fixtures and networks without limits is no progress. Figures for Europe in this respect give rise to concern, as road and rail infrastructure in 1998 accounted for 1.3% of the area of EU-15 countries (4% in Belgium) and 0.82% of the area of 13 applicant countries (including Turkey) See: Paving the way for EU enlargement. Indicators of transport and environment integration. TERM 2002. European Environment Agency Copenhagen 2002. http://reports.eea.europa.eu/environmental_issue_report_2002_24/en.

30 Technological integration of rail transport is particularly important in the European Union, where national rail systems exist that are incompatible with one another, due to different rail gauges as well as power supply, coupling and braking systems. These barriers are to be removed under the Community concept of interoperability of the railway (both high speed and conventional) and the Technical Specifications for Ineroperability (TSI).

abrupt weather changes (gale, fog, blizzard), aircraft icing, heavy dependence on liquid fuels and on technically advanced systems, and accessibility limited to areas with well-equipped airports.

The existing deficiencies of particular systems and modes of transport encourage research and innovation in both, means of transport and their propulsion as well as in node and linear infrastructure that they have to use. Innovative trends in this respect are of three types: (1) innovation adjusting means of transport to the technologically or naturally limited parameters of the infrastructure, (2) new generation transport infrastructure, better suited to the parameters and operational characteristics of the means of transport, (3) new transport subsystems built from scratch, involving previously unknown solutions – both mobile and stationary. The first type of innovative trends can, for instance, be seen in inland water transport, where new concepts emerge of ships adjusted to the navigation in shallow rivers. An example of the second trend in the construction of new generation seaport and airport terminals and new generation infrastructure in intermodal transport. The third type of innovative change may emerge in the future, provided research and construction efforts in transport systems are properly organised and funded. Traditional systems of moving cargo by rail or by road may partly be replaced by automated transport technologies.

Observation and study of transport innovations around the world as well as spreading knowledge about them may help to accelerate the process of creation and implementation of new ideas and solutions. A barrier to the creation of a pool of reliable knowledge about them is the fact that much of the research work is wrapped in secrecy and the progress achieved is not duly described. From time to time however, publications and reviews do appear with behind-the-scene information about the birth of the most promising innovations.

Of greatest importance for future transport systems will be the implementation of most promising, breakthrough innovations, work on which continues in many scientific and industrial research centres across the world. There is no universally accepted definition though, of the notion of “disruptive technology”, which could be applied in all sectors and to various degrees of subsystem spe-

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cialisation. What this notion actually means is that mankind should stop using a solution that has been known and used for decades. A disruptive technology in rail transport is the replacement of the motion of steel wheels on rails with train movement on a magnetic cushion, but it has not caused a breakthrough in the market yet. Similar quantum leaps may be sought in road, water and air transport technologies.

4.3. Environmentally clean road vehicles

Innovative trends in road transport can be divided into inventions in the field of new generation vehicles and innovations in new generation road infrastructure. The underlying motive of innovation is to replace the stock of currently operated vehicles with ones that will be environmentally clean, more functional, safer and requiring less space.

Motor vehicles of all types have a long history of development, but they are a type of industrial product with broad prospects for further innovation. Apart from dealing with the observed dysfunctions of road transport, innovations are meant to improve its quality by implementing solutions that will make the vehicles safer, more reliable, more comfortable, more environment friendly (green car, hybrid car, clean green car), less fuel-intensive, capable of running on alternative fuels (biofuels, fuel cells), more resistant to rough roads, etc. There is not much interest today in conceptual work aimed at replacing vehicles rolling on wheels with ones using a different motion technology (sliding, hovering). The technological breakthrough that will occur in this transport sector within the next twenty years will mean the replacement (nearly completely) of motor vehicles powered by combustion engines with electric ones.

A wide range of innovations in motor vehicles and their equipment deal mainly with new types of propulsion and alternative fuels. Most significant examples of specific solutions include:

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33 There are, in fact, a number of definitions and interpretations of the notion of “disruptive technology”, but they are all questionable. Many engineering circles would like to see a broad application of the term, even to the manufacturing of specialist tools. Cf.: Disruptive technology – http://en.wikipedia.org/wiki/Disruptive_technology; Disruptive technology – Whatis?com – http://whatis.techtarget.com/definition/0, sid9, gc945822,00.html; Definition of Disruptive technology – http://encyclopedia2.thefreedictionary.com/Disruptive+technology; What is a Disruptive Technology? – http://www.distechs.com/index.php?page=disruptive-technology-defined and others.


35 J. Burnewicz, Nowoczesna wizja transportu, op. cit., p. 70.
vehicles entirely powered by electricity (All-Electric Vehicle, Battery Electric Vehicle – BEV)\textsuperscript{36};
– Fuel Cell Vehicle – FCV\textsuperscript{37};
– Hybrid Electric Vehicle – HEV\textsuperscript{38};
– Compressed-Air Car\textsuperscript{39};
– Road Automatic Guided Vehicle – AGV\textsuperscript{40};
– Full Transparent Front Vehicle\textsuperscript{41};
– Road Trains – developed chiefly in Australia, the USA and western Canada\textsuperscript{42}.

The most likely to make a technological breakthrough in road transport is the concept of electric car, the invention of which has a long, successful history beginning in mid-19th century, later disrupted by the substitutional introduction in 1908 of mass production of combustion-engine motorcars by Ford (starting with the famous Ford T). While in the past the development of this type of vehicle depended only on expertise in design and technology, today there are three new major factors that can make it popular: (1) promotional activities of the public authority, (2) restrictions on the use of conventional fuel-engine vehicles in large cities and (3) the spectre of depletion of liquid fuels, which have been so cheap to use. The new era in the development of electric car was heralded by the successful Henney Kilowatt introduced in 1959-1960 with the support of the National Union Electric Company. It was capable of travelling 97 kilometres after a single charging of its 72-Volt batteries (100 vehicles were produced, of which 47 were actually sold)\textsuperscript{43}. The vehicle was a harbinger of a new


era in technology, but had no commercial success due to problems in the production of suitable batteries and their high cost.

At the beginning of the 21st century, the prospect of commonly used electric cars is becoming more realistic and imminent as the awareness grows that internal combustion vehicles will decline when the non-renewable global resources of oil run out.\(^{44}\)

The ambition of inventors is to maintain the characteristics of the car as a means of individual transport (which unlike the trolleybus, does not depend on power-supply infrastructure). It is this independence that was behind the overwhelming success of the car – a token of freedom and democracy. If the electric car is to maintain all the practical values of the combustion-engine vehicle and become a symbol of Zero-Emission Vehicle – ZEV, it is indispensable that it should:

1) have powerful, electronically-controlled, new generation batteries, fixed or replaceable, much lighter than the traditional ones, performing both in cold and hot climate zones;

2) ensure a satisfactory range after a single charging of the batteries, requiring no frequent disruptions of the journey (80-200 kilometres in cities, at least 300 km in long-distance traffic);

3) be fitted with affordable batteries, with the running costs comparable or lower to the cost of buying the fuel and the high-temperature lubricants used in the traditional car;

4) have a well-developed power network at its disposal throughout the country, capable of quick recharging or replacement of the new-generation, high-performance car batteries.

If these four essential requirements can be met, the electric car will gain a lasting technological and commercial advantage over the conventional fuel-propelled car. The first one – efficient, powerful new generation batteries has largely been met, since 2008. Previously, electric cars would use from 10 to 18 kWh of energy per 100 km (depending on the vehicle, manner of driving, traffic conditions, etc.). As a result of technological progress, this ratio has gone down to 7-9 kWh/100 km. A range comparable with fuel-burning cars would require the installation of a battery with the capacitance of several dozen kWh. The choice of batteries available to electric car makers for the past few years has included sodium batteries (resistant to low temperature), lithium-titanium, lithium-cobalt, lithium-nickel, lithium-iron-phosphate, and many others.\(^{45}\)

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lithium-phosphate, lithium-ion (SCIB\textsuperscript{46}) and lithium-polymer\textsuperscript{47} The latter are most advanced, the least expensive (less than 5,500 USD for 10 kWh) and the lightest (a 10-kWh unit weighs less than 100 kg). Propulsive efficiency of electric cars is 75-80\%, compared with 15-20\% of fuel-burning vehicles, which ensures low costs of running one (equivalent to fuel consumption of 2 litres per 100 km).

A breakthrough in introducing and promoting a successful modern Battery Electric Vehicle (BEV) was made on 19 July, 2006, by Tesla Motors\textsuperscript{48} (linked with Google, eBay, PayPal and other Californian IT companies and supported by governor Arnold Schwarzenegger), who launched a luxury sports car Tesla Roadster. The car was developed in cooperation with Lotus Cars and AC Propulsion engineers. The engine is a three-phase, 185 kW (251 HP) electric motor reaching 13.5 thousand rpm. The vehicle noiselessly accelerates to 60 mph (96.6 kph) in 3.9 seconds. Power is supplied by a set of 6,381 lithium-ion batteries that will last 100 thousand miles (161 thousand kilometres). Their total weight is 450 kilograms and they take 3.5 hours to recharge when fully discharged. The travel range of the car is nearly 250 miles (402 km). If Tesla Roadster were fuel-propelled, using it would be like driving a car with an average fuel consumption of 1.74 litres per 100 km\textsuperscript{49}. The fundamental disadvantage of the car is its price, 90-120 thousand USD, depending on the amount of extras.

The need to substitute the battery electric vehicle (BEV) for the traditional combustion engine car is the greatest in large cities and urban areas. In these populous places there is not enough room any more for the traffic or for the parking or garaging of the cars bought and operated hitherto (typically 4.25 metres long and 1.76 metres wide)\textsuperscript{50}. The replacement of these traditional cars with electric ones means not only getting rid of the exhausts, but also reducing the space requirement as the new electric city cars give some economies in this respect – they are shorter and narrower and can be parked somewhat like trolleys in the supermarkets; they may have a horizontally revolving body and the doors that can be opened in different planes. Other innovative solutions are used as well, (more windscreen to enhance front vision, precision parking devices and others).

In the early 2009, there were already more than 100 models and prototypes of electric cars of various makes ready for launching in the nearest years\textsuperscript{51}. It has

\textsuperscript{46} SCIB – The Super Charge Ion Battery
\textsuperscript{50} A large conurbation with 1 million passenger cars needs 12 square kilometres to park them and 28 km\textsuperscript{2} of road surface to ensure a reasonably swift traffic.
become a matter of honour for major car makers to develop their own model of electric car, either as a Neighbourhood Electric Vehicle (NEV), or an Electric Highway Car (EHC), or – most commonly so far – as an Electric Sport Car (ESC). There is now a group of several dozen companies from various industries, who make the electric car their flagship product\textsuperscript{52}.

One of the pioneers promoting electric cars in Poland is the Green Stream group\textsuperscript{53}, whose aim is to make Poland independent of oil. They are planning to start test stations in Warsaw and Cracow to charge electric vehicles. The project provides for the installation of 330 battery charging outlets, the purchase of test vehicles of various make, building a model garage, starting a GPS system of monitoring and management and even work on the design for Polish-made electric car. The Green Stream has received 20 million euro of EU co-funding\textsuperscript{54}. Attempts to develop a Polish model of electric car, a more advanced Melex\textsuperscript{55} successor, deserve special attention.

Among the neighbourhood electric vehicles already marketed and operated most popular so far have been:

- Norwegian TH!NK city, with a range of 170-180 km\textsuperscript{56}, increasingly popular in the Nordic and North-American markets, well performing in cool climate;

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\textsuperscript{54} Electric cars are coming to Poland – http://www.wykop.pl/ramka/150235/samochody-elektryczne-ju-z-wkrotce-w-polsce.

\textsuperscript{55} Melex – a small vehicle powered by an electric motor, made since 1971 by a company of the same name based in Mielec. Originally made as a golf-course float, it is now produced in several versions of various applications. See: WIKIPEDIA – http://pl.wikipedia.org/wiki/Melex . New types of Polish electric cars in 2009 included Elipsa car made at ZNTK in Radom, a three-wheeled SAM made by Impact Automotive Technologies of Pruszków and a number of garage-made conversions of fuel-powered vehicles.

– best-selling in the world, light and efficient but slow, Indian electric vehicles made by REVA\(^57\) (models REVAi Standard, AC, Classe, Spl. Ed.) with a range of up to 80 km;
– British-made NICE\(^58\) NEVs (Mega City, My Car, Ze-0, e500) with a range of 100-120 km, with good parameters to move in traffic jams;
– Italian electric micro-cars by Micro-Vett Ydea\(^59\), with a range of 50-200 km, very practical in congested Italian cities covered by considerable combustion car access restrictions;
– Tango T600 – an exceptionally fast and agile in traffic jams American electric car by Commuter Cars Corporations\(^60\) with an average range of 150 km. In terms of design it is a compromise between a motorbike and a motorcar (a very slim vehicle – 99 cm in width). According to its manufacturer, it is the most economical car for 2 people made from materials like the ones used to build Formula 1 cars (it accelerates to 100 km/h in 4 seconds despite its weight – 1,364 kg);
– Canadian-made ZENN\(^61\) electric car (city ZENN), with a range of 50-80 km, adjusted to slow-moving urban traffic (speed up to 40 km/h);
– large neighbourhood electric vehicles (sedans) made by Dynasty Electric Car Corporation\(^62\) of Canada (five models were on offer in 2006: Sedan, Cargo Van, Sport, Utility and Tropic), with a range of up to 70 km;
– a small, electric two-seater Kurrent made by American Electric\(^63\), tailored for congested roads (1.27 m in width), with a range of 64 km;
– a small neighbourhood electric vehicle Maya Mobility made by Electrovaya\(^64\) of Canada, with a range of 192 km, designed for low-speed traffic;
– a small neighbourhood electric vehicle Flybo XFD-6000ZK made by Jinan Flybo Motor Company of China, with a range of 120-240 km (depending on the manner of driving). Its weakness is limited efficiency in winter weather;
– Toyota FT-EV (Future Toyota – Electric Vehicle)\(^65\) is a mini-NEV based on Toyota iQ. The FT-EV is to be launched commercially in 2012. With fully charged batteries, the car can cover the distance of 50 miles;

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\(^{58}\) See: NICE Electric Cars – http://www.nicecarcompany.co.uk/electric_cars.html.


Battery electric vehicles for long-distance traffic must have a much greater travel range. While being an asset for the car, this results mostly from the scarcity of power infrastructure capable of charging car batteries quickly. As frequent recharging of the batteries would be a serious inconvenience, the cars have to be fitted with a larger state-of-the-art battery blocks, which boosts the weight and the price of the car. In 2009, the following BEVs were among the most mature in operational and commercial terms;

- **eBox** – Toyota Scion converted to electricity by AC Propulsion. Fitted with 35 kWh lithium-ion batteries, which give it a range of up to 240 km when fully charged. Marketed in California at a price of about 80 thousand USD;

- **sports Lightning GT** made by Lightning Car Company of the UK, fitted with the most recent AltairNano lithium-titanium, quick-charge batteries. When fully charged, it has a range of 300-400 km, but you have to pay as much as 120 thousand GBP to buy one;

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– sports **Tesla Roadster** made by Tesla Motors (Google) of the USA, fitted with 56 kWh lithium-ion batteries giving it a range of 390 km and offered at a price of 99 thousand euro;

– **ZAP-X Crossover EV** has been designed by ZAP Motors of California. It is fitted with lithium-titanium batteries producing a range of 350 km and is scheduled to be marketed in the USA in 2010;

– **Dodge ZEO** is an electric highway car designed by Chrysler, fitted with 64 kWh lithium-ion batteries, producing a range of up to 400 km (the future of the model looks uncertain after Chrysler went bankrupt in May, 2009);

– **Koenigsegg NLV Quant** is a production of Swedish companies Koenigsegg and NLV Solar AG, fitted with flow batteries made by the latter. They produce a range of 500 km, and the charging is quick – only 15-20 minutes. The car accelerates to 100 km/h in 5.2 seconds and its top speed is 275 km/h. Propulsion by two induction motors with an aggregate capacity of 512 HP. Nearly the whole body of Koenigsegg NLV Quant is covered with solar cells in the form of a thin, transparent film. The car is expected to be marketed in 2012.

The “Green Car” (“Green Vehicle”) concept involves the promotion of hydrogen as the fuel. Hydrogen is generally believed to be environmentally the cleanest and the most friendly fuel, as only water is liberated in the combustion process, whether it takes place in the air or in oxygen. Meanwhile though, hydrogen is not at all a “clean” fuel. This is because the largest amount of cheap hydrogen are produced through the reaction of methane or coal with water, during which carbon dioxide is liberated – a “greenhouse” gas when the amounts are excessive. This is why hydrogen generation directly from water is being developed (with the use of solar or wind energy) so that the oxygen and hydrogen cycles in nature are closed. As a fuel, however, oxygen has serious faults, like • high tendency for engine knocking due to low octane rating • strong interaction with metals, especially in high temperatures • tendency to decompose the lubricants, as a result of which aggressive compounds, detrimental to engine parts are formed • low energy density content when in liquid form • difficult storage.

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Fuel Cell Vehicles – FCVs\(^75\) are a technological innovation designed to reduce exhaust emissions into the atmosphere. Hydrogen can be used as a car fuel in various ways. It may be burnt in a traditional internal combustion engine or used in fuel cells to generate the power for the engine.

A fuel cell generates electric power through a process of fuel oxidation, the fuel to be constantly supplied from outside. Most fuel cells use hydrogen at the anode and oxygen at the cathode to produce electricity. (The fuel may also be potassium hydroxide, phosphoric acid, methane or methanol). Unlike the voltaic cells (batteries), which must be charged with electricity from outside, fuel cells need no charging – only to be supplied with fuel. The most sensitive element of a PEFMC fuel cell (Proton Exchange Membrane Fuel Cell) is the polymeric membrane which, due to its saturation with water, must be protected from freezing temperatures.

In 1970, professor Karl Kordesch of Graz university in Austria designed the first motorcar powered by fuel cells. This was a hybrid vehicle, with a 6 kW alkaline fuel cell, a lead battery and a 20 kW electric motor. Since then, the scope of application of movable cells has grown to cover virtually all transport modes; by air, by sea and by land. Efforts are being made to implement fuel cells in submarines, ferries, aircraft and two-wheeled vehicles\(^76\).

At present, practically all major car makers conduct tests on FCVs, whose cost-effectiveness is comparable with modern hybrid cars. As fuel cell technology spreads, FCVs are sure to become very popular. The advantages of fuel cells for the propulsion of means of transport are their high efficiency (65% compared with 35% for the internal combustion engine), absence of vibrations and noise incidental to the energy generation process, production of energy that actually powers the electric motors, no fuel burning when the vehicle has to stop, constant torque and many others. The main problem in marketing FCVs is their high price\(^77\).

According to analysts of the FCV sector\(^78\), vehicles of this generation are being tested by practically all major global automotive companies (Audi, AvtoVAZ, BMW, Daihatsu, Daimler-Chrysler, Dongfeng, ESORO, Fiat, Ford, GM, Honda, Hyundai, Kia, Mazda, Microcab, Mitsubishi, Morgan, Nissan, Pininfarina, PSA, Renault, Shanghai Automotive Industry, Suzuki, Tecnalia, Toyota, VW). Between 1994 and 2009, about 105 models of vehicles of this generation have been tested.


In the early 2009, the product range of technologically mature hydrogen vehicles included:

- **Honda FCX Clarity**\(^79\) is a 100 kW (136 HP) hydrogen-electric car, with a range of 430 kilometres, fuel consumption at a level of 3.3 litre per 100 km and zero-emission of noxious substances. The hydrogen tank capacity is 171 litres. A new generation PEMFC fuel cell generates electric power stored in a lithium-ion battery. This is the first passenger car powered by hydrogen alone;

- **BMW 7 Hydrogen**\(^80\) is a classical combustion car launched in 2007, which can use hydrogen as fuel. It has a 260 HP, 12-cylinder engine, giving acceleration from 0 to 100 km/h in 9.5 seconds. Electronically-controlled maximum speed is 230 km/h. The BMW series 7 Hydrogen engine has a push-button dual propulsion system, which can be easily switched between hydrogen and traditional petrol fuel. The car is fitted with a traditional 74-litre petrol tank and an extra tank to hold up to 8 kg of liquid hydrogen. The dual propulsion secures a range of more than 600 kilometres;

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– **Toyota FCHV**[^1] is another of Toyota's models fitted with new, highly efficient Membrane Electrode Assembly (MEA) fuel cells, tested since 2008. The success of the designers is the solution to the problem of the water produced during the operation of the cell, which in low temperatures interferes with electricity generation by the MEA. The vehicle is fitted with Toyota-designed, high-pressure (70 Mpa) hydrogen tanks, which give it a range of ca 830 km;

– **Mazda RX-8 Hydrogen RE**[^2] is a hybrid car (petrol-hydrogen) with a Wankel engine, tested from 1991 and launched in 2004 – initially on the Japanese market, and since 2008, on the Norwegian market as well. The power of the engine is 210 HP when petrol-fuelled and 109 HP when running on compressed hydrogen. The car is fitted with a 61-litre petrol tank and a 110 l tank to store hydrogen under the pressure of 350 bars. The range is 549 km on petrol and 100 km on hydrogen. Propulsion can be changed with a switch inside the car;

– **Mazda Premacy Hydrogen RE Hybrid**[^3] is the second, after the RX-8 Hydrogen RE, hydrogen car with a 150 HP Wankel engine, tested since 2008. Premacy is a series hybrid, which means that the hydrogen-powered Wankel engine drives a generator supplying energy to the batteries and the electric motor turning the wheels. When the car runs out of hydrogen, driving is continued on petrol. Owing to the hybrid propulsion, Premacy has a range of 200 km – double the range of RX-8 Hydrogen RE;

– **Nissan X-Trail FCV**[^4] has since 2000 been an element of “Nissan Green Program 2010” – a medium-term environmental policy aimed at CO₂ emission reduction in Nissan products and operations across the world, as well as a reduction in the emission of other fume substances and an increase in recycling activities. The vehicle is fitted with Nissan fuel cells and compact lithium-ion batteries. Hydrogen is stored at 700 bars in a specially designed tank. The model has been tested on roads in Japan and California since 2006. It reaches a maximum speed of 150 km/h and has a range of 500 km. Its maximum power is 90 kW;

– **Suzuki Hydrogen Fuel-Cell SX4-FCV**[^5] is a prototype of a hydrogen vehicle presented at the Paris show in 2008. It has an 80 HP engine and a range of 250 km;

DaimlerChrysler Mercedes-Benz B-Class F-Cell Tourer is a hydrogen car model tested in several countries since 2005. It has a 100 kW engine and a range of 250 miles (410 km). The propulsion is highly efficient, as it uses 0.87 kg per 100 km – an equivalent of 2.9 l of diesel fuel per 100 km;

Fiat Panda Hydrogen is a prototype launched in 2006, the successor of the 2004 hydrogen Panda and an earlier Seicento Elettra H2 Fuel Cell of 2001. The fuel cell energy is transferred directly, without a battery, to the 49 kW electric motor. The vehicle has a top speed of 130 km/h and a range of 200 km. In 2008, tests on a newer model – Fiat Phyllis-Fuel Cell began;

Other major hydrogen car makes are Chevrolet Sequel, Opel Zaphira Hydrogen (called HydroGen1), Ford Focus H2RV Fuel Cell, Hyundai Santa Fe FCEV and Hyundai Tucson FCEV-Fuel cell, Peugeot H2Origin-Fuel cell, Audi A2H2, Chrysler Jeep Treo-Fuel cell, GM HydroGen4, Volkswagen Tiguan Hy-motion-Fuel cell.

Fuel cell propulsion finds its application not only in motorcars, but also in buses and other vehicles (passenger river boats). The spread of hydrogen buses in large cities is thought particularly important in view of the need to reduce smog and noise levels. In the early 2009, there were forty-four project all over the world aimed at the implementation of hydrogen or methanol technology in city buses. Technological success stories in this area include the following bus models:

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- **Daimler Mercedes-Benz Citaro fuel cell bus O530BZ (Netbus successor)** launched in 2003 – a full-size bus propelled by a compressed hydrogen engine. Thirty-five vehicles of this generation are being tested in several locations across the world;

- **Flyer Invero LF Bus (F40LF)** – full-size CNG-hydrogen city buses made by New Flyer Industries Inc. based in Winnipeg, Canada, marketed in various versions since 1997;

- **Toyota FCHV-BUS** is a full-size, fuel cell bus jointly made by Toyota and Hino Motors, tested since 2006 at Tokyo airport;

- **MAN Lion’s City (H2ICE)** is a full-size city bus tested by the manufacturer since 2009 in Rotterdam;

- **Irisbus Iveco (Fiat) City Class hydrogen** is a full-size bus tested since 2004 in Italian cities;

- **Ford H2ICE Hybrid Bus** a suburban traffic minibus, with a seating capacity of 12, tested by Ford since 2004, with hybrid (fuel cell and petrol) propulsion.

There are also concepts and designs of fuel cell cars that are not meant to be mass produced, like e.g., **Daimler Mercedes-Benz F-CELL Roadster**. It is a fuel cell powered two-seater, with an environment-friendly 1.5 kW (2.04 HP) motor. Maximum speed is only 25 km/h, but the F-CELL can travel up to 350 kilometres without recharging. The car is steered by drive-by-wire technology, and the traditional steering wheel has been replaced by a joystick. The concept has been designed by Daimler’s undergraduate trainees.

The development of hydrogen powered cars results in the need for developing (from scratch) a network of hydrogen filling stations all across the country. This is happening in many developed countries. As shown by research, hydro-
gen production concentrated in larger centres and its distribution by pipelines is more effective than local production.\(^{105}\)

Progress in hydrogen filling network development in the EU till 2009 is shown in Fig. 16. As can be seen, the leaders are Germany, Italy, France, the Benelux and the Nordic countries.

Another “green” alternative to fuel burning cars are hybrid propulsion cars, most often electric-fuel, but also hydrogen-fuel and electric-hydrogen-fuel. Fuel engines and electric motors can work alternately or side by side, as the need may be, e.g., electric motor in urban traffic and fuel engine in long distance traffic. The electric motor can be a generator, charging the batteries or the capacitor when powered by the fuel engine or as a result of engine braking. While in urban traffic the future belongs to Battery Electric Vehicles or FCVs, in long distance traffic hybrid cars are likely to be more useful, owing to their greater

range. The popularity of hybrid passenger cars is growing – 200 thousand a year were sold in the US market in 2006-2008. In the early 2009, there were 46 models and prototypes of hybrid cars of various makes\textsuperscript{106}. The most popular among them are: Toyota Prius, Toyota Highlander, Honda Civic Hybrid, Lexus RX 400h and Lexus RX 450h, Ford Escape, Toyota Camry Hybrid, Honda Accord Hybrid, Merkury Mariner Hybrid, Honda Insight, Ford Fusion Hybrid, Nissan Altima Hybrid.

Among the “green” innovations are concepts connected with the development of Air Powered Car technology. This is an old, 19th-century invention of a Polish engineer Ludwik Mękarski. Buses and trams built on the basis of this concept carried millions of passengers in France and the USA, but the invention was abandoned in the 1930s as far-reaching improvements were made in the internal combustion cars. Now, the invention has its comeback, with improved design and efficiency of compressed air engines. A new generation Air Car has been designed by the MDI of France and Luxembourg (Moteur Developpement International)\textsuperscript{107} and is to be produced in plants in France, Spain and India (Tata). Different versions of the car have a fibreglass body, ABS and airbag. MDI is marketing 5 models: AIRPod, OneFlowAIR, MiniFlowAIR, CityFlowAIR and MultiFlowAIR. The car can be filled in two ways; at a filling station with compressed air – the filling takes ca. 3 minutes then – or by plugging the car in – the motor-alternator works then as a compressor and fills the tanks with ambient air. In this case, however, the filling up takes 4 hours. The AirCar is rational environmentally, and the efficiency of filling and low running costs may make it popular for urban traffic.

Another vast area for innovation in road transport is the infrastructure. Here innovations may be less of a breakthrough than in the automotive industry, but they nevertheless enable the construction of better and more durable roads. Research work is conducted to resolve road traffic issues as well as to make road building and maintenance more efficient processes. Efforts are being made to deal with such chronic traffic ills as disruptions caused by the weather (slippery surface, covered with ice or snow), the limited strength and load-bearing capacity of the road surface, congestion, deficient road geometry and the related risk of accidents, limited access to current traffic reports. A more detailed analysis of the problem is contained in the next section of this study.

\textsuperscript{106} List of Hybrid Cars – http://www.hybridcars.com/top-hybrid-cars-list.
\textsuperscript{107} Moteur Developpement International – http://www mdi.lu.
4.4. Innovations upgrading rail services

Rail transport is not very susceptible to disruptive technologies. Such is the nature of the rail track that it can hardly be changed, and replacing it with something else would simply mean the end of this transport mode. Innovative processes concerning rail infrastructure are targeted at greater possibility of incorporating it in various spatial dimensions. These processes have resulted in the emergence of not only flat surface rail tracks\(^\text{108}\), but also of elevated and underground rail structures, as well as cable and magnetic cushion rail. In terms of rail systems, there are two major, seemingly opposing innovative tendencies: • on the one hand, to lower unit costs by developing heavy train technologies\(^\text{109}\); • on the other, attempts are made to increase spatial accessibility of the rail services by using light rail units requiring tracks that are cheaper to build and operate. The former innovative tendency has brought positive effects in cargo traffic (with Europe trying to follow the USA by increasing the weight of cargo trains). Innovations in passenger rail transport are more diverse. In practice, the greatest effect has been achieved owing to the high-speed train technology, on routes between 300 and 800 kilometres, with annual passenger traffic of more than five million. The decentralised regional passenger services are being upgraded by the introduction of rail units which are much cheaper to operate owing to smaller weight, lower energy consumption, fewer staff and more efficient systems detecting vandalism – a real plague of regional rail services. An important branch of rail innovations is the search of most effective systems of switching to various rail gauges\(^\text{110}\).

High-speed trains (the Japanese Shinkansen\(^\text{111}\), the French TGV\(^\text{112}\), the German ICE\(^\text{113}\), the Spanish AVE\(^\text{114}\), the Italian Pendolino ETR\(^\text{115}\), the Swedish

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\(^{108}\) Rail traffic on conventional track of 2 rails can take place, depending on the line category, with the grade between 0.6% and 2.5%. There are, however, numerous successful exceptions, especially with high-speed trains (grades of up to 4%) and trams (grade of 14% – Lisbon) Rack railways can have the grade of up to 48%. See: Pilatusbahn – http://de.wikipedia.org/wiki/Pilatusbahn.

\(^{109}\) There is a considerable difference between European and American railways in terms of train weight. The allowable axle load in the USA is usually 35 tonnes, while the usual figure in Europe is 22. tonnes. See: A. Massel, *Techniczne i organizacyjne czynniki wzrostu konkurencyjności kolejowych przewozów towarowych*. “Zeszyty Naukowe Wydziału Ekonomicznego Uniwersytetu Gdańskiego. Ekonomika Transportu Lądowego” 2006 No. 34, p. 250.


\(^{112}\) TGV – the fastest trains in the world – http://www.tgv.pl/tgv/listatgv.html.


X2000\textsuperscript{116}, the Finnish S220\textsuperscript{117}, the Norwegian Flytoget\textsuperscript{118}, the American Acela Express\textsuperscript{119}) are no longer an innovation, but a solution more and more commonly applied. Of the new concepts and innovative rail technologies described in publications or on the Internet, the following deserve special attention:

– passenger double-deck high-speed trains\textsuperscript{120};
– tram-trains\textsuperscript{121};
– train scheduling optimizers\textsuperscript{122};
– telematics systems of rail cargo carriage control\textsuperscript{123};
– advanced bimodal and underground systems of urban cargo transport\textsuperscript{124};
– energy efficient rail propulsion systems (hybrid train)\textsuperscript{125}.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|p{5.5cm}|}
\hline
No. & Barrier type & Barrier description \\
\hline
1 & Institutional & Monopoly-based model of the sector \\
& & Political nature of the decisions taken (internal and external) \\
\hline
2 & Organisational & Insufficient funding for investment \\
& & Insufficient skills of the workforce \\
& & Insufficient technical expertise in specific planning areas \\
& & Constraints resulting from European railway restructuring (vertical competition within the sector), demonstrated by less cooperation and more uncertainty \\
\hline
3 & Social and culture rooted & National orientation of rail companies \\
& & The rail viewed as old-fashioned by consumers \\
\hline
4 & Technological & Long cycle of rail innovations \\
& & Lack of understanding of consumer needs \\
\hline
\end{tabular}
\caption{Barriers to innovation in rail transport}
\end{table}


\textsuperscript{119} Acela Express – http://www.trainweb.org/tgvpages/acela.html.
\textsuperscript{120} Double-Deck High-Speed Trains show a productivity that is 1/3 higher than with conventional high-speed stock. See: A better way to fly. (railway innovations) – http://www.high-beam.com/doc/1G1-20350844.html; SNCF TGV Duplex – http://en.wikipedia.org/wiki/TGV_Duplex.
Lack of eye-catching concepts and the slow pace of innovation in rail transport induces analysts of the sector to try and identify the causes. According to A. Nash and U. Wiedmann, there are four groups of factors behind the low intensity of technological progress of the rail (see Table 15).

The amount of attention given to rail innovations by research and industrial circles, much lower than to innovations in the automotive sector, partly results from the little role of the rail services in the lives of households (less than 1% of expenses, while motor transport accounts for 10-12% of their budgets). The smaller a sector and its market, the greater is its reluctance to invest in innovation changing technological quality and development prospects. Despite the limitations, innovative solutions can be applied in the rail transport, even the same as in road transport. Regeneration of regional railway lines may be assisted by the new generation propulsion of rail buses. They can move more efficiently and cause lower fume emission if equipped with hydrogen engines or electric motors. It is a priority for major international rolling stock manufacturers to seek innovation, so they present prototypes of new generation trains for long-distance, regional and urban traffic.

4.5. New generation passenger aircraft and airports

Aviation is the transport mode in which technological development has its definite logic and clear-cut stages of development. One of possible interpretations of this development between 1930 and 2030 is shown in Fig. 17.

Modern innovative processes in civil aviation include: (1) concepts of new generation planes, (2) new generation navigational equipment of existing aircraft, (3) air transport systems based on IT and satellite technologies, (4) new generation airports and airfields. Major innovative tendencies in this mode of transport are as follows:

- concepts and prototypes of variable wing geometry, vertical takeoff aircraft (Rotorcraft, Tiltrotor) of such manufacturers as Textron, Erica and others;

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– new generation cargo airships (Airship, Dirigeable)\(^{128}\);
– designs of low-noise, low-CO\(_2\) eco-friendly planes\(^{129}\), like the hydrogen powered Cryoplane;
– new generation “flying wing” planes (with no traditional fuselage);
– very large passenger airliners (like the Airbus 380, the prototype of a one-thousand-seat Boeing 797 Blended Wing, an experimental craft developed by Boeing and NASA X-48B) to limit the number of takeoffs and landings and thus reduce congestion;
– new generation airports (including Smart Automated Airports, Highway in the Sky, Off-Shore Air Stations)\(^{130}\).

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– merger of huge airports with cities and transforming them into logistics centres (Aéropolis)\textsuperscript{131};

– technologies of safe, automated air traffic management (ATS)\textsuperscript{132}.

Some think that biofuel application in aviation will be a complete, environment friendly breakthrough. First experiments in this field are being conducted by the British (Virgin Atlantic), which is demonstrated by the Amsterdam service of a Boeing 847-400 powered by a mixture of coconut and bamboo oils. This proves that large aircraft powered by this kind of fuel may fly at an altitude of ten thousand metres, even though it was previously thought the mixture would freeze in these conditions\textsuperscript{133}.

It seems, however, that a far greater breakthrough will be caused by the Cryoplane technology – a hydrogen powered plane, once it has been brought into general use,\textsuperscript{134} or by the hydrogen powered Dimona turboprop tested by Boeing\textsuperscript{135}.

Apart from these really disruptive technologies, numerous innovative experiments are made in aviation, like the test flights of solar power planes (HP-SIA Solar Impulse plane designed by Bertrand Piccard of Switzerland).

Traffic overload is the problem of large airports and their expansion is limited for spatial and environmental reasons. If airports are to operate more efficiently, innovative concepts of their location must be worked out as well as greater harmony in the make-up of individual modules of an air terminal, fast and reliable transfer of passengers between the terminal and the city and new technologies of passenger and baggage handling. Meeting the demands of the constantly growing air traffic is not possible through traditional investment projects, but only through seeking innovative solutions, of which the most promising are the concepts of:

– offshore airports\textsuperscript{136};

– common-use self-service kiosks, Self-service baggage check, high-capacity flow-through elevators\textsuperscript{137};


\textsuperscript{132} IFATS – An Innovative Future Air Transport System concept – http://www.ifats-project.org/IFATS_IW.pdf.


Intense activity can also be observed outside Europe of research centres, the shipbuilding industry and governments aimed at creating innovation transforming the nature of modern sea transport and ports.

Despite intensive research and implementation efforts, innovation in maritime transport is rather slow and not very spectacular. Of the solutions described in various publications, the following attract attention:

- designing and building High Speed Craft for passengers (HSC), reaching a speed of 35-45 knots and Super High Speed Container Ships (HTH) of more than 50 knots;
- concepts of environmentally friendly ships propelled by compressed natural gas (e.g., concept vessel E/S Orcelle developed by Wallenius Wilhelmsen Logistics);
- automated container handling in ports (Automated Container Handling Technology);
- concepts of automated logistics systems in seaports (including virtual deep-sea terminals) and new generation containers (foldable container).

Future shipping and seaports will be based on new generation technologies based on process automation systems, IT and satellite traffic control and management, integrating the functions of traditional operators and subcontractors.

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140 HSC with a speed of 45 knots may cover a distance of nearly 2000 kilometres a day provided it does not have to go through canals or busy straits.
141 Super High Speed Container Ships are designed by Hydro Lance Corporation. See: http://www.hydrolance.net/RO-RO-container-FastShips.htm.
The idea of sea-going All Electric Ships (AES)\textsuperscript{147} may seem too futuristic, even though electric ships do sail some lakes, especially those under strict conservation\textsuperscript{148}. There is greater possibility of replacing the traditional fuel propulsion of ships with one using natural gas or hydrogen\textsuperscript{149}.

The greatest technological breakthrough in shipping will be the design of a ship that will not sink even after an accident or break-up, as well as a ship powered by natural gas or hydrogen. Breakthrough technologies in seaports will be those which automate cargo handling and optimize port logistics.

4.7. Innovative concepts in inland waterway transport

Innovative solutions are most difficult to develop and implement in inland shipping due to natural limitations of the waterways. Even though European Inland Waterway Transport Innovation Fund\textsuperscript{150} was established by the EU in 2006, its impact on the number of innovative ideas must not be overestimated. Despite the limitations, innovative processes do take place in this mode of transport, of which the following deserve special mention:

- new generation inland craft (including energy-efficient, “clean” inland container vessels, ro/ro catamarans or articulated container vessels with pivot system as well as INBAT\textsuperscript{151} vessels capable of navigation in shallow waters);
- solutions promoting road-to-water cargo shift\textsuperscript{152};
- advanced River Information Services (RIS) systems and technologies\textsuperscript{153};


\textsuperscript{148} E.g., all electric cruise boats in the Alpine lake Königssee in Berchtesgaden valley in Germany. See: Königssee – http://www.cityscouter.com/travelguides/munich/Konigssee.html.


\textsuperscript{152} EU EU-funded project CREATING – shifting cargo from road to water – http://ec.europa.eu/research/transport/news/article_4291_en.html.

– new technologies of winter inland waterway navigation\textsuperscript{154}.

A technological breakthrough that would grossly mitigate the major weaknesses of inland waterway navigation (low speed and limited spatial accessibility) is hardly possible. There is a limit to the speed of inland craft which must not be exceeded because of environmental constraints. Possibilities of developing new generation vessels are greater in large inland or coastal water basins. What would be a breakthrough is the introduction of low-noise hydrofoils, powered by natural gas or hydrogen.

4.8. Innovations changing urban transport

Large urban areas is where the chronic transport burden and difficulties concentrate. Despite the development of underground transport (the metro) and the implementation of electronic traffic management systems, we are still unable to create a model city with fully efficient motor transport of passengers and cargo. The situation gets particularly difficult when free movement of all kinds of motor vehicles (including heavy goods vehicles – HGV) is allowed.

The phrase “innovative urban transport”\textsuperscript{155} sounds attractive and is frequently used, but it is not always that it involves an optimistic vision of a transport system composed of breakthrough technologies and organizational concepts that will secure swift traffic causing little burden to the neighbourhood, universal access to comfortable and reliable means of transport, low operational costs of transport systems and popularity with the inhabitants. There are many institutions, centres and initiatives in the world, which are supposed to generate innovation and develop systems of sustainable urban transport. Increasingly often they concern not only the transport of passengers, but also urban freight. Overall measures in this respect have been formulated and are generally approved. They include: • Intelligent Transport System (ITS) applications, which optimize passenger transport, • telematics and satellite systems (GALLILEO services), with digital city maps and congestion-reducing systems of navigation, • “green vehicle” technologies (environment-friendly), • parking space and time management, • access restrictions, • access fees in most sensitive areas of the city.


Literature of the subject and the Internet describe the following significant innovations, mature in terms of technology and organization and designed for the sustainability of urban transport:

- radical redirection of urban traffic towards public transport through reorganization and redevelopment of city districts in terms of urban planning;
- environmentally clean vehicles in urban traffic (powered by electricity, natural gas, hydrogen, compressed air or hybrid propulsion);
- automatic Personal Rapid Transit (PRT) systems – PRT vehicles work like taxis and move, depending on the type, along various specially prepared and dedicated routes (ground, elevated or suspended);
- Low Emission Zones (LEZ) with strict rules of access and parking for internal combustion vehicles;
- Urban Lift-sharing Services, also called Car-Pooling, Car-Sharing or Ride-Sharing;
- systems of on-demand minivan transport (Call-a-Bus Services also referred to as Demand Responsive Transport – DRT).

A solution to the car congestion may be the propagation of a system which the public still find difficult to accept, under which cars are used jointly by residents (carsharing, known in French as partage de véhicule or autopartage), or used by different people at various times of the day (carpooling, known in French as covoiturage), which are more universal systems than rent-a-car. Also

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157 The Swedish city of Göteborg is an example, where the Lundby district is an area of efficient public transport. See: Freight Cooperation in Lundby – http://www.managenergy.net/download/nr279.pdf.


innovative are some forms of non-motor urban transport – among them the bike-sharing system,\textsuperscript{165} increasingly popular in European cities, not only those with moderate climate. Owing to it, some of car traffic changes to bicycle traffic (see Fig. 18).

Organized innovation efforts to create sustainable urban transport systems have for years been made by the European Union\textsuperscript{166}. The March 2009 directive \textit{On the Promotion of Clean and Energy-efficient Road Transport Vehicles} is of considerable significance for the promotion of innovative urban vehicles.


4.9. Innovations in the construction and operation of transport infrastructure

Innovation processes in the field of transport means and their propulsion cause the need for new generation transport infrastructure. This is particularly conspicuous in aviation and rail transport, where the design characteristics of innovative vehicles preclude them from using traditional routes and terminals. There is, however, a tendency for breakthrough technologies to be introduced in infrastructure, irrespective of developments in propulsion concepts and technologies. This is because of the need for improved functionality, safety and security as well as durability of the infrastructure, which is expected to operate more smoothly and at a lower cost. The most significant breakthrough in the construction of roads was the advanced mechanization of construction works (see: Fig. 19).

Rationalization of construction and operation of transport infrastructure takes many forms, which can be grouped as follows:

– innovations in infrastructure design and integration with the environment;
– innovations in the use of materials;
– concepts of extra fittings and furnishings;
– systems improving traffic flow and safety;
– intermodal solutions.

Innovative design of transport infrastructure means a comprehensive approach to the solving of project-specific problems, which concern not only engineering, natural and financial issues, but also long-term macroeconomic aspects, attitudes of the public, business risk as well as other important socio-economic concerns.

Innovative design of transport infrastructure is close to the notion of Integrated Transport Planning, which has for some years been in the focus of na-
tional and EU authorities as well as of specialized institutions and design firms. The previous absence of this kind of planning in Europe has led to excessive technical diversity of transport systems, numerous bottlenecks and missing links in the network. The methodology of integrated planning, especially in intermodal transport, was studied theoretically during research projects of the EU 4th and 5th Framework Programmes.\textsuperscript{167} Some design firms, however, abuse the term “integrated planning” by referring it to the traditional planning of local engineering solutions like ring roads, new junctions and the new elements supplementing the traditional transport network\textsuperscript{168}.

The adjusting of the transport infrastructure capacity to economic and social needs requires the application of a whole range of measures covering the conventional construction of new connections and facilities as well as giving new properties to the existing infrastructure by implementing the Intelligent Transport Systems and Services concept (ITS)\textsuperscript{169}.

Most successful ITS applications for the network include traffic management and control systems (European regional projects – part of the long-term indicative TEMPO 2001-2006 programme), inland navigation systems (River Information Systems – RIS and the SafeSeaNet) and the European Rail Transport Management System (ERTMS)\textsuperscript{170}.

In the civilized world today, the development of an infrastructural project is a complex, multi-layered process covering many aspects, requiring new forms of public consultation, new types of experts' reports and IT simulations of how the new facility will work in the future. A useful new tool in the solving of conflicts and problems arising from infrastructural projects is the exchange of best practices – one of the most useful forms of benchmarking in transport. The process is founded on a reliable description of examples of empirically proven solutions. Examples of transport investment projects which have been completed in Europe are really numerous, however only few of them contain the word suc-cesful in their description. Even if a new piece of infrastructure works well and


produces satisfying effects, it does not yet have to be labelled successful and a best-practice example. After all, there is nothing special about project completion in favourable conditions. Various organizations of international networking, however, try to create best-practice manuals. Efforts to organize European exchange of best practices in transport should be viewed as definitely positive. The commitment of the European Rail Infrastructure Managers (EIM)\textsuperscript{171} is a good example as well as the activities of the UITP for the comparison of best practices in urban transport\textsuperscript{172}. Also national systems of best-practice analysis and description systems created in Germany, France, the UK and other EU member states are of high cognitive and applicative value.

A very important innovative trend in transport infrastructure is the concepts and application of new materials and prefabricated elements for its construction. Even though a technological revolution in this respect is not to be expected and asphalt and concrete will continue to be the main materials in roadbuilding, just like ballast and steel rails in the construction of rail and tram tracks, but the infrastructure will contain more and more new generation materials. There are two reasons behind innovation in this area: (1) infrastructure quality, durability and safety enhancement, (2) the use of wastes that are difficult to manage otherwise. The former objective is met in roadbuilding by alternative subgrades and base courses, anti-skid surfacing as well as materials and installations for monitoring (optical fibre and others)\textsuperscript{173}, the latter by the development of new possibilities of large-scale management of industrial and construction wastes.

The most complex and material intensive is the construction of and operation of road and bridge infrastructure, requiring huge amounts of (coarse) crushed aggregates, sand, gravel and the like. Such large consumption of natural resources degrades the environment and the landscape, while the mining and processing of these materials is costly and energy intensive. On the average, one kilometre of a new dual carriageway (motorway) takes 800-1000 tonnes of asphalt or ca 3,500 tonnes of concrete. There is the dilemma: should we build motorways with bituminous or concrete surfaces? Bituminous road surface is half the cost of the concrete surface, while the latter lasts 2.5 to 3.5 times longer, but is less recycleable\textsuperscript{174}.

A comprehensive picture of innovative roadbuilding of the future was outlined in the New Road Construction Concepts (NR2C) – a project conducted in 2005-2008 within the EU 6 Framework Programme by the Forum of European

\textsuperscript{171} European Rail Infrastructure Managers – http://www.eimrail.org.
Road construction in the future will have to meet four groups of requirements:

1) reliability – the road should: last long, be built quickly and at low cost and be easy to maintain and repair;
2) low environmental impact of infrastructure – reduced in terms of noise, pollution and vibrations;
3) safety and functionality – achieved through the application of electronic and intelligent systems;
4) convenience for the public – infrastructure must be harmonized with various aspects of human life, perform a number of functions and tasks and be compact in form in cities.

Innovation in terms of materials in roadbuilding mean the use of alternative materials and ones refining asphalt, concrete and road foundation. Quality aggregates in short supply can be replaced by clinker aggregate and cement clinker mixes.

Innovative solutions and technologies are developed and implemented based on high-strength materials. To this end, nanotechnologies, microtechnologies and biotechnologies are used, modifying the structure of materials, e.g.:

- alternative materials in road construction, recycled materials in road construction;
- new materials that are added to conventional asphalt, concrete or asphaltic concrete (geotextiles, geosynthetics, composites, polymers and others);
- skid-resistant road surfaces;

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– solar collectors to de-ice the road surface in winter\textsuperscript{181};
– new noise-absorbing road surfaces in housing estates, etc.\textsuperscript{182};
– traffic control and satellite navigation systems\textsuperscript{183};
– on-road parking space management systems\textsuperscript{184};
– underground infrastructure for cargo transport\textsuperscript{185}.

Innovative non-organic stabilizers like Durabind\textsuperscript{186}, recycled materials\textsuperscript{187}, recycled glass\textsuperscript{188} or recycled cold asphalt are used more and more often in roadbuilding. These materials must be adapted to local weather conditions, in particular great temperature variations between the summer and the winter. In Poland, innovative roadbuilding might be the user of one of the most troublesome wastes – asbestos – used in the countryside from the 1960s on as roofing material.

Railway line construction and maintenance using traditional technologies is slow, material intensive and putting a burden on the environment. The protracted use of these technologies is the reason why rail infrastructure is degrading in many countries, train speeds are decreasing and many lines are decided not viable. Infrastructural innovations in the rail sector may be of twofold nature: (1) they may upgrade the conventional rail track and its elements (switches and rail joints), (2) they may introduce unconventional railway solutions (magnetic levitation, Sky Train and others\textsuperscript{189}).

Innovative materials in railway construction do not emerge too often. A review of information published by rail manufacturers does not reveal significant

\textsuperscript{183} M. Saïd, Systèmes de transport intelligents : modélisation, information et contrôle. Hermes Lavoisier 2007.
innovation in terms of rail shape and the metals used. Usually, efforts are made to enhance rail durability, which greatly affects Life Cycle Cost (LCC)\textsuperscript{190}.

Of great importance for rail traffic safety and quality is the application of such innovative materials and subsystems as: • noise absorbing sleepers and fixing\textsuperscript{191}, • pre-formed surfaces that eliminate road vehicle bumps at rail/tram crossings, • innovative materials for the construction of rail noise screens.

Aviation infrastructure is basically nodal, which means lower material intensity in its construction in comparison with road or rail networks. Research work on new technologies concentrates on heavy-duty materials for runway construction. New building materials in aviation infrastructure are most useful in the construction, upgrading and recycling of runways. The properties sought in these materials are greater durability (crack resistance), better visibility for pilots (concrete or asphalt mixed with granulated glass), proper surface texture, hydroplaning prevention in heavy rain. Innovations in this area do not mean, however, replacement of the conventional concrete, asphalt or mixtures of the two, but refining them with innovative additives.

In port construction, innovative materials are inspired by the challenges of protecting the infrastructures against the destructive impact of the waves, preventing siltation of port basins and canals (caused by sea currents). Innovations in the area of materials used in this transport mode are much more difficult than in land transport, as recycling opportunities are limited (materials used in hydrotechnical engineering must not be toxic, must have a long life cycle and be friendly to the marine environment).

Another innovative trend in the area of transport infrastructure is the concepts for its additional elements of various degrees of technological advancement. These may be structural elements as well as entire intelligent systems. Among the less ambitious ones are construction improvements designed to calm the traffic and enhance safety, like small roundabouts, safety islands in residential areas, visibility enhancement devices at crossroads and curves, additional traffic lanes on slopes, roadway narrowings, raised tables etc.\textsuperscript{192} Not all the aforementioned solutions work well in practice\textsuperscript{193}.

The greatest added value is contributed to transport infrastructure by intelligent systems (ITS), which are a large set of various technologies (ICT, IT, auto-

\textsuperscript{190} INNOTRACK objectives – http://www.innotrack.net/overview.html.


\textsuperscript{193} Too many roundabouts in towns and cities slow down the traffic, jam the streets and cause exhaust emissions to increase. Quite often, the money spent on roundabout construction could be used more effectively to build ring roads around towns/cities and housing estates. Safety islands, unless properly shaped (a shuttle, not an oblong) can undermine road safety rather than improve it.
information and measuring), as well as management techniques used in transport to protect the lives of traffic participants, boost transport system efficiency and protect the natural environment. ITS systems provide an ample set of information for motorists and passengers, help in traffic management, enrich the vehicles with useful equipment, make help more easily available in an emergency, make electronic toll collection possible.

The quality of transport infrastructure has a major influence on its proneness to accidents and disasters, particularly in rail transport. Measures to improve safety are not limited to conventional investment projects and repairs, but include additional on-board and ground systems as well. In road transport, they are an element of the international Transport Information and Control Systems (TICS). The infrastructural elements of the system are solutions like the instruments of Infrastructure Maintenance Management or Intelligent Junctions. In European rail transport, this role is performed by the ERTMS and its modules – ETCS and ETML, while in air transport, by ATS.

Intermodal transport systems are still waiting for breakthrough technologies. The existing solutions have little to do with intermodality understood as the ability of a means of transport to move swiftly in various transport environments (roadway, railway, waterway). The DMV concept of road-rail vehicles, (road-rail buses, dual-mode vehicles) goes in this direction. One example is an articulated road-rail minibus in the Japanese island of Hokkaido.

Innovative intermodal solutions are created to eliminate or mitigate the faults and weaknesses of traditionally understood intermodal systems. Generally speaking, they include the development of new technologies of transport means operation, new ways of cargo handling, new design concepts of loading units and new communication techniques between entities in the intermodal supply chain.

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Infrastructural innovations aim at adjusting railway lines and terminals to the requirements of the new systems. The most promising innovation area is rail terminals, which are highly absorptive of information and IT systems, leading to a reduction in operational time and costs. There is not much progress, however, when it comes to innovative solutions that would swiftly and effectively improve elements of road-rail technology adapted to the loading gauge limitations of the railway lines

4.10. Bibliography


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204 The Rollende Landstrasse (RoLa) system has been the only attempt to radically change road-rail transport technology. It did not include changes in railway line parameters. See: Rolling highway – http://en.wikipedia.org/wiki/Rolling_highway and Loading gauge – http://en.wikipedia.org/wiki>Loading_gauge.


5.1. Introduction

The early development of contemporary logistics is related to military logistics connected with transportation of soldiers, arms and supplies. With the beginning of World War II, logistic concepts have been significantly improved and transferred to the world of business. The application of logistics on a wider scale in business operations and the implementation of new solutions in the logistics of enterprises took place in the 1950s and the early 1960s, although it was in fact only military organizations that used the term logistics in that period. Initially, logistics was identified with inventory control and physical distribution of goods, mainly in terms of optimising transportation and warehousing processes. Later, logistics also integrated such areas as stock management, location of manufacturing and warehousing facilities, information flow, etc. A gradual evolution was taking place through creation of supply chains to include integrated management activities and virtual networks and transition from pursuing operational goals to strategic objectives. The essence of contemporary logistics is most of all the flow of information, as a result of which rationalised physical flow occurs.

The rise and development of the “new economy” in recent years has been possible owing to the progress in information technologies and the new business models. The advent of the new age of technology and the Internet has led to transformation-based changes in the economy. Combining available technologies with knowledge makes it possible to formulate the notion of “technological competence,” which should be understood as a certain package of technological resources, skills and experience that enable companies to build sus-
tainable competitive advantage in the new global economy\(^1\). Companies that establish new business models often derive great benefits from the idea of using new sources of income by way of applying technologies and satisfying new forms of market demand.

Changes occurring in logistics are most of all related to macroeconomic changes influenced by globalisation, integration processes, development of e-economy, shorter product life cycles and increasing customer requirements. The purpose of this chapter is to present these changes and examples of technological and organisational innovation exerting significant impact on the directions of development in logistics. It was noticed already a long time ago that more attention in the logistic industry should be paid to innovations concerning the services provided and many scientific studies and empirical work have been devoted to this issue. Innovations in logistics may be implemented by means of the so-called new resources, i.e. technology, knowledge and cooperation networks, which are of substantial importance if companies are to operate effectively and use the possibilities of achieving the position of innovation leader in the market\(^2\).

### 5.2. The essence of innovation and its types in logistics

Innovation of enterprises manifests itself in implementing new technological solutions or solutions related to the organization of business operations. This means that innovation in logistic services may refer both to services as a product and to the process of their provision, enterprise organization and management, or relations with the environment. The activities undertaken are focused on implementing changes which lead to making the company more advanced and more competitive.

Demand for new technological concept generated by research and development is usually lower in the service sector than in manufacturing and in many cases it is the industrial sector that is the source of technological innovations in logistics. The first stage in the process of implementing innovations in a logistics enterprise is often to adapt a new technology (e.g. ICT), the application of which brings benefits in the form of more effective processes within the enterprise, which in turn contributes to a better quality and better methods of providing

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services. New types of services may originate only as an effect of implemented changes. Marketing and organizational innovations are of much greater importance for the service sector. Unfortunately, most of the research related to technology and innovation is focused on the manufacturing industries, although greater attention has recently been paid to technological innovations in service sectors, too.

An important factor influencing the innovativeness of logistic services is the company’s ability to create, acquire and manage knowledge. This translates into the structure of innovation sources, mainly external partners where the high importance of contacts with customers is strongly emphasised. And the personnel of a logistic enterprise are a key element of the resources of knowledge involved in the process of searching, creating and implementing innovation.

The purpose of innovation in the logistic services industry is most of all to improve the quality of services, diversify the offer, adapt its scope to specific needs and try to lower the clients’ logistics costs. The effects of innovations implemented by logistic enterprises are less “visible” because they are intangible and difficult to measure. Then, the lack of objective criteria to assess the innovativeness of those services is the reason why it is difficult to convince the customer that a given service is innovative and that it is worth paying a premium price for it. Unfortunately, the intangible nature of services is also the reason why non-technological innovations may be relatively easily imitated by competitors. Enterprises implementing such innovations must take into account the fact that their ideas may quickly be duplicated and become widespread, thus ceasing to be innovative any longer. This is likely to happen also because innovations of this type are rarely protected by the law (e.g. in the form of patents).

Many classifications based on the specifics of the conducted operations are to be found in literature, mainly in foreign publications. Logistic innovations refer to all changes in logistics and services provided in the supply chain, which may range from basic and gradual, to comprehensive, complex and highly transformed ones. The most often used classification distinguishes between technological (product and process) and non-technological (organizational and marketing) innovations. Sometimes in a reduced version, technological, organisational and market innovations are mentioned. The classification is particularly important in such service sector as TL, where technological and, especially, ICT innovations have contributed to the fast growth of the sector over the last

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6 R. Chapman, C. Soosay, J. Kandampully ..., op. cit.
ten years. Technological innovations often lead to manufacturing new products or services, whereas “soft” innovations focus on organizational and management issues: to improve the organizational structures, tailor the services to the customer’s requirements, extend the sales networks, improve the orders and distribution system, financing methods, etc.

Due to the nature of the supply chain logistics and management, the impact of improvements on the functioning of individual enterprises, supply chains or even the whole industry should be analysed. The type of implemented changes will affect the period after which effects can be seen. D.W. Allvine and T. Gore have divided the solutions implemented in supply chains into four groups: “quick hits”, short-term, medium-term and long-term7 (see Table 16).

<table>
<thead>
<tr>
<th>Improvement project</th>
<th>Duration</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick hit</td>
<td>1-6 months</td>
<td>Provides immediate benefits. Includes simple changes in a process or policy of the company and is easy to implement. Can also be a temporary solution put in place until larger, more strategic improvements can be implemented.</td>
</tr>
<tr>
<td>Short-term</td>
<td>Less than 6 months</td>
<td>May refer to pilot efforts identified in the supply chain diagnostic. Often includes process, policy and organisation changes. May also include minor technology enhancements.</td>
</tr>
<tr>
<td>Medium-term</td>
<td>6-18 months</td>
<td>Often consists of significant organizational change of one or more key supply chain components. Can include additional rollouts of piloted efforts and large-scale technology improvements.</td>
</tr>
<tr>
<td>Long-term</td>
<td>More than 12 months</td>
<td>Strategic and large in nature. Often includes changing the way an organisation approaches the supply chain. Can be the large-scale change that allows organizations to maximize their supply chain and differentiate themselves from their competitors.</td>
</tr>
</tbody>
</table>


Innovation is a necessity for logistics companies serving “new economy” markets. Certain conditions in terms of technology, knowledge and relations in the chain must be fulfilled if companies are to be innovative8. Knowledge is an important element in the flow of materials, information and services for the needs of logistics. The amount of data and information in the economy of today is enormous, and companies have to transform it into knowledge and action to effectively implement innovations. In order to improve their market position, logistic companies will have to catch up with the progress in information and

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communication technologies. Correct implementation of those technologies may be the source of significant competitive advantage for enterprises. It is important for the logistic industry with its dependence on access to information and on information flow. Information and communication technologies in logistics refer to hardware, software, and design of networks required to process and exchange data. Hence, they include such elements related to the supply chain as, for instance, electronic data exchange (EDI), Web-based orders, bar code system and radio-frequency identification (RFID) systems, satellite navigation systems, applications supporting supply chain management, transport management (including vehicle operation planning and transport supervision), stock replenishment, automation of warehouse operations, etc. Some of these solutions will be discussed later in this chapter.

5.3. Innovative organisational concepts and solutions in logistics

5.3.1. Evolution of innovative concepts in logistics and supply chains

The commonly quoted definition of logistics developed by the USA-based CSCMP (the Council of Supply Chain Management Professionals) shows that logistics is a supply chain element and it is closely related to supply chain management. Logistics is defined as this part of the supply chain processes which plans, implements, and controls an efficient and productive flow and storage of goods, services and related information between the point of origin and the point of consumption, in order to meet customers’ requirements. In many academic centres a different view is taken, namely, that the supply chain management is only a part of logistics, which deals with logistics going beyond the company, i.e. at the contact point between customers and suppliers. Literature of the subject, particularly European, sometimes identifies logistic management with supply chain management and the terms are used alternately. Although many theore-

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10 Former CLM (Council of Logistics Management).
ticians, researchers and practitioners believe that supply chain management is a broader notion than logistic management, there is no conceptual agreement in this respect. However, notwithstanding the manner in which logistics and its relations with supply chain management is defined, all changes and innovations implemented in supply chains will also apply to logistics. The latter covers various concepts of managing the process of physical flow of goods based on an integrated, systems approach to those processes, which makes it possible to rationalise total logistic costs. Rapid development of logistics has the following causes:

- exhaustion of the possibilities of reducing production costs;
- increase in transport costs;
- increase in stock handling costs;
- greater differentiation of products and change in the structure of marketed goods;
- globalisation of economic processes;
- development of state-of-the-art IT tools.

Along with the changes in the environment, there has been a transition from many decentralised logistic tasks carried out in enterprises separately under various functional areas towards a system approach to logistics, within which the logistic system of an enterprise is treated as a subsystem in the supply chain. Many enterprises from various industries have decided to subcontract logistic functions to specialist operators. As simple cost reduction methods have been exhausted, greater attention is paid to stock control, in an attempt to decrease its levels in the whole logistic chain and accelerate their turnover. In the 1980s, the term ‘integrated supply chain’ started emerging, covering enterprises cooperating with one another and forming simple chains or more complicated networks. Effective management of a whole network of enterprises was aimed at optimising the value in the whole chain, and the determinants of its effectiveness were quality, time and costs of operation. Such commonly known concepts as “just in time” or “lean management” are related to that period.

The concepts of supply chain management are subject to constant transformations. The expectations of customers concerning supply chains and directions of their development reflect changes occurring in the environment. Initially, supply chain management was defined as a new approach to more effective performance of logistic functions and better integration of customers and suppliers into one stream of supply and distribution. At the present time, supply chain management describes both the philosophy of business and the tools of practical operation, focused on an effective flow of goods and services from the manufacturer to the end user.

E. Frazelle has distinguished five development phases in logistics, while the rapid development of the e-economy is the reason why it is possible to talk about the sixth phase called e-logistics (see Fig. 20).

The Internet and e-commerce are new challenges for logistics. Rapid development of information and communication technologies was the main driving force for the service sector’s growth and is still an important factor of innovation. The Internet enables self-service of customers to a larger extent, and this is the reason why companies interact with customers and business partners providing services immediately, regardless of national borders. Companies have had to reassess their opportunities and challenges and to examine which concept of conducting operations to adopt. If they wish to actively operate in the global market, they must first of all adopt innovative strategies and business practices. Enterprises that are market leaders have transformed their supply chains from static and isolated to demand driven. The latter are integrated with customers, partners, suppliers and service providers from beginning to end.

The best supply chains have the capacity to quickly respond to changes in demand on the basis of innovative products and services. To achieve this purpose, they apply different variations of strategies and business models in combination with leading concepts and practices of management. Various surveys

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Fig. 20. Logistics development phases

show that it is the time of response, flexibility, speed of delivery and sensitivity to costs that will determine the competitive advantage in the years to come\textsuperscript{17}.

\subsection*{5.3.2. Modern forms of outsourcing logistic services and new business models}

As one of many functions within an enterprise, logistics may either constitute its key competence, or be subjected to the process of outsourcing. The decision whether to outsource, and to what degree, is influenced by the enterprise development strategy as well as the specific features of the industry. In West European countries, the most often outsourced operations include transport, transport (fleet) management, warehousing and IT systems\textsuperscript{18}. The scope of these activities is being extended all the time as new services are introduced by logistics providers. Interdependences may be also mentioned as the requirements of customers ordering services and competition in the TL market enforce implementation of innovative solutions in supply chains, and on the other hand, the increased effectiveness and improved quality of logistic services induces manufacturing or trading businesses to use outsourcing.

Reports on outsourcing logistic services have been regularly published for thirteen years. They are prepared on the basis of an analysis of opinion polling and experiences of users of services provided by logistic companies (3PL) worldwide\textsuperscript{19}. Table 17 shows the scope and percentage share of services subcontracted to logistics companies in 2007 and 2008.

On the basis of an analysis of the data contained in Table 17, it can be concluded that the markets for logistic services in Europe and in North America differ quite strongly. In Europe there is significantly stronger inclination to outsource transport services and fleet management and services related to product packing, labelling, packaging, etc., whereas in North America the outsourcing is more significant in respect of customs clearance and insurance brokerage, audit and handling of payments and supply chain consultancy, i.e. activities usually called “office” activities. Fairly significant changes occurred in respect of outsourcing of some logistic services in 2007-2008. In the European market the largest increase in the number of services subcontracted to external companies took place in respect of the logistic handling service of returned goods, activities related to labelling, packing, packaging, cross-docking and handling of orders (7-9\% per annum). A reverse tendency was noted in the outsourcing of forward-

\begin{itemize}
  \item \textsuperscript{19} The State of Logistics Outsourcing. 2008 third-party logistics. Cap Gemini, Georgia Institute of Technology, Oracle, DHL 2008, p. 7.
\end{itemize}

126
ing services and fleet management (decrease by 6-7%). It is emphasised, not without a reason, that the logistic services market still has considerable development potential. To a large extent it results from the ability of logistic companies to adapt to the changing conditions and implement state-of-the-art solutions which give customers such an added value which they would not be able to create on their own.

A display of such adaptation ability was the introduction of newer and newer outsourcing forms or, as defined by some, new business models\(^\text{20}\). Traditionally shippers purchased transport services from asset-based carriers that were able to provide the services at lower costs due to the benefits of the production scale and specialization. However, the importance of non-asset-based providers of logistic services was growing all the time as information technolo-

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### Table 17. The scope of outsourcing of logistic services in Europe and North America (2007-2008)

<table>
<thead>
<tr>
<th>Type of logistic service</th>
<th>Share of services outsourced to logistic companies (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic transport</td>
<td>91</td>
</tr>
<tr>
<td>International transport</td>
<td>87</td>
</tr>
<tr>
<td>Warehousing</td>
<td>68</td>
</tr>
<tr>
<td>Customs clearance and insurance brokerage</td>
<td>58</td>
</tr>
<tr>
<td>Forwarding</td>
<td>51</td>
</tr>
<tr>
<td>Cargo consolidation</td>
<td>44</td>
</tr>
<tr>
<td>Cross-docking</td>
<td>35</td>
</tr>
<tr>
<td>Returns logistics</td>
<td>33</td>
</tr>
<tr>
<td>Product labelling, packaging, assembly, kitting</td>
<td>33</td>
</tr>
<tr>
<td>Transport management (planning of cargo handling and carrier selection)</td>
<td>41</td>
</tr>
<tr>
<td>Freight bill auditing and payment</td>
<td>18</td>
</tr>
<tr>
<td>Supply chain consultancy by 3PL</td>
<td>11</td>
</tr>
<tr>
<td>Fleet management</td>
<td>21</td>
</tr>
<tr>
<td>Order entry, processing and fulfillment</td>
<td>7</td>
</tr>
<tr>
<td>LLP/4PL services</td>
<td>11</td>
</tr>
<tr>
<td>Customer service</td>
<td>10</td>
</tr>
</tbody>
</table>

gies were gaining more importance in supply chains integration. More and more often, the benefits of scale or those resulting from the possibilities of management and integration of complementary logistic services became a source of cost reduction or improvement of the provided services and were a basic selection criterion for those services. The globalisation of business activities increased the demand for global supply chains, which were becoming longer, more complex and more and more costly. Manufacturing and trading businesses search providers of logistic services that may fulfil their global logistics needs.

The tendency to outsource logistic activities, contributed to the business development of logistics providers referred to as 3PL, and then also 4PL and 5 PL. The scheme of implementing innovative forms of outsourcing in logistic services is shown in Fig. 21.

![Fig. 21. Forms of outsourcing of logistic services](source)

The term 1PL (in-house logistics) means that logistic services are provided by the owner of distinct resources such as vehicles, warehouses or handing equipment on their own. 2PL (second-party logistics, logistics service provider – LSP) means management of traditional logistic functions such as transport and warehousing. The services are provided by external providers such as transport, handling or storage companies, providing services within a relatively narrow

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scope. The main reason for using providers of the 2PL services is the intention to reduce operating costs and avoid costly capital investments.

As the demand for one-stop solutions was growing, many 2PL business evolved into 3PL by adding new logistic possibilities and integrating their operations. 3PL (third-party logistics, forwarding logistics or contract logistics) means using external organizations to perform logistic functions which may apply to the whole logistic process or to selected functions only. The supplier of 3PL services acts as a “third-party” between the manufacturer and the final customer. Cooperation with a 3PL company may be also defined as a logistic or a strategic alliance, which means a close relation between the company and the logistics provider, not limited only to logistic handling of tasks, but including also the sharing of information, risk and benefits arising from the long term contract.

4PL (fourth-party logistics, supply chain logistics, lead logistics provider – LLP) companies manage and conduct complicated logistic operations covering the whole supply chain from beginning to end. The key factor contributory to the development of 4PL providers was the necessity to engage and manage information within the supply chain. 4PL providers have often originated from 3PL companies, however, their activity has a much wider scope, particularly in respect of information services and management of business processes. 4PLs coordinate execution of logistic processes occurring along the whole supply chain of their customer, from suppliers of raw materials to final purchasers, and not only on a specified section of the chain as is the case with 3PLs. In the 4PL model, 3PL is basically raised to the rank of a coordinator of the flow of goods, and not only a physical operator carrying the goods.

The providers of 4PL services are in fact integrators of logistic services as they are responsible for executing contracts with all 2PL and 3PL providers. The company that uses 4PL services is in contact only with the operator that manages and integrates all types of resources and supervises all functions in the entire supply chain. Having a full view of the supply chain and large logistic and information capacity, 4PL providers may also provide to the manufacturer consulting services with a high added value.

The 5PL outsourcing model is a subsequent step in the development of full logistic integration. 5PL (fifth-party logistics) companies are providers of integrated logistic services. They are able to develop and implement flexible supply chains of a network type to satisfy the demand of all partners, including manufacturers, suppliers, carriers and buyers. A 5PL provider manages the supply

24 The Logistics Players- From 1PL to 5PL, LinkGlobal Logistics Co, http://www.linkglobal.net/1g/e-xxyd-001.htm#08 of 10.10.2008.
chain at a strategic level and focuses on providing logistic solutions throughout the entire supply chain. There are 5PL model interpretations where it is emphasised that enterprises operating in the 5PL model originate from lower logistics levels and have been created to serve the e-business market. 5PL providers are considered to be 3PL and 4PL companies that manage all links in the supply chain for e-commerce. 5PL organizations are almost fully virtual, as having no typical assets, they focus on acquiring the necessary skills to manage and coordinate operations of other providers of services through dedicated information solutions, and they are also associated with the demand and supply sides through electronic logistic services markets.

The major tasks of 5PL companies include mapping and reengineering of the supply chain, the 4PL functions (integration and control of transport, handling, warehousing, etc.) and providing integrated information systems to ensure real-time visibility and control of the supply chain. Another task of 5PL is also to adapt specific supply chains to the operation of a common network managed by one organisation at the strategic level. The network participants are able to derive greater benefits from the visibility of flows in real time and the economies of scale, achieving better efficiency and lower costs, which they would never achieve using 3PL services.

5PL is not a physical organisation but a system that provides information to the chain participants under its control. Then, individual participants manage various supply chains in the network on the basis of the information received in real time and adapted to such logistic services as transport, forwarding, warehousing, etc. Development and coordination of specific supply chains and their transformation into supply networks by 5PL involves formation of virtual corporations.

Through new business models, companies generate greater possibilities for integration of supply and cooperation chain, which translates into producing new values for customers and business partners. Network organisations such as Virtual Network Consortia (VNC) and joint ventures increase the width and depth of their supply chains and significantly improve the industry’s position in international markets. Global competition requires more and more joint initiatives and cooperation for innovations, both at the industry level and the supply chain level. The tendency to combine the logistic service of flow of goods with the management of information and knowledge will become more and more important in the future.

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5.4. The scope of technological innovation in logistics

The development of new technologies has led to significant changes in business practices, particularly those related to marketing, communication and distribution. Based on the scope of logistic operations, innovations in logistic technologies may be divided into four categories:

– data identification and acquisition technologies;
– information technologies;
– warehousing technologies;
– transport technologies.

5.4.1. Innovations in data identification and acquisition technologies

Providers of logistic services deal with large amount of goods and related information every day. Many technologies defined by a common term of automatic identification system (Auto-ID), or more broadly Automatic Data Capture (ADC), are used in supply chains. The automatic identification system is a set of technical means and devices used for automatic collection, processing and transmission of data. Owing to the system, data can automatically be captured and entered into the database of an IT system without the use of a keyboard. The quality of these activities is decisive for information management, security and shipment control. The systems allocate a unique code to the product model or type, which may be automatically read and used by information processing systems. Auto-ID systems are marked by high precision, speed and automation of certain operations. The precision in capturing data from shipments helps logistics providers to supply goods to customers efficiently and accurately. Automatic identification systems limit the need for the manual filling of documents and entering of data into the system, which minimises the number of errors.

The most frequently used automatic identification system is bar codes, however the use of radio-frequency identification (RFID) systems is on the increase. Other methods of automatic identification of goods include: Optical Character Recognition (OCR), magnetic tracks, vision systems, smart card technologies (memory and chip cards) and biometric technologies (voice identification and fingerprint scanning).

The basis for exchange of information and applications of state-of-the-art technologies is a unified and determinate identification system. It is also neces-

28 Chieh-Yu Lin, Factors affecting innovation..., op. cit.
29 K. Rutkowski, Technologia RFID w zarządzaniu łańcuchem dostaw. “Gospodarka Materiałową i Logistyka” 2003 No. 11/12.
sary for company management and for effective exchange of goods. A breakthrough in logistic was the introduction of bar codes. The 12-digit system of product labelling, the Universal Product Code (UPC), was for the first time used in the USA, and then the European Article Number (EAN) was developed on its basis. At the present time, international standards of marking goods by bar codes, identification of businesses and services and electronic exchange of information are included in the EAN.UCC system.  

The use of two-dimensional (2D) codes could also be recognised as technological progress. The development of bar code reading techniques and a drive for including in the code as much information as possible led to the creation of a new code type with a considerably greater density of data recording. The 2D code makes it possible to store much more data without enlarging the code area. In addition to digits, it can contain a graphic entry or even sound. One two-dimensional code may accommodate up to 3,500 symbols while a linear code – up to 50 symbols.  

Another generation of product identification systems is the Electronic Product Code (EPC) related mainly with the RFID technology. It is recorded on an electronic carrier called tag, which is placed on the identified object. The EPC global concept was created several years ago in the course of preparing a uniform international standard for coding products – both for single units of merchandise and bulk packs used during transport. The currently developed EPC Global concept combined two technologies: radio-frequency identification (RFID) and the Internet, owing to which the product supplied with a tag is visible in the whole supply chain in real time. The RFID technology uses the radio signal to transmit data between the tag and the reader. In addition to this, middleware is used, which plays the role of an interface between the reader and the application (e.g. ERP system) and the Internet, which is used to manage the information flow in the whole EPC network.  

The RFID technology, currently implemented in logistics and based on radio wave emission, does not require physical contact between the reading device (scanner) and the identified element. It offers significantly greater possibilities than bar codes, however, it is not free from faults. The basic benefits resulting from implementing the RFID technology include saving the time required for scanning (the tag does not have to be visible in the course of reading) and operational improvement achieved due to greater accuracy of reading and a smaller number of scanning errors. Additional benefits include a longer read-
ing range, a possibility of simultaneous reading of many tags and marking each single merchandise item with a different code. When RFID technologies are combined with appropriate computer software, information about goods in stock, production processes or incoming orders and returns is obtained on a current basis. Application of RFID technologies allows efficient and precise execution of orders and tracking of the tagged goods throughout the entire supply chain.

Despite its obvious advantages, the RFID identification system cannot replace the bar codes. The basic barriers to its application include high cost of implementation and operation as well as problems of frequency band allocation. Controversies are caused by the possibility of violating the privacy of individuals due to the fact that a tag may be read from a long distance without the knowledge of its holder; another cause for concern is excessive monitoring of workers. The features of identification by means of bar codes and RFID tags are the reason why each of these technologies finds an appropriate sphere of application. Despite the introduction of the RFID system, bar code technologies continue to be developed in order to increase their capacity and to application in a greater number of areas. The RFID technology supplements the bar codes rather than competes with them, extending the existing possibilities of managing the flow of goods.

5.4.2. Innovations in information technologies

Methods of data collection and transmission and the involved identification technologies have an impact on the quality of the organization’s information system. A logistics information system is a set of mutually interrelated elements including people, hardware, software and procedures ensuring access to relevant information required for planning, execution and control of logistic activity. The information system determines the flow of information in the organization and communication of commercial information between business partners which affects many aspects of management including customer service and creation of added value.

The validity of information depends on the methods of its collection, the information channels used, configuration and reliability of information transmission networks and the information flow frequency. In this context, great importance is attached to implementing innovations providing access to information in real time. The information technologies which are commonly used in the logistics industry include:

35 Chieh-Yu Lin, Factors affecting innovation..., op. cit.
- Electronic Data Interchange (EDI);
- the Internet;
- Value Added Network (VAN) containing additional services and functions assigned to a specified group of persons or entities;
- logistics information system;
- Point of Sales (POS);
- Electronic Ordering System (EOS);
- VOIP telephony;
- enterprise information portals.

The development of information systems is related to the integration of various IT systems and the use of the existing data exchange standards. An IT system is a separate part of the information system which is computerised from the point of view of the adopted goals, i.e. the flow of information takes place owing to the use of information technologies in the form of network, hardware and software infrastructure. The newly implemented IT systems are characterised by greater capacity in respect of the volume and speed of data processing. This applies both to integrated information systems in a single organisation and to network systems\(^\text{36}\).

The regulation on the terms of issuing and transmitting invoices in electronic form\(^\text{37}\) gave rise to new practices also in the field of logistics. The e-invoice regulation permits two mechanisms of protecting the authenticity and integrity of such an invoice: secure electronic signature and Electronic Data Interchange (EDI) standards. The most important advantages of the e-invoice to be mentioned include lower costs of issuing and sending original copies of invoices and storage of invoices, significantly faster invoice delivery and automation of the invoicing process. A possibility of account settlement using electronic invoices with a digital signature is introduced by TNT Express. A new service called Express Invoicing will be available in 30 countries, including Poland. Instead of a paper document an e-mail will be sent to the customer with a link to a secure Web page (access protected by password) in which electronic invoices will be kept. Such documents will be available in different formats, including PDF and CSV as well as XML\(^\text{38}\).

The implementation of EDI requires a telecommunication network to connect an organization with its business partners. Value Added Networks (VAN) or the Internet are used for this purpose. Several EDI types are used in Internet communication solutions: Mail-based EDI (using electronic mail), WEB-EDI (us-

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\(^\text{36}\) M. Krasinski, A. Sadowski, Rozwoj systemow informatycznych w logistyce. "Logistyka" 2006, No. 6.
\(^\text{37}\) Regulation of the Minister of Finance of 14 July 2005 on issuing and sending invoices in electronic form, and also on storing such invoices and providing access to them to the tax authorities or fiscal inspection authorities. (Journal of Laws of 2005, No. 133, item 1119).
\(^\text{38}\) P. Wielopolski, E-faktury z podpisem cyfrowym. "Eurologistics" 2008 No. 3.
Supply chain management using state-of-the-art IT tools and Internet communication becomes more and more common. Electronic tools and the Internet are used for cooperation and transmission of data between partners in supply chains and networks and a potential of coordination and integration of logistic processes is formed in this way. According to the data of the Central Statistical Office, the main purpose of using the Internet as indicated by TL sector enterprises is access to banking and financial services (72% of those with Internet connection) and e-administration services (59% of those with Internet connection). An increasing number of transport and logistics enterprises invest in creating their own Web sites. Most of them treat it as a way of promoting the company and communicating with the existing and potential customers. Other purposes included the need to monitor the market, receiving goods and services in electronic form, placing and accepting orders, training and education and post-sale service

In logistics, Internet platforms enjoy a growing interest of enterprises not only directly connected with the industry. Such Internet platforms for fast and

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**Fig. 22. Reasons for Internet use as indicated by TL sector enterprises in Poland in 2006**


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effective solution of logistic tasks in road transport of goods are transport ex-
changes. Consignors, carriers and other TL industry enterprises use the ex-
change to have access to a wide range of logistic services; they can buy and sell
cargoes, loading space in vehicles, etc.

A very important aspect of using information technologies is building inte-
grated systems supporting management of different areas of operation, and en-
terprises use IT systems for this purpose on a wider and wider scale. The specific
way in which IT tools are applied in the TL industry depends largely on the ba-
sic services provided by the enterprise. In addition to automatic identification
systems of goods, mainly bar codes, logistics operators use information tech-
nologies to manage the supply chain – SCM systems, or selected modules, such
as WMS, to manage the warehouse, or TMS systems for effective transport man-
agement41.

The basis of a management system is always the master program, which
may be, for example, an industry standard enterprise resource planning system
(ERP). ERP systems were created as a result of a gradual evolution on the basis
of Manufacturing Resource Planning systems MRP and MRPII. The ERP system
covers all production and distribution processes integrating various areas of ac-
tivity of an enterprise and improving the flow of information important for its
operations. For on-line systems, the information is updated in real time. ERP
systems are focused on optimising the use of the available resources, reducing
the costs and improving business processes. The implementation of the ERP sys-
tem is only the first step on the way to computerise management in an enter-
prise as other modules related to the company’s needs may be attached to the
system. ERP systems supplemented with new functions or packages make it
possible to provide better customer service, particularly when they are extended
by Customer Relationship Management (CRM) or Supply Chain Management
(SCM) systems. CRM systems are the expression of a tendency in marketing and
management whereby enterprises lay emphasis on good relations with custo-
mers and try to win their loyalty. The systems gather all information related to
customers to ensure effective customer service. They are an integrated system
for marketing, sales, technical service and support. SCM systems, on the other
hand, are advanced planning and supply chain optimizing systems in the area
of procurement, production and distribution and they integrate the enterprise
with its suppliers and customers. Such tools are helpful in integrating specific
links in the whole supply chain and lead to comprehensive coordination of the
supply chain management (CILS)42. Figure 23 shows the place of individual sys-
tems depending on the degree of integration of logistic activities and their im-
 pact on the enterprise’s competitiveness.

41 B. Trochymiak, Nowoczesne technologie pozwalają na podwyższenie jakości usług. “Gazeta Prawna”
2006 No. 198.
42 J. Bendkowski, M. Kramarz, Logistyka stosowana metody, techniki, analizy. Part II. Wydawnictwo Po-
litechniki Śląskiej, Gliwice 2006, p. 490-496.
5.4.3. Innovations in warehousing technologies

The dynamic development of the economy has enforced urgent upgrading of the logistic processes of enterprises and, in particular, the storage of goods concept. The warehouse has been often perceived as a place for storing products, however activities related to storage play a very important role in logistic systems. A well functioning warehouse is able to ensure a continuous stream of flows of goods responding to the needs of customers. Automatic information about inventory or placement of materials in the warehouse is not only a great improvement of operation, but increasingly often it becomes a necessary condition of the enterprise’s competitiveness in the market. The systems automatically take over many processes related to movement and storage of cargoes, which allows the personnel costs to be reduced. The warehousing technologies which are commonly used in the logistics industry include:

- automated storage (AS) and retrieval (RS) systems;
- automatic sorting system;
- computer-aided picking system;

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43 Chieh-Yu Lin, Factors affecting innovation..., op. cit.
thermostat warehouse.

Automation of storage processes guarantees an optimized use of the available warehousing space owing to high density of storage and minimum width of service corridors. It also allows much taller warehouses to be built in comparison with traditional, manual service facilities, whereby it is possible to lower the cost of land purchase. The most important elements of an automated warehouse include:

- automated stacker cranes;
- pallet transport systems;
- Warehouse Management System (WMS).

Automated high storage warehouses are currently the state-of-the-art solution for storing goods. Operation of such a warehouse is based on auxiliary directories of address (pallet) locations where goods are stored as the knowledge about the place of storage of specific goods is of key importance for efficient management of goods in developed warehouses. Shelves may be even up to 40 metres high and automated stacker cranes to handle pallets on shelves are used instead of fork lifts. A very important role is played by the Warehouse Management System (WMS) used for intelligent management of various aspects of in-house logistics such as receipts, storage, order completion or shipment. The system manages the location of cargoes, ensures immediate receipt of required information and warehouse stock control, as well as simplification of stock taking procedures. The in-house transport and storage technologies used in the facility should correspond to the specific properties of the goods handled.

An innovative technology, more and more commonly used in warehouse management systems, are voice systems. They are a breakthrough in the communication between the computer system which manages the warehouse and the human being. Voice systems are able to ensure a quick and effective way of finding and shipping goods stored in the warehouse. They are a technology which is complementary to popular solutions used in warehouses such as, for example, RFID. The voice control system receives the warehouse management system (WMS) input data, such as the order packaging list or request to replenish stock, and uses the voice technology to instruct the workers, informing the user precisely which products and from which warehouse location to pick. The operator receives specific voice instructions from the system and confirms completion of operations in a similar way, by voice. Warehouse workers equipped with voice terminals can carry out all warehouse operations such as receipt, stock taking and movement faster and more efficiently, however, the greatest advantages of using voice technologies are with order completion. The voice

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technology may find application also in other segments of logistics, particularly where immediate, wireless and convenient form of communication between the operator and the IT system guarantees fast and faultless customer service.

5.4.4. Innovations in transport technologies

Transport is one of the most “visible” elements of logistic operations. Effective transport management both in respect of procurement and distribution is one of the basic tasks of a logistics operator. Transport should be organised in such a way so as to enable the enterprise to achieve maximum increase of production and sales with the lowest possible logistic costs. Transport of goods must be accompanied by access to information concerning the shipment, meeting the requirements of customers.

Enterprises distributing substantial amounts of goods to many recipients face the problem of transport organization. It is necessary to allocate the supplies to an adequate number of vehicles, indicate the appropriate sequence of calls at specific customers and select optimized routes. Proper planning of distribution makes it possible to reduce costs and execute orders in a timely manner. For a certain scale of operations optimised transport management is not possible without using IT tools.

The transport technologies commonly used in the logistics industry include real-time transport information systems, the Geographic Information System (GIS), the Global Positioning System (GPS), radio-frequency communication system and transport data recorder, e.g., tachograph47. These technologies are used for:

– vehicle and shipment tracking;
– route analysis and planning;
– facilities and depot management;
– routing and scheduling48.

The transport information system based on the geographic information system helps logistics managers to plan, manage and control tasks related to transport, provides information about available parking space, congestion and expected travel time on a specified route.

Complex navigation and positioning systems based on the GPS or GSM technology allow more effective use of the enterprise’s human and equipment resources, contributing at the same time to the reduction of unfavourable external effects of transport operations. The use of digital maps to plan the exact and error-free transport route makes it possible to optimize the route, the travelling time, control the progress of transport, minimise fuel costs and road charges and

47 Chieh-Yu Lin, Factors affecting innovation in logistics..., op. cit.
assess the productivity of the rendered service. While monitoring fuel consumption, protection and condition of cargo, vehicle axle load or vehicle condition, the applied technologies contribute to improving safety and reducing the negative environmental impact of transport\textsuperscript{49}.

Intelligent transport systems (ITS) comprising various technologies will be used on an increasingly large scale in the years to come. They are created by implementation of interrelated telematics solutions comprising a set of miscellaneous tools based on information technology, wireless communication and vehicle electronics. ITSs allow effective and efficient management of transport infrastructure, efficient passenger service and such management of vehicles and routes that is contributory to better safety, lower congestion, shorter travel times and reduced fuel consumption.

The area to use intelligent transport systems important for optimising transport processes is cargo carriage and fleet management. More common application of ITSs in this respect is supportive of increasing the effectiveness of transport as well as contributory to improving road traffic safety. The use of ITS in fleet management allows the following\textsuperscript{50}:

- to ensure safe transit due to exchange of information and automatic control of vehicles and drivers;
- to administer transport by recording the vehicles, permits for special loads and automatic charges;
- to electronically monitor vehicles;
- to manage transport operations in logistic centres by preparing transport schedules, setting routes, monitoring the transit.

The use of the ITS makes it possible to improve the exchange of information between drivers, carriers and logistic centres. Advanced information exchange programs make it possible to increase the safety of vehicle traffic while shortening the period of administrative procedure at the same time. The effectiveness of urban freight distribution increases through better planning of deliveries, higher vehicle load ratios and more effective use of vehicles. Integrated systems comprising intelligent route planning, driver support, intelligent vehicles and interactions with the infrastructure are used for this purpose\textsuperscript{51}.

It is also the Galileo European satellite navigation system which is planned to be launched in 2013 that will find application in all transport modes. It will be used in shipment identification and tracking systems, in “smart vehicle” systems to implement new technologies in vehicles, in the SESAR program which will

\textsuperscript{49} J. Łacny, W. Zalewski, Wpływ rozwiązań telematycznych i informatycznych na funkcjonowanie międzynarodowego transportu drogowego w Polsce. “Logistyka” 2007 No. 3.


contribute to air traffic management and in the ERMTS railway system. The increasing application of intelligent transport systems will foster not only further increase in transport operations, but better management of vehicles as well.

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Chapter 6
NEW-GENERATION TRANSPORT INFRASTRUCTURE
(Krystyna Wojewódzka-Król)

6.1. Introduction

Transport infrastructure has for ages expressed the needs, the problems, the possibilities and the aspirations of its time. The tasks it had to do gave rise to unconventional solutions, which can amaze us even today.

Transport infrastructure has always performed a number of diverse functions:
– it satisfied specific socio-economic needs by providing spatial connections;
– it performed transport policy tasks by imposing the ways in which these connections were made;
– it shaped our heritage – long-lasting infrastructure had a durable land-use impact, while the structures themselves often became monuments of architecture and famous landmarks.

The infrastructure of today also fulfils those functions while taking into account the needs and problems of our times. Therefore, new-generation transport infrastructure is primarily the infrastructure which:
– stimulates socio-economic growth through:
  • regional development,
  • international co-operation,
  • eliminating unemployment,
  • attracting foreign investors,
  • enhancing competitive advantage of companies, sea ports,
  • providing inhabitants with equal access to work, culture and education;
– solves the problems of modern transport policy by:
  • reducing congestion;
• improving safety;
• attenuating noise;
• low footprint requirement;
• low environmental impact,
• shaping environment-friendly modal split;
• integrating transport systems;
  – shapes the image of modernity with its aspirations and capability in terms
  of technology and economics, but also architecture, through:
  • making dreams come true, previously unattainable (for technical or eco-
    nomic reasons);
  • remarkable ability to combine functionality with architectural merit;
  – is built under modern pressures of:
    • continued traffic;
    • reliability of transport;
    • severe environmental constraints ("green" pressure),
    • time and the abruptly changing conditions.

A substantial part of new-generation transport infrastructure facilities meet
major demands of today in that:
  – they reduce congestion,
  – they are environmentally friendly (by improving safety, fitting well in the
    landscape, lasting long);
  – cutting-edge solutions are used during construction, often conducted in
    the most difficult conditions of not disrupting the surroundings;
  – they also represent high architectural value.

6.2. Fixed links construction

Current needs and priorities of socio-economic development, as well as prob-
lems of transport policy pose the challenge of building fixed links – bridges and
 tunnels – often to replace ferry crossings where previously there was no such
need or technical possibility (see Fig. 24).

Obviously, local bridges and tunnels have always been with us. However,
present-day aspirations, justified by global trends and growing congestion at
the crossings, result in the tendency of bridge islands and even continents.

Therefore, the new-generation infrastructure is most synonymous with
building fixed links under extreme conditions. These links either satisfy the ex-
isting transport needs (e.g. the Akashi Bridge) or quite the opposite – generate
new needs in order to stimulate socio-economic development and narrow the
gap between various regions (e.g. the planned bridge over the Strait of
Messina).
The Akashi Bridge, the tallest, the longest and the most expensive bridge in the world, was constructed following the tragic sinking of a ferry carrying a school excursion. The need to increase safety became a pretext for starting the project. Other factors which also played a role in the decision included the following:

- congestion,
- technologies making construction possible in extreme conditions (typhoons, storms, earthquakes, currents) – like new type of concrete;
- technologies reducing the weight of the structure – special lightweight high-strength cables, which allowed the designers to halve their number from four to two;
- regional aspirations;
- modern technologies allowing construction without interfering with navigation;

The Akashi Bridge, with a total length of 3,911 metres, the central span of 1,991 metres and the pylons nearly the height of the Eiffel Tower (297 m), was opened in 1998 and remains the record holder in its category (suspension bridges). Built in an area of both intensive shipping and frequent seismic activity, the bridge stood its first test when in 1995 – during its construction – the city of Kobe was hit by a 7.2 Richter-scale earthquake with the epicentre only
10 km away (the bridge was designed to withstand earthquakes of 8.5, with the epicentre 150 km away). Despite the fact that the bridge structure was unstable, the damage was relatively small – the pylons were moved by 1 meter\(^1\).

The unusually complex construction was conducted while normal traffic of ships continued – the process could not have interfered with the 1,400 vessels sailing through the strait every day\(^2\).

The planned bridge over the Strait of Messina is an example of an immense task undertaken mostly to stimulate socio-economic growth, with the main goal of promoting the development of Italy’s poorest region – Sicily (see Fig. 25). The Italian government hopes the bridge will make this part of the country flourish – also owing to tourists, for whom Sicily today is not easily or safely accessible. The government also expects the bridge to boost economic development on both sides of the crossing.

These aspirations are reflected in the parameters provided for in the bridge design – it is to be the tallest, the longest and the widest, 12-lane crossing in the world (six lanes with a total capacity of nine thousand vehicles an hour, two rail lanes for 200 trains, with the remaining four dedicated to emergency and maintenance services).

The Italian government plans the project to be accompanied by modernization of the motorway leading to the world’s widest crossing.

The Channel Tunnel (1994), the fixed link between Denmark and Sweden (2000), the tunnel between the islands of Honsiu and Hokkaido (1988), as well as the planned bridge over the Strait of Messina are all fixed links of strategic importance, whose significance is frequently compared with intercontinental links\(^3\).

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Among intercontinental crossings is the new bridge over the Panama Canal completed in 2004, while further projects are well in progress, linking:
- America and Asia – the Bering Strait bridge;
- Europe and Africa – the Strait of Gibraltar bridge;
- Europe and Asia – rail tunnel under the Bosporus (next to the two bridges built in 1974 an 1988).

Some of infrastructure development goals have – to a varying degree – always been the same but modern times create new constraints and standards in the way of:
- the environment;
- architecture, although this aspect remains debatable;
- time and method of execution.

6.3. Sustainable development of transport infrastructure

Environmental impact of transport infrastructure may be both direct and indirect.

Transport infrastructure is permanently tied to the land; as a result its construction is an intrusion on the environment, changing it in a lasting way. However, it does not always have to mean a loss for a given area or region. There are examples of infrastructure harmoniously set in the surrounding landscape and enhancing its visual or natural value.

Construction of transport infrastructure causes, in the first place:
- absorption of land;
- its disintegration;
- lasting intrusion on land use;
- possible interference in the existing water conditions.

Moreover, construction and operation of transport infrastructure may have impact on:
- energy consumption (may vary depending on road layout and technical parameters);
- air pollution (connected with energy consumption),
- water and land pollution (the degree of degradation may depend on location and mode of operation);
- safety level (depending on the method of construction and parameters);
- noise emission (connected with construction technology and location of the infrastructure).

However, through appropriate policy of infrastructure development, positive influence on modal split of transport systems may be exerted, creating favourable conditions for the development of environmentally friendly modes
(the rail and the inland water transport), as well as a preference for alternative means of transport (the bicycle). In this way, the environmentally degrading impact of transport may indirectly be controlled.

Construction of certain types of infrastructure may benefit the society, as it helps to lessen the degrading environmental impact of a specific mode of transport (e.g. road transport) owing to:

- motorways ensuring smooth flow of traffic and moving it away from urban areas, replacing networks of low-capacity roads prone to congestion;
- ring roads taking some of the cars away from city centres;
- car parks next to public transport stations, allowing car owners to conveniently use urban transport etc.

The amount of land taken by infrastructure built in highly developed countries is increasing at a rate which is a threat to the possibility of satisfying other needs (food, housing, leisure, tourism). Generally speaking, in smaller countries it has already reached the maximum acceptable level.

The land requirement is closely connected with the modal split in transport systems and the technologies in use. Among the ones with the highest land requirement is motor transport whose infrastructure takes up 70-80% of total transport surface (see Table 18). Due to the fact, considerable savings in land use may be obtained through the development of intermodal technologies, using the advantages of both rail and motor transport. Railway tunnels like the previously mentioned Channel Tunnel and Bosporus Tunnel allow to increase the role of environmentally friendly transport modes.

Table 18. Transport infrastructure share by mode in total transport land requirement of various countries in 1989 (%)

<table>
<thead>
<tr>
<th>Country</th>
<th>Road</th>
<th>Rail</th>
<th>Airports</th>
<th>Seaports</th>
<th>Ports and canals of inland waterways</th>
<th>Pipelines and power network</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>80.9</td>
<td>4.7</td>
<td>1.8</td>
<td>3.6</td>
<td>4.5</td>
<td>4.5</td>
<td>100.0</td>
</tr>
<tr>
<td>France</td>
<td>76.3</td>
<td>4.7</td>
<td>4.7</td>
<td>2.0</td>
<td>4.3</td>
<td>8.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Netherlands</td>
<td>69.2</td>
<td>3.2</td>
<td>2.4</td>
<td>7.8</td>
<td>12.1</td>
<td>5.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Japan</td>
<td>83.2</td>
<td>2.4</td>
<td>1.5</td>
<td>6.4</td>
<td>1.3</td>
<td>5.2</td>
<td>100.0</td>
</tr>
<tr>
<td>Poland</td>
<td>80.2</td>
<td>10.2</td>
<td>0.2</td>
<td>0.5</td>
<td>0.1</td>
<td>8.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Germany (excluding former East Germany)</td>
<td>74.4</td>
<td>8.2</td>
<td>4.2</td>
<td>1.7</td>
<td>3.3</td>
<td>8.2</td>
<td>100.0</td>
</tr>
<tr>
<td>USA</td>
<td>71.4</td>
<td>4.7</td>
<td>10.1</td>
<td>4.8</td>
<td>4.6</td>
<td>4.4</td>
<td>100.0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>67.5</td>
<td>6.2</td>
<td>5.0</td>
<td>8.4</td>
<td>4.3</td>
<td>8.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Italy</td>
<td>74.5</td>
<td>5.2</td>
<td>2.2</td>
<td>7.5</td>
<td>2.3</td>
<td>8.3</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Each human action has an effect on the surrounding environment. Infrastructure construction, due to its character, creates lasting impact which frequently causes irreversible environmental changes. Therefore, it is important to minimize the negative environmental impact of infrastructure development and attempt in every feasible way to shape the modal split and its technologies in an environment-friendly way.

The degrading environmental impact of infrastructure may be alleviated through various active protection means (noise screens, human and animal crossings etc. (see Fig. 26), as well as passive means (appropriate site selection, road routeing which will bypass most sensitive areas on the one hand, and ensure smooth traffic flow or limited intrusion on the environment on the other, etc.).

Another example of alleviating negative impact on the environment may be construction of viaducts which change the environment to a much smaller degree than conventional roads.

The Millau Viaduct – the tallest in the world – is an example of such a solution. Its designers and builders are rightly proud of their high skill with which they harmoniously integrated the structure into the surrounding landscape, causing very little degradation even during construction.
During the construction phase of the crossing – which is part of the Paris-Barcelona route – particular attention was placed on limiting the environmental impact. This aspect was closely documented by a number of methods including photos taken at various stages of construction. The entire operation remained open to public scrutiny, as regular sightseeing tours of the construction site were very popular (which also had the side effect of making the viaduct, as well as its designers and builders quite famous, giving boost to regional development). The unique architecture and immense height of the viaduct – two of the pylons are 40 metres taller than the Eiffel Tower – proved to be a real magnet for tourism.

Today, the viaduct does not in any way resemble a busy motorway but quite the opposite, it is associated with quiet, rural countryside (see Fig. 27). This har-

Fig. 27. Surroundings of the Millau Viaduct

Fig. 28. Comparison of the Millau Viaduct and proposed Rospuda crossing
monious effect remains ingrained despite considerable traffic and large numbers of tourists continuing to visit the famed structure.

Incidentally, the controversial ring-road of Augustów running through the Rospuda Valley is much like a miniature version of the Millau Viaduct. While the Rospuda viaduct is five times shorter and fifty times lower than the French giant, it is integrated into the surrounding environment in a similarly harmonious way, designed to enhance the beauty of the landscape. (see Fig. 28).

6.4. Architectural value

Transport infrastructure, which plays a significant role in economic development, has a bearing on the situation and position of regions, countries and entire country groups. For this reason, the infrastructure increasingly often takes (or perhaps has always taken) the shape of outstanding architectural work, becoming the landmark of the place.

This is precisely why today’s greatest architects frequently take on the challenge of designing selected elements of infrastructure.

Santiago Calatrava is the Spanish architect and sculptor who has to his credit quite a number of such projects, as infrastructure remains in the mainstream of his interests. Calatrava’s designs are often inspired by nature and remain unique in their masterly use of exceptional form and innovative technology. The TGV Station of the Lyon Airport is an excellent example of brilliant functional solutions and sculptural form (see Fig. 29). The building is constructed in the shape of a bird rising from the ground. The lightness of its elegant structure is remarkable while at the same time various functionalities have masterly been included.

The great challenge of designing the Hautbanhof Berlin (see Fig. 30) – Europe’s biggest railway station – was taken on by architect Manfred von Gerkan. His concept called for a nearly transparent, glass structure which would merge with the existing buildings of downtown Berlin while allowing daylight admission in the lowest levels of the station.

In order to achieve this goal, steel glass plate frames were reduced to the minimum, allowing the greatest possible amount of light to pass through. Pillars typical for this type of structures were eliminated and the ceiling was designed to reflect natural light down to two levels below the ground.

The existing development made building conditions extremely difficult. In addition, the multi-level railway station is located next to the Spree River on sandy soil with high groundwater level. As a result, the main challenge consisted in constructing sufficient area of foundations which amounted to 11 football pitches, placed 2 floors below the groundwater level.
Another problem consisted in conducting highly complex construction work without stopping rail traffic, as this would paralyze the entire European transport network. The only planned suspension of traffic was a 54-hour period reserved for operations hazardous to passenger safety. Unfortunately, a sudden downpour and storm which took place during at the time made the planned tasks of lowering towers over the station's glass roof very difficult. Despite the adverse weather conditions, the operation was carried out as planned, since halting rail traffic again was out of the question.

Fig. 29. Gare de Lyon Saint-Exupéry

Fig. 30. Glassed-over construction of Hauptbahnhof Berlin
Source: http://upload.wikimedia.org/wikipedia/commons/6/6f/Berlin_Hauptbahnhof_180_panorama_top_level.jpg.
Regrettably, the project was not completed as originally designed. Due to significant budget and construction schedule overruns, the investors decided to limit the scope of the project to make certain that it would be ready in time for the 2006 European Football Championship. The glass dome extending over the tracks was shortened by 100 metres and the idea of the daylight reflecting ceiling was abandoned.

The architect, convinced that the creation of his lifetime was mutilated, sued the DB hoping that the court would issue a decision forcing the investor to complete the building as originally designed.

The previously mentioned Millau Viaduct is the creation of one of the most outstanding contemporary architects – Norman Foster. Its design is characterised by elegance, simplicity and exceptional ability to harmoniously place such a huge structure in a landscape which is not in any way reminiscent of a busy motorway, maintaining its quiet, rural character with surrounding old farm buildings, pastures and fields. The viaduct does not disfigure the landscape but quite the opposite, it gives it additional appeal.

Fig. 31. The tallest boat-lift in the world in Strepy-Thieu, Belgium opened for use in 2003. (73 m, for 1350 t ships)

The role of exceptional works of infrastructure in shaping our heritage stems from their architectural value and lasting life-span, finding expression in special attachment to such works. Once their function ceases, or when they require
modernization, it is very often the case that they are built anew in their old shape, often at a cost significantly exceeding the expense of building a completely modern structure, like the modernization of the Golden Gate Bridge. At the very least, they are kept as tourist attractions with a new structure frequently built next to them, e.g., the Strepy-Thieu boat-lift – the tallest structure of this kind in the world, which replaced four old ones, or the Niederfinow boat-lift located next to the original one. (see Fig. 31).

6.5. Time in the process of infrastructure development

The element of time in infrastructure development should be understood as:
– completion date;
– project time;
– project co-ordination.

Because of its special nature (technical and economic indivisibility), long life and various correlations throughout its development, infrastructure takes a long time to develop. This includes long designing period (the necessity to account for all the correlations) and long construction time, often divided into stages for reasons of financial constraints.

The fast pace of modern life, as well as technical, technological, organizational and economic possibilities of using alternative solutions impose much stricter time discipline in infrastructure development.

Remote completion dates, which as experience shows are not kept, facilitate the search for alternative solutions which may permanently alter the nature of infrastructure construction. Therefore, close and constant monitoring of the situation is essential.

This results in strong emphasis on project time in modern large-scale infrastructural projects, e.g.:
– the Akashi Bridge, the completion of which was delayed by a month only, despite an earthquake during construction and the necessary redesign work;
– the Millau Viaduct was completed a month ahead of completion date.

However, despite all efforts, final completion dates are not always kept as large infrastructural projects are usually unique and unexpected technical difficulties commonly appear, resulting in economic problems leading to delays.

Coordination of infrastructural projects is also very important, since lack of proper access roads; support facilities etc. may seriously lower the efficiency of investment projects.
6.7. Bibliography

7.1. Introduction

It is not possible to achieve the goals of sustainable development of transport in Europe today without widespread use of satellite navigation. This is the kind of statement which one may be tempted to make when observing what was planned and what has been achieved in terms of external transport cost reduction, including congestion and accidents. If the European Union proves unable to successfully complete its plans with regard to Galileo, the first ever civilian-controlled satellite navigation system, the field will be left open to the natural expansion of the already existing, and dynamically developing, American (GPS) or Russian (GLONAS) solutions. One must also mention the Chinese expansion in this market, in the form of their navigation system called BEIDOU, in the first stage covering China and neighbouring countries, but with the potential to expand and cover the entire globe. Irrespective of how the implementation problems are resolved, the perspectives for transport applications of navigation systems are manifold.

Meanwhile, the European satellite navigation system, Galileo, is implemented with considerable delay, facing numerous organisational problems. This is partly due to the ways in which public-private projects work. Indeed, the development of the Galileo is the responsibility of a consortium including private companies. It is with great difficulty that the consortium reaches agreement with regard to management, distribution of work and participation in the costs of the undertaking.
The purpose of this chapter is not to describe the characteristics or the potential applications of the Galileo system, but rather to relate to the broader perspective of how innovative satellite navigation solutions can be used in the transport sector, and the degree to which they may help with the ambitious goals of sustainable development of transport.

7.2. Satellite navigation in the light of the current goals and principles of the European transport policy

The application of satellite navigation in transport is indisputable as it enables automatic identification of travelling vehicles, but also traffic management, providing the drivers with relevant information or warning them about possible threats. In addition to these basic capabilities, however, one can mention far broader perspectives for applications, taking into account the specific nature of the various modes of transport.

The European Union regards building a sustainable transport system in Europe as the main goal of its transport policy. According to the recent document on the directions and instruments of the European transport policy (White Paper of 2001 entitled European transport policy for 2010: time to decide¹), the objective is to be achieved by implementing twelve instrument packages covering the various transport areas. These packages include the following: improving quality in the road sector, revitalising the railways, controlling the growth in air transport, linking sea and inland waterways, helping to start up intermodal services, creating trans-European networks, improving road safety, adopting the methodology of effective charging for transport, respecting rights and obligations of users, developing high quality urban transport, promoting research and technology focused on environmentally friendly and effective development of transport and managing the effects of transport globalisation.

The issue of satellite navigation was directly included in two instrument packages: package six – building trans-European transport networks, where the TEN network includes project for Galileo, the satellite navigation system, and package twelve – managing the effects of globalisation, where one of the objectives is to achieve independence in terms of satellite navigation by developing Europe's own system Galileo. However, using a satellite navigation system is possible, or even essential for the implementation of other objectives of EU transport policy, such as improving road safety or adopting the principles for

effective charging for transport. The application potential and scope of satellite navigation for the achievement of current objectives of EU transport policy have been indicated in Table 19.

The scope of instruments presented in 2001 in the White Paper confirms the need to use satellite navigation in transport. One should also note the fast technological progress in transport in recent years, as well as increasingly serious environmental challenges, which seem to suggest that the scope and extent of applications of satellite navigation in transport will be broader than envisaged in the recent European transport policy document.

Table 19. Applications of satellite navigation supporting the goals of the European transport policy

<table>
<thead>
<tr>
<th>Item</th>
<th>Goals / instrument packages of the European transport policy (according to the White Paper 2001)</th>
<th>Application of satellite navigation</th>
<th>Areas of application of satellite navigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Improving quality in the road transport sector (e.g. standardisation of professional training of drivers, harmonisation of working conditions)</td>
<td>Limited</td>
<td>Improving drivers' working conditions, including safety</td>
</tr>
<tr>
<td>2</td>
<td>Revitalising the railway (e.g. liberalising international and national rail cargo markets, gradual opening of international passenger markets, improving safety and interoperability, improving the quality of passenger services)</td>
<td>Limited</td>
<td>Current information for passengers, facilitating service quality improvements</td>
</tr>
<tr>
<td>3</td>
<td>Controlling the growth of air transport (e.g. creating a uniform air space, harmonisation of airport fees, reducing noise and emissions, in emission of pollutants, improving safety)</td>
<td>Supporting</td>
<td>Improving safety, including airport safety, by using satellite navigation also in ground operations</td>
</tr>
<tr>
<td>4</td>
<td>Promoting sea and inland waterway transport (e.g. the concept of sea motorways, improving safety at sea, technical and social harmonisation, improving seaport effectiveness, developing inland waterways information system)</td>
<td>Supporting</td>
<td>– improving safety, – waterway information systems, hydrographic control, – supporting search and rescue systems (e.g. SAR)</td>
</tr>
<tr>
<td>5</td>
<td>Real development of intermodal transport (e.g. technical harmonisation of loading units, financial support)</td>
<td>Wide-ranging</td>
<td>– freight tracking, – current information for clients</td>
</tr>
<tr>
<td>6</td>
<td>Building trans-European networks (e.g. implementing network projects, improving safety in tunnels, financial support)</td>
<td>Wide-ranging</td>
<td>– traffic management, – construction of the European satellite navigation system Galileo</td>
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<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Approach</th>
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<tbody>
<tr>
<td>7</td>
<td>Improving road safety (e.g. reducing the number of accidents, harmonising the system of roadside checks and fines, using new technologies)</td>
<td>Wide-ranging</td>
</tr>
<tr>
<td>8</td>
<td>Adopting the principles of effective charging in transport (e.g. real cost accounting in transport, internalisation of external costs, harmonisation of the system of charges in particular transport modes.)</td>
<td>Wide-ranging</td>
</tr>
<tr>
<td>9</td>
<td>Respecting the rights and obligations of users of transport systems (e.g. reimbursement and compensation for delays, accidents etc., harmonisation of procedures, improving passenger information)</td>
<td>Wide-ranging</td>
</tr>
<tr>
<td>10</td>
<td>Developing quality urban transport (promoting “clean” public transport, supporting practical solutions)</td>
<td>Wide-ranging</td>
</tr>
<tr>
<td>11</td>
<td>Research and technology focused on environmentally friendly and effective development of transport (e.g. new traffic management instruments, improving technical standards of vehicles)</td>
<td>Wide-ranging</td>
</tr>
<tr>
<td>12</td>
<td>Managing the effects of globalisation (e.g. reinforcing the position of the European Community in international forum, construction of the Galileo system)</td>
<td>Wide-ranging</td>
</tr>
</tbody>
</table>

source: own study.

7.3. Application of satellite navigation in the various branches of transport

The European Commission perceives the development of satellite navigation as an indispensable instrument supporting the goals of not only transport policy, but also energy, agricultural and environmental policies, as well as goals in civil defence and emergency response. The Green Paper on the applications of satellite navigation⁴ was published in December 2006, with the aim of initiating...
public discussion on the potential applications of the system in the European Union. Furthermore, the tasks of the public sector were indicated, where it should support work on the applications. In September 2007, the European Commission plans to sum up the results of the public debate and prepare a set of practical instruments for implementation as of the beginning of 2008.

The main application of satellite navigation in transport is vehicle tracking. With an on-board satellite positioning receivers, the vehicle’s movements can be monitored from any location in the world. Just by fitting a vehicle with an on-board computer connected to the receiver, it is possible to obtain and transmit (e.g. to a traffic management centre of the company) additional, highly detailed information about the speed, the distance covered, fuel consumption, vehicle operating time etc. Information can also flow in the other direction, namely from the centre to the driver, using alert signal, fax or telephone / GSM (depending on the operational capabilities of the terminal fitted in the vehicle). Such information can pertain to incidents on the road, information about the route etc. Advanced technical methods allow the use of satellite navigation as a tool supporting or even enabling the movement of a vehicle in difficult conditions (e.g. in seaports –vessel handling in adverse atmospheric conditions).

The range of applications of satellite navigation in the various transport modes is presented in Table 20.

7.3.1. Road transport

The first mode of transport to use satellite navigation was sea transport. But when technical parameters made it possible (reduction in the size of the devices fitted in vehicles), car satellite navigation system was introduced. At the moment, applications of satellite navigation in road transport are wide-ranging. Increasingly often, GPS receivers are installed in up-market vehicles, enabling the use of satellite navigation in the car. Computerised road maps and atlases have also become popular. With technological progress, additional applications are possible, such as alerting emergency services (in the event of accident or breakdown, etc.) together with automatic vehicle location or even, using the on-board computer, information about the type of damage; also tracking a stolen vehicle.

The common use of satellite positioning systems in vehicles will also become an increasingly precise traffic management instrument. The potential functions of the navigation systems are used as one of the main elements of the so-called Intelligent Transport System (ITS). Traffic monitoring and management can therefore be greatly improved. If the average speed of vehicles equipped with satellite positioning devices is significantly reduced, the traffic control centre can

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<table>
<thead>
<tr>
<th>Application area / transport mode</th>
<th>Road</th>
<th>Rail</th>
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<tbody>
<tr>
<td>Passenger</td>
<td></td>
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<tr>
<td>The car</td>
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<tr>
<td>Public transport</td>
<td></td>
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<tr>
<td>Freight</td>
<td></td>
<td></td>
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<tr>
<td>Information transfer / traffic management</td>
<td>Information for drivers about jams, accidents etc.</td>
<td>review of the technical condition of rail tracks, control systems, better information flow on routes with heavy traffic</td>
</tr>
<tr>
<td></td>
<td>Element of intelligent transport systems</td>
<td>precision control information about vehicles, etc.</td>
</tr>
<tr>
<td>Vehicle tracking / fleet management</td>
<td>Vehicle location in the event of theft, accident etc.</td>
<td>freight tracking</td>
</tr>
<tr>
<td></td>
<td>Information for the operator of the bus company, taxi fleet etc.</td>
<td>precise information for emergency services</td>
</tr>
<tr>
<td>Emergency services</td>
<td>Alerting emergency services coupled with automatic vehicle location</td>
<td>rescue</td>
</tr>
<tr>
<td>Freight</td>
<td></td>
<td></td>
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<tr>
<td>Passenger</td>
<td></td>
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<tr>
<td>Freight</td>
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<tr>
<td>Driving assistance</td>
<td>Computerised road atlases (e.g. for tourists)</td>
<td>Computerised road atlases (e.g. for taxi drivers)</td>
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</table>

A phase element of an Advanced Driving Assistance System (ADAS), e.g. vehicle speed control.

Potential implementation of the best possible differentiation of user charges, based on multiple factors (type current pollutant emissions and noise levels, time of day, type of road, distance).

Source: Own study.
predict a traffic jam on a specific section of the road and send a warning to vehicles moving close to the section, together with a suggested alternative route\(^\text{5}\).

Moreover, satellite positioning improves the effectiveness of fleet management by transport companies (both in passenger and cargo transport), forwarding and logistics companies, or taxi corporations. We must not ignore the potential applications of satellite navigation in the work of emergency services, either. An ambulance equipped with a satellite positioning receiver connected to a traffic management centre may enjoy numerous benefits, such as traffic control at crossroads. The time of reaching the accident scene can be radically reduced both owing to better management of the fleet and automatic information fed from the scene from vehicles equipped with GPS (or other) receivers connected to on-board computers.

Satellite navigation can also be used as an important element of an Advanced Driving Assistance System (ADAS). It provides important information about the surroundings, road hazards, or approaching a scene of an accident, but also directly controls the movement of the vehicle, for instance, by automatically reducing speed when the vehicle approaches a bend with excessive speed and the visibility is poor\(^\text{6}\).

One of the main goals of European Union’s transport policy, but also of the respective member states, is to introduce fair and effective transport charges, instead of diverse payments which are not supported by the taxes and other charges paid. An effective way allowing a practical implementation of complex principles of cost calculation, at a level nearing the marginal costs of an additional vehicle in the transport network, is to use a satellite navigation system and introduce an electronic toll collection system. Solutions based on satellite navigation allow the highest differentiation of fees (which is not possible with the traditional toll systems, or even a system of dedicated short-range communications – DSRC), i.e. differentiating the charge on the basis of vehicle type, road type, distance covered, journey time, speed, emissions and many other. It is also worth noting that the high cost of implementing a system of electronic road charges will be offset by discontinuing expensive solutions, such as traditional toll gates on motorways, with the characteristic traffic jams.

The application of satellite navigation in tourist traffic must also be mentioned. In individual motoring, further possible applications are mentioned of the already popular so-called computerised road atlases. In other modes of transport, especially the coach and the rail, one can expect direct and up-to-date information provided to the user, about journey time, delays, next connection etc. Benefits can apply to both, passengers on board (e.g. tourist information

\(^{5}\) Project GIROADS, http://www.intelligentroads.org/.

about the passed locations) and to off-board passengers waiting at stops and stations. The systems may be used in coaches (and trains), but also in rental cars.

A separate issue is the use of satellite navigation by taxi drivers and their clients, as well as taxi fleet operators. They can help the driver to chose the best route in order to avoid traffic jams and to precisely locate the destination. It helps the operator to manage the fleet better. Moreover, positioning receivers installed in mobile phones can automatically locate the passenger calling a taxi.

Satellite navigation can also support the development of unconventional public transport services, e.g. suburban bus service in the form of taxi-bus service. The drivers could adjust the route, within specified limits, in response to immediate needs, for instance, to pick up a passenger from home.

Satellite navigation is obviously a tool improving the safety of bus and taxi drivers. In case of danger they can immediately alert the police, who can automatically locate the vehicle thanks to the terminal installed on board.

### 7.3.2. Rail transport

The use of satellite navigation in rail transport will create conditions to make this mode of transport more competitive, which is one of the conditions to change the modal split in haulage. Satellite navigation can be used to control movement of vehicles, especially on regional lines with low traffic, where the infrastructure does not include traditional traffic control devices. This will improve rail safety. A satellite navigation system together with telecommunications services can provide the engine driver and the supervising system with the relevant set of information. New possibilities can also be seen on lines with heavy traffic, where the common use of satellite navigation will improve traffic flow.

In freight transport, satellite navigation will make direct freight tracking possible and, consequently, allow more effective rolling stock management.

In a similar way as in public road transport, rail transport can also, perhaps even to a higher degree, use satellite navigation to create a kind of guide for onboard passengers about the surroundings and the location of the train, as well as journey time, further transfers etc. Thanks to these devices, also information for passengers waiting at railway stations can be more precise, giving train arrival times or delay times.

Satellite navigation can also support engine drivers by helping them to optimise energy consumption. Thanks to precise information about train’s position relative to its surroundings, speed can be better adjusted to driving conditions, energy recovering breaking can be used, etc. Moreover, in checking the condition

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of rail tracks, inspections and tests using satellite navigation can replace the costly geodetic methods\textsuperscript{8}.

7.3.3. Aviation

Satellite navigation has been used in aviation ever since the GPS system was first developed. Pilots can use satellite navigation in various phases of the flight, from taxiing, through takeoff, flight and landing, which is particularly important in difficult weather conditions. The growing congestion in airports and on most busy routes is becoming an increasing problem in air transport. As a result, traffic management gains importance and it would be hard to imagine it without satellite positioning of airplanes. Moreover, in congested airports satellite navigation can improve ground operations.

Thanks to GPS devices (or other satellite positioning systems) it is possible to provide traffic controllers with precise and up-to-date information about the bearings, the speed or the heading, especially in those areas where ground infrastructure is not sufficiently equipped in radar and communications devices\textsuperscript{9}. The overriding goal is to improve safety in commercial flights. But satellite navigation can also be applied in recreational or sports flights of balloons, gliders etc.

Another specific area of application for satellite devices in aviation is their installation in SAR and ambulance helicopters which, by their very nature, frequently take part in rescue operation in bad weather or in otherwise difficult conditions. Thanks to such application, the safety of these helicopters can be greatly improved.

7.3.4. Maritime and inland water transport

Initially, the civilian application of satellite navigation was only limited to maritime transport. This was due to the considerable size of the devices, both the terminals and the satellite aerials. The fundamental application in this mode of transport is supporting open sea navigation, in order to improve safety at sea and prevent collisions. This is true for both cargo and passenger fleet, as well as tourist cruises, for instance in sailboats.

Satellite navigation also improves operations in seaports, especially in bad weather conditions. This is also true for inland waterways, especially in difficult or narrow sections, in case of congestion or bad weather. Moreover, wherever


on-board automatic navigation is used and there is traffic control, satellite navigation proves an indispensable supporting tool.

What must also be noted is that satellite navigation revolutionised hydrographic reviews and checks. Such checks will be possible without the need to install any additional, costly devices. It is also possible to track underwater obstacles easily and precisely. It will be possible to use GPS receivers (or Galileo, or others) not only on board moving vessels, but also in engineering works, such as dredging, waterway maintenance in ports, or to plan icebreaker routes.

One must also mention the development of the search and rescue system (the European SAR / Search and Rescue convention from 1979, the Russian COSPAS system built earlier or the American SARSAT). These systems can function thanks to alarm system transponders mounted on satellites, which relay alert signals from users’ transmitters (radio beacons) to SAR coordination centres which initiate rescue operations.

Besides, one can mention ex-transport applications of satellite navigation in fisheries and merchant fleet, for better fleet management and for fishing gear or obstacle location. It is also possible to find applications in oceanography, like tide tracking or river current tracking.\(^1\)

### 7.4. Bibliography


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8.1. Introduction

Intensive global economic development creates new challenges for transport systems. The heart of economic and social expectations lies in calls for economically effective and the safest possible solutions to the issues of the mobility of people and goods. Modern telematics and ICT systems provide a chance for improving both: security and safety as well as effectiveness of road transport.

This paper presents the significance of telematics systems both for making proper decisions in the management of road transport operations, as well as improving transport security and safety by constant monitoring of vehicles, cargo space, containers and drivers’ performance. The efficiency of such systems is presented on the basis of analysing selected international road transport companies.

8.2. Telematics – a chance for progress in transport

An analysis of the functioning of road transport should start with accepting its absolutely leading role in the economic development of the modern world. While the hazards of road transport are kept in mind, it should be emphasized that the only way to increase its economic efficiency, security, safety and sustainability is through cutting-edge systemic, technical and technological solutions in
transport modes, infrastructure and organization. It is impossible to ensure constant development without the proper use of vehicles, road networks and fuel resources, accompanied by simultaneous reduction of costs.

At the current stage of socio-economic development, effective use of road transport, improvement of its forms, creation of more and more advanced transport systems and constant upgrading of transport fleets is a process which cannot be avoided. Modern telematics and ICT systems present a chance for reaching this goal and are gradually becoming vital tools in modern logistics. Telematics systems allow the permanent monitoring of vehicles and cargo, as well as controlling the parameters of drivers' performance and sending the recorded data through telecommunication channels to a processing centre. ICT systems allow recorded data to be processed to make them useful for more effective management of the company, its human and technical resources, as well as greater control over cargo flow and minimization of the risk of misplacement or loss of cargo.

Numerous cutting-edge management support systems appear on the modern European market owing to the constant development of the IT sector and increased availability of GPS (Global Positioning System) applications. Data gathered with these tools support management processes, increasing the effectiveness and competitive edge of road transport companies. The collected information not only allows the creation and development of data bases for route optimization, lower costs and more efficient fleet control, which significantly shortens transit time and strengthens management capability, but also increases the security and safety of drivers, vehicles and cargo.

Telematics gives transport the capability of using technologies and methods of remote access to vehicles or cargo through a wireless network. Being one of logistics' executive tools, telematics not only helps to support management but also to increase efficiency and competitiveness. This instrument improves transport safety and supports traffic flow control, as well as development of databases in companies, organizations and institutions. Thanks to telematics elements (ICT networks, traffic control systems, electronic location of vehicles and cargo, electronic exchange of documents) vehicle routes can be optimised, which greatly shortens shipping time. Telematics technologies employed for tracking vehicles and cargo are of particular importance in transport of hazardous materials, especially following the events of 11 September, 2001.

The development of telematics systems and their growing use in transport allows for increased mobility of shipping, widening the offer of service providers, increasing their competitiveness and activating regional economies. It is thought that competition between commercial vehicle producers for new buyers will be an important development factor in telematics. This assessment is based on the forecast that growing numbers of new vehicles will be equipped with interfaces for telematics and fleet management systems.
The GPS/GSM system forms the basis for the functioning of modern telematics solutions. The system consists of a network of 24 satellites placed on 6 orbits of the Earth by the U.S Department of Defence and a land based cellular phone network operating at the frequencies of 900MHz and 1800MHz. The system, which is managed by Navstar Global Positioning System, was intended to serve military purposes, but in 1980 the government of the United States made it also available for civilian use. It does not require any subscription or installation fees paid by the user. It works under all weather conditions, in any global location, 24 hours a day. The complete set of 24 GPS satellites circumnavigating the Earth twice a day on very precise orbits was achieved in 1994.

Signals sent by the satellites and received through devices installed in cars or containers allow to determine and record their position, speed, direction of movement etc. The exact measurement of the time difference in sending and receiving GPS signal permits the calculation of the distance between the satellite and the destination, while measurements from a number of satellites allow the calculation of geographic coordinates, which can then be displayed on a digital map.

In recent years, Polish road transport network has undergone very dynamic growth, as a result of increased needs in the area of moving both people and cargo. Within the last decade, the country has experienced a fivefold increase in the number of vehicles in international road transport. Such a sudden growth has caused intense and irrational competition between hauliers, frequently culminating in economically unjustified and damaging price wars. This destructive approach to pricing lasted from the end of 2004 and started to abate only in mid 2006, when rates stabilised at a relatively reasonable level.

An analysis of direct transport costs identifies two potential areas which may be sources of significant growth in the productivity of road transport operations. The first is minimization of fuel costs in executing transport tasks and optimization of fuel purchasing. The second is minimization of financial effects of cost internalization. Data from the last 15 years show a threefold increase in fuel costs. Due to the fact that fuel constitutes 36-41% of direct costs in transport, it may be concluded that every attempt at lowering these costs is well worth the effort.

The situation in relation to the process of cost internalization is similar in that the 8-euro fees for the use of infrastructure are being successively replaced in the EU countries with tolls of 0.13-0.26 euro per 1 km. Assuming that 450 km is the average daily distance travelled, the increase amounts to at least 700%. Therefore, looking for savings in this area has become the priority of every well managed company, giving a sudden boost to interest in the use of telematics and IT systems in transport.

The use of GPS/GMS devices in road transport allows a substantial amount of highly useful information to be gathered. In particular, they make it possible to:
– plan the routes and optimize parking and refuelling with detailed digital maps;
– analyse and control vehicle and cargo itineraries, including distance and cost minimization and elimination of irregularities - ensuring dynamic service;
– record basic vehicle use parameters, such as, speed, distance and route travelled, engine rpm, fuel consumption, axle load as well as to monitor cargo space, control on-board systems, cargo temperature etc.;
– supervise driver's performance in terms of compliance with regulation on maximum driving times, minimum breaks and rest periods, as well as optimum driving technique facilitating economical vehicle operation, selection of optimum detours, parking or refuelling sites, etc.;
– increase driver, vehicle and cargo safety and security;
– mitigate the terrorist hazard by creating the potential for permanent control of cargo space, especially in terms of cargo space integrity, and for monitoring of any intrusion into it, which counteracts the threat of illegal immigration or terrorism;
– define exact delivery time and effect precise distribution of goods.

8.3. Telematics and safety and security in transport

The use of telematics and IT systems in transport allows to increase safety of road traffic through dynamic monitoring of the driver's behaviour, condition of the vehicle and cargo, as well as the safety and security of both. However, a new security aspect has emerged in transport. It is the security of the vehicle and cargo, which can be used in terrorist attacks.

Results of studies on the economic processes of transport facilitate correct decision making, constituting the key to the assessment of efficient management in the area. At the same time, analysis of losses due to ineffective cargo security point to it as the source of huge additional costs, due to theft during transit. The American Chamber of Commerce estimates that these losses in the USA market amount to 30-60 billion dollars annually. An exact estimation of the losses is extremely difficult since they occur mainly outside the USA and take place mostly during container transport. The losses are rapidly growing as a result of equally rapid growth in trade resulting from the progress of globalization.

It appears that globalization is not the only challenge for the modern world, capable of adapting quickly to new economic conditions resulting from the growing trade exchange, the free movement of capital and the use of cheap labour markets. Despite the scale of the losses, as long as they affected only private business it was hard to rally such global institutions and organizations as

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the UN, the WTO, the WCO or the EU to help. The events of 9/11, which made it apparent that terrorism has become a serious threat to the security of democracy and economy, proved to be the turning point in this respect. Poorly controlled international cargo shipments create immense risk of being used in terrorist attacks. It should be emphasized that in the case of 9/11, as well as the tragic events in Madrid or London, public transport means and infrastructure were used to carry out the attacks.

Until now, the attacks have been directed mostly against human targets and this is probably the reason behind the use of passenger transport infrastructure. However, in attacks against structures and other facilities, terrorists may attempt to make use of cargo carrying infrastructure, such as road vehicles and containers. The awareness of the scale of the terrorist threat has led to greater interest in increasing the global security of transport. The Transatlantic Security Initiative is the fruit of cooperation between Europe and North America in the area of exchanging knowledge, experience and technologies to protect the most vital, sensitive and vulnerable elements of the supply chain. Its goal is to substantially speed up the development and widespread implementation of a comprehensive system which would considerably increase – at the very least – the security of NATO and EU countries, especially in transport. Reaching this goal is not possible without the use of telematics and IT solutions.

The application of even relatively simple systems of monitoring cargo with GPS transmitters and receivers may cause significant safety and security improvement. Currently employed and increasingly popular solutions allow for the installation of a GPS receiver, which in conjunction with a door opening sensor, cargo space air pressure sensor or probes measuring the state of a liquid both in terms of pressure and position, permits the monitoring of the object involved. The values of the monitored parameters may be periodically sent to a control centre at any interval, depending on selected time period, as well as automatically forwarded when certain threshold values are exceeded or at the request of the centre.

At this point it should be emphasized that practically all telematics devices need a source of power. This problem is relatively simple to resolve in a vehicle connected cargo space, but in the case of multimodal and especially intermodal transport the cargo security for containers in storage lots, depots, warehouses, ships or railway cars becomes more complicated to solve.

8.4. Influence of telematics on transport productivity

One of the fundamental advantages of road transport, aside from the fast, “door-to-door” movement of goods, is the “just in time” completion of deliver-
ies. In modern logistics systems, the client or the consignees also want to know delivery time and current vehicle location. These, in turn, have a direct impact on fuel consumption and road fees, which can result in lower direct costs.

Each of the currently available systems, if used to its full capability, may provide measurable economic benefits in at least a few aspects. The first is the correct vehicle route ensured by on-board navigation systems, resulting in the optimization of the itinerary and time of carriage, as well as a reduction in the fuel costs and road tolls paid. The second is the possibility of controlling driver's performance on a permanent basis. After all, the driver has the sole control of highly valuable assets in the form of the vehicle and its cargo. The possibility of complete and exact route planning through the use of digital maps is the third aspect. The fourth one is highly practical as it allows monitoring the accuracy of automatic invoicing which is done in Germany, Austria and the Czech Republic, owing to the use of on-board devices marketed in those countries.

Sophisticated navigation and positioning systems capable of operating both in on-line and off-line modes, ensure a more effective use of human and fleet resources. They enable the supervision of fuel consumption, where the vehicle was refuelled, its axle load, cargo safety, thermograph performance, vehicle status (e.g. whether the vehicle is in motion or stationary at a given moment, if its engine is on or off), as well as reproduce the route covered, based on digital information collected in SQL databases or even stop the vehicle in an emergency. They also make monitoring of sounds in the driver's cabin or cargo space possible.

The aforementioned digital maps used for planning itineraries (including alternative routes) are an example of telematics and IT solutions which translate directly into economic effectiveness of road transport services. In the process of itinerary optimization, the IT system must take into account numerous factors and not concentrate solely on finding the shortest route, since aspects such as availability and prices of parking and fuel, transit or infrastructure tolls, traveling time and possible average speeds are all vital elements which allow an exact calculation of fuel consumption or delivery time.

This chapter presents an example of calculating the itinerary between Sopot and Munich, selecting the shortest route, as well as two alternative ones. An analysis of direct costs and travel time was carried out for each of the routes. Varying costs and travel times appear in each of the three solutions presented. The findings which take into account fuel cost, road tolls, vehicle speed related to the road category and land topography and the resulting fuel consumption were obtained through primary research carried out in transport companies. Thanks to such analysis it is possible to compare the options available both in qualitative and quantitative terms.

The option which is considered the best may be sent to the driver through a GPS system. The forwarded information includes not only the route but also the location of border crossing points, filling stations (with info on fuel prices,
VAT and possibility of its refund, etc.), and the choice of the safest stopovers which is vital both in Eastern and Western Europe. The possibility of specifying average travel speeds in each territory allows for a precise and credible determination of delivery time. Another important advantage is the ability to adjust the itinerary on the basis of the information available on-line on road conditions and traffic accidents.

The analysed example applies to a shipment carried out with a Euro 3 tractor and a semitrailer carrying about 20 t of cargo from Sopot to Munich. Option I presented in Fig. 32 shows a route leading through Poland to the Kolbaskowo border crossing and across Germany. A large proportion of this route is on motorways, which makes high average speeds possible, but is relatively costly due to the tolls collected.

The second option is illustrated in Fig. 33. It leads through Poland, crossing the border in Jędrzychowice and then continuing on a German motorway, but in this case the motorway section is shorter than in the previous case and consequently, less expensive in terms of tolls.
Option III shown in Fig. 34 leaves Poland through the Jakuszyce border crossing and continues through the Czech Republic where tolls and fuel prices are less expensive, but the topography and road category result in lower travelling speed and increased fuel consumption.

The best option selection depends not only on its length, travel time or direct cost but also on the day of the week and the time of the vehicle’s departure from the point of origin, driving and rest time regulations, breaks and rest periods, further plans for using the vehicle, etc. Therefore, it is a question of a highly dynamic optimization of decision-making processes, which can not be carried out effectively without the support of telematics and IT systems.

Table 21 presents the respective lengths of the analyzed options, as well as fuel consumption and a toll cost estimate for the entire route, time of completing the journey by a single driver, average travelling speed and the total cost of covering the route. The conclusions are the following:

– average journey time points to Option I as definitely the best, although it is connected with the most costly motorway tolls in Germany, furthermore the route cannot be done on the fuel purchased in Poland only, which adds a significant cost element;
Table 21. Comparison of assessment parameters of Sopot-Munich itinerary

<table>
<thead>
<tr>
<th>Route</th>
<th>Route length (km)</th>
<th>Fuel cost (€)</th>
<th>Km of toll-roads(D,CZ)</th>
<th>Toll paid (€)</th>
<th>Total travel time</th>
<th>Average speed (km/h)</th>
<th>Total cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option I</td>
<td>1068.080</td>
<td>523.36</td>
<td>676.5 km</td>
<td>88.21</td>
<td>34h05'</td>
<td>53 km/h</td>
<td>611.57</td>
</tr>
<tr>
<td>Option II</td>
<td>1106.510</td>
<td>542.19</td>
<td>553.2 km</td>
<td>73.40</td>
<td>45h08'</td>
<td>46 km/h</td>
<td>615.59</td>
</tr>
<tr>
<td>Option III</td>
<td>1107.620</td>
<td>542.88</td>
<td>446.3 km</td>
<td>45.51</td>
<td>52h07'</td>
<td>42 km/h</td>
<td>588.39</td>
</tr>
</tbody>
</table>

Source: Own research conducted in shipping companies; conversion rates: 1 EUR = 3.88 PLN and 1 EUR = 28.055 CZK. Estimated minimum cost (fuel+ other direct costs) – 0.49 EUR/km.

- the lowest total cost, including the least expensive tolls points to Option III as the best choice, but only if the delivery time is not the prime criterion. While the topography may cause a small increases in fuel consumption, the savings of 30-40 euro on tolls constitute about 5% of the freight for such a shipment;
- despite opinions of many carriers to the contrary, the route presented in Option II is definitely the least favourable due to the relatively high tolls, long distance and travel time; this assessment is also supported by the highest overall cost.
Optimization of route selection depends on client requirements but it also must take into account the close relation between the requested conditions regarding e.g., delivery time and the offered unit freight rate.

There are further advantages of using telematics and IT solutions in transport. One of them is the optimization of route and points of discharging through a cargo delivery plan, which takes into account, among others, the opening hours of the consignee's warehouses. Another is the access to data on driving and rest time recorded on digital tachograph and the driver's smart card. This information can be remotely forwarded through the Internet or GPRS as required by the UE Regulation 561/2006 - that is at least once in 21 days. Readers which have recently appeared on the market, such as TachoDrive2, are becoming vital, especially in road tramping where vehicles do not come back to their base locations for 21 days or longer.

The use of telematics and IT solutions along with constant data processing also permits direct control of company dispatchers, allowing a comparison of the planned shipments and unit freight rates with the actual values settled after the vehicle returns to base or by any other method of closing transport cycles.

### Table 22. Comparison of data used in performance assessment of forwarders

<table>
<thead>
<tr>
<th>Transport cycle no.</th>
<th>Total km</th>
<th>Loaded km</th>
<th>Declared km</th>
<th>Loaded freight/km</th>
<th>Declared freight/km</th>
<th>Total freight/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3790</td>
<td>3552</td>
<td>3860</td>
<td>0,75</td>
<td>0,74</td>
<td>0,71</td>
</tr>
<tr>
<td>2</td>
<td>3570</td>
<td>3256</td>
<td>3519</td>
<td>0,77</td>
<td>0,75</td>
<td>0,70</td>
</tr>
<tr>
<td>3</td>
<td>4370</td>
<td>3982</td>
<td>3822</td>
<td>0,69</td>
<td>0,67</td>
<td>0,59</td>
</tr>
<tr>
<td>4</td>
<td>3461</td>
<td>3096</td>
<td>3494</td>
<td>0,81</td>
<td>0,78</td>
<td>0,72</td>
</tr>
<tr>
<td>5</td>
<td>3327</td>
<td>3070</td>
<td>2785</td>
<td>0,68</td>
<td>0,66</td>
<td>0,63</td>
</tr>
<tr>
<td>6</td>
<td>4317</td>
<td>3846</td>
<td>4195</td>
<td>0,70</td>
<td>0,68</td>
<td>0,63</td>
</tr>
<tr>
<td>7</td>
<td>3156</td>
<td>3070</td>
<td>3451</td>
<td>0,81</td>
<td>0,79</td>
<td>0,71</td>
</tr>
<tr>
<td>8</td>
<td>4425</td>
<td>4141</td>
<td>3552</td>
<td>0,67</td>
<td>0,65</td>
<td>0,61</td>
</tr>
<tr>
<td>9</td>
<td>4108</td>
<td>3629</td>
<td>4070</td>
<td>0,80</td>
<td>0,71</td>
<td>0,67</td>
</tr>
<tr>
<td>10</td>
<td>3930</td>
<td>3624</td>
<td>3868</td>
<td>0,88</td>
<td>0,82</td>
<td>0,73</td>
</tr>
</tbody>
</table>

Source: own study carried out in transport companies.

The use of telematics or IT solutions may have a significant impact on the assessment of productivity in international road transport of cargo. It makes it possible, for instance, to define the actual revenue on each kilometre travelled by the vehicle in every closed transport cycle. Primary research carried out in transport companies shows that the unit freight rate calculated, for instance per each loaded kilometre differs from the value of freight per kilometre declared by the forwarder, which of course considerably diverges from total unit freight in a given transport cycle.
Table 22 presents values selected from companies' empirical data. An important element of such research consists in establishing the accuracy of the calculated profitability on a given transport task. It turns out that thanks to ICT solutions, the errors that happen are negligible. On the other hand, without them it is difficult to even discuss productivity before a shipment is actually completed and the forwarder is forced to rely solely on the experience and intuition of his/her decision makers.

8.5. Bibliography

Chapter 9
NEW INFORMATION TECHNOLOGIES IN LOGISTICS
(Halina Brdulak)

9.1. Introduction

New methods of increasing competitive edge in business are concentrating on co-operation and co-ordination between supply chain partners, focusing on possibilities of increasing multidimensional integration. These activities are aimed primarily at shortening the processes within the entire chain, making them more transparent to all participants. IT systems provide considerable support for such activity which, is influenced by dynamic development of the Internet and new information technologies. The risks emerging during integration demand that particular attention be paid to the safety of information transfer. Numerous attempts are made to minimize these risks, among them is introduction of regulations on safety system certification\(^1\). This applies the most to those businesses in which the role of information is vital, such as banks, insurance companies, IT firms, as well as increasingly often to logistics providers.

9.2. Role of value chain integrators

Introducing solutions aimed at value chain integration should result in increased transparency, as well as shortened reaction time to dynamically fluctuating orders. In demand driven chains characterised by the use of modern IT – the

\(^1\) This is ensured, among others, by ISO 27001 which is based on British standards.
concepts of optimization and back-end planning become of greater importance in relation to previous emphasis which more traditional solutions placed on the front-end of supply chain. The concept is illustrated in Fig. 35.

Such change of approach allows for increasing the level of ROI in relation to what has been the experience so far. The differences between traditional approach to logistics and the one employing IT platforms are presented in Table 23.

Table 23. Differences between traditional logistics and e-logistics

<table>
<thead>
<tr>
<th></th>
<th>Traditional logistics</th>
<th>E-logistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution model</td>
<td>Push</td>
<td>Pull</td>
</tr>
<tr>
<td>Customer</td>
<td>Strategic or a few key ones</td>
<td>Wider customer base</td>
</tr>
<tr>
<td>Demand</td>
<td>Predictable, stable, may be erratic</td>
<td>Dispersed</td>
</tr>
<tr>
<td>Cycle period</td>
<td>Weekly/ multidaily</td>
<td>Daily, hourly</td>
</tr>
<tr>
<td>Shipment type</td>
<td>Wholesale</td>
<td>Small batches</td>
</tr>
<tr>
<td>Deliveries</td>
<td>Concentrated</td>
<td>Dispersed, greater distances</td>
</tr>
<tr>
<td>Supplementation</td>
<td>Planned</td>
<td>In real time</td>
</tr>
<tr>
<td>Responsibility</td>
<td>Single link</td>
<td>Through entire supply chain</td>
</tr>
<tr>
<td>Customer service</td>
<td>Fixed standards</td>
<td>Flexible</td>
</tr>
</tbody>
</table>


The novel business model created on the foundation of IT platforms may cause development of a new business group of Value Chain Integrators (VCI), who building on their high IT competence will through the use of the right software increase the value of order processing services they provide. Among competitors and at the same time suppliers of logistic companies IT firms will appear which will be well versed in understanding supply chain processes, providing the competence necessary for their improvement. Simultaneously, IT teams operating within logistics companies will increase their capabilities through deeper knowledge of business processes, offering customers additional service in value
building. The competitive advantage of VCI companies in the virtual market will stem from providing services based on a high level of smoothly coordinated operations within supply chain/network, since the biggest economic value lies in the part of the supply chain/network covering the customer.

If we take a look at today's customer expectations regarding time and reliability (quick and loss-free delivery, short order completion time, instant product availability and cost information, order status reports in real time, prompt reaction to order changes), we can assume that they can be satisfied only through increased IT saturation of traditional services, which leads to the already mentioned business model change. Among e-business orientated companies, the share of IT driven activity is on a dynamic increase – starting with electronic order, on-line payment, tracking of shipment and possible divergences during order processing, confirmation of delivery, as well as tracking returns and responding to complaints or generating reports. Since customer quality service expectations are much higher than in the case of traditional services, it is essential to secure customer's trust through high level of reliability, as well as safety during the entire supply chain.

Another area requiring special attention from the VCI point of view is connected with the process approach. As has already been demonstrated, in many cases IT integration is associated with the actual linking of operator and customer operating systems (e.g. when the software applies to the operations of sales, financial or logistics team), since in order to achieve optimum benefit it is necessary to connect and integrate respective processes. Such applications are known as end-to-end (connection of front-end, applications - supplier relations with back-end applications – customer relations). So far, relatively few companies are equipped with applications covering order processing in its entirety. Among the ones that are we can find UPS, FedEx, DHL, TNT, Amazon or Dell. It can also be noticed that relatively many firms (over 25%) decide to outsource the above applications, although the tendency has dropped in relation to the period of 2000-2005. In my view, this is connected with the increasing significance of IT (understood as a defined system and not just a tool) and the ensuing business model change previously described. Increasingly often, IT systems do not function separately, as tools only, but are closely integrated with processes. As a result, they become company's core business, and there appears a growing interest in having IT teams inside the company (as strategic resources). The method of organizing these teams and their size are separate issues. It is possible that their structure should change with outsourcing of certain basic tasks.

In the context of the above solutions, it is worth noting that information technologies include both methods, as well as tools allowing for information interchange - the fundamentals of IT. Consequently, the human factor in the approach to these tools is of critical importance. Therefore, currently used IT systems should be highly correlated to company management structures. Hence, it
is first necessary to define the management model and only then select such tools which ensure that the selected model is supported by IT systems.

New challenges that logistics companies are facing are connected with the following factors:

a) IT system integration not only within company and its individual departments, but also throughout the entire supply chain/network;

b) the ensuring of high level of information security in its flow between individual links of the supply chain within supply networks (ISO 27001 certificates);

c) self-evolution of solutions dedicated to specific fields, e.g., pharmaceutical, automotive, FMCG, electronic.

The above processes aim at shortening the time from order placement to its completion, decreasing the level of errors and irregularities, as well as accelerating the process of adapting the supply chain/network to market changes and decreasing the cost of running a business by maintaining quality adequate to market expectations. The changes which have taken place in the last two or three years are connected mostly with increasing the level of risk in running a business, which results mostly from spreading globalization and uncertainty, as well as the growing significance of transaction costs. Efficient processes and low logistic costs increasingly frequently become the factors which make a given market product different from others, therefore having a decisive role in forming its competitive advantage.

9.3. Basic rules of IT system integration and the risks involved

Most frequently used in chains and networks are the SCM and ERP systems, which are described in detail in specialist literature. However, it is worth noting that SCM systems should include in their make-up a variety of well integrated IT systems, which include:

– systems for electronic data exchange – an “integration rail” between various systems;

– systems for receiving and recording orders at the customer’s side;

– systems allowing placement of transport orders to logistics providers (usually the provider does not have own transport fleet, relying on contracts with shippers), as well as facilitating preparation of shipment documentation;

– mobile systems for drivers, as a type of terminal of integrated systems supporting logistic provider’s internal organizational processes;
– systems for planning and optimization of pick-up and delivery at the logistic provider's side;
– integrated management systems supporting logistic provider's internal organizational processes;
– WMS (Warehouse Management System) class systems if logistic warehousing services are provided;
– reporting systems allowing for order tracking, as well as control of performance indicators in a chain (KPI).

However, in this paper I would like to concentrate on presenting the risk which is created in using diverse IT systems among chain/network participants. Most logistic companies use individual systems created by their own IT teams. These systems take into account specific company offer and are well adjusted to the service range. They evolve and develop depending on business needs. Quite frequently, however, system development takes place through the so-called “patches” placed in the existing system. This increases the risk of malfunction or inaccuracy, which appears when large streams of information must be simultaneously transferred and analysed in a given time unit (on-line). This issue can be partially solved by providing the information almost in real-time which means that work is done on data updated at certain time intervals (off-line) depending on the needs of a given process. Another solution which is not without risks either is the purchase of a system generally available on the market. However, such systems are much less flexible than own solutions and take less of company's individual character into account. Their unquestionable advantages lies in standardization and ease of integration within the same system group. Nonetheless, as far as time factor is concerned, full implementation of such as system still takes one or two years depending on the number of employed modules, and with support from an external firm or the producer of the software. During that time the risk of malfunction and/or user errors steadily increases, which may worsen the quality of the executed processes. Therefore, the decision whether to develop an in-house system which is later expanded or purchase an off-the-shelf product requires detailed analysis of the risk of losing competitive quality as a consequence of a particular choice (among others, degree and scale of damage, incomplete integration with external systems, user skills i.e. the level of difficulty, availability of people able to instantly solve and repair system problems etc.).

The need for integration appears as a result of searching for business advantages. In order to fully capitalize on technological integration, it should be preceded by process integration. Such approach forces the participants to conduct a joint analysis of their own processes, thus making their sequences clear to others, and then look for ways of shortening or even eliminating certain sub-processes which do not create value in the supply chain as a whole. IT system integration is usually connected with changes among system participants. They can be of organizational character, but may also regard the course of certain
sub-processes such as flow of documentation, control systems, methods of generating management reports or entering new information into databases. The fundamental risk which may become apparent at this stage of decision making is omission or insufficient use of IT teams in constructing a solution. It should be noted that the role of such teams is currently changing. Due to the increased level of business dependence on IT, its specialists are expected not only to act reactively to reported needs but also to creatively participate in system solutions. This results in significant expansion of their competences and better understanding of the essence of company operations. The trend is a part of the spreading phenomenon of a multi-functional employee, capable of more than performance of a specific task and, if needed, able to handle different work responsibilities with understanding of own role in the process.

Customers sometimes air the opinion that the processes taking place at logistic providers should be constructed in a way allowing for their easy “docking” to customer’s processes. These views reflect the role of the customer in the entire supply chain/network as its leader. However, in reality there are increasingly frequent cases of the main architect’s role being transferred to logistic providers, who thanks to their own knowledge and competence should, while maintaining quality and low cost; be able to create a process solution optimum from the perspective of the entire network (all participants). The provider does not take a complete service-providing function in relation to the customer (as was the case in the past) but also consults with the customer the methods by presenting available tools. Therefore, the final parameter of goal completion is an outcome of customer expectations and provider capabilities. Hence, if the customer expects more advanced tools, both sides jointly decide how to best share the cost of their use.

One of the key parameters in a solution accepted by chain/network participants is system availability (possibility of system use by authorized persons at defined time period). Very high parameters in this area are usually connected with extensive cost and the need to make additional investment. Therefore, it is necessary to establish who and to what degree will make the outlays to achieve specific parameter level. After a close analysis, it may appear that in the end the participants will accept a lower parameter level if additional costs do not mitigate the risk to a sufficient degree.

Integration technology has become a type of a new product on the market. It is offered under a variety of names, e.g. “integration rail”, SOA (Services Oriented Architecture) solutions or EDI platform. This type of evolution may also be observed in the integration service itself. It is offered by some logistic providers as added value for customer. It may appear in the form of a specific software package to be chosen by the customer, depending on employed technologies.

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2 It may be EDI solution which usually requires advanced technological level, as well as use of Internet technology or installation of special software on customers’ computers.
and consist of defining information interchange standards (EDIFACT, XML), en-
coding channels (such as HTTPS, SFTP), all the way to user help-desk solutions
and 24/7 assistance\(^3\). The role of IT support does not end at the moment of com-
pleting successful integration of the systems of chain/network participants. It is
also necessary to maintain the efficiency of the system. It turns out that in a cri-
sis situation it is the close co-operation between all system users that proves to
be most effective. This also applies to having a combined negotiating power in
relations with a company, e.g., telecom operator, which is not part of the
chain/network, allowing for having breakdowns repaired quickly. The oper-
ational effectiveness of such a system is measured thorough KPI (Key Perform-
ance Indicator). This can be done, among others, with the use of Internet avail-
able tools, which can, to a certain degree, be configured to customer’s expecta-
tions and then generated and e-mailed automatically\(^4\).

It is worth pointing out that this type of integration service is relatively re-
cent and indicates developmental direction of logistic providers’ product range.
Owing to the substantial increase in the role of IT, it is also included as part of
provider’s core competences.

9.4. Security of information

Access to information and its quality are key factors of effective management of
an integrated supply chain. Logistics provider, acting as the link between indi-
vidual parts of the chain should ensure flow of credible and detailed informa-
tion between all chain participants. The bases of this process are formed by in-
ternally created company procedures which ensure appropriate level of secu-

The analysis of IT hazards and their impact determines the degree of IT sys-
tem availability of business processes for logistic operators. Based on the recom-
mandations of such analysis, a decision on back-up processing units and WAN

\(^3\) Setting of various service levels usually takes place depending on customer expectations regard-
ing time of response to reported breakdowns and the time of repair.

\(^4\) In case of the global logistics provider Schenker, these are among others: Advanced Tracking, E-
connect or Lopass.

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connections can be made. System breakdowns resulting in lack of access to the system, often lead to high losses for customers, therefore it is important to establish, together with the customers, two basic parameters in this respect:

1. which systems are of critical importance for the customers and their market competitiveness;
2. the period of time after which the system must recover after a possible breakdown.

In fact, having the shortest possible system recovery time following a breakdown is not necessarily worth the very high costs such approach entails. The time period should be properly balanced between possible loss level (lost opportunity costs) and the costs necessary for system recovery.

Confidentiality means securing the information against unauthorized access, both from the outside and inside of the company. In well protected systems there are appropriate procedures which clearly state who (level of job position) has access to specific information. At the same time, it is also necessary to separate access to information from the possibility of editing it.

System integrity is connected with lack of conflicts between interconnected sub-systems. As has previously been stated, very often companies have a set of cooperative systems dedicated to specific company functions. If disruptions connected with interchanging data appear as early as the sub-systems level, the risk of their emergence at the level of integration with customer systems (usually a few) is definitely greater.

**9.5. Bibliography**


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5 In the main processing unit all equipment elements are backed up and the entire configuration does not have a definite identifiable point of breakdown. For instance, breakdown of a single disk or damaged disk replacement do not interfere with the continuity of matrix, and servers housing database and application work in a cluster configuration, thus breakdown of a single server has no effect on operating continuity of production systems. Malfunction of any network device results in its function being automatically taken over by a back-up device, processing centre is equipped with a high capacity UPS and an automatic diesel powered generator. The above configuration protects against hardware problems in a processing centre. In the event of damage done not only to the hardware or when other problems with the CPU appear, its function is taken over by a back-up unit. The time needed to start the back-up unit does not exceed one hour. Such a high degree of system availability may be obtained through constant standby status of the hardware and the software of the back-up unit (so called 'hot backup'), data replication carried out every few minutes from the main unit to the back-up and short time of reconfiguring the entire WAN network (based on PBI Schenker Ltd.)

Chapter 10
MODERN URBAN TRANSPORT SYSTEMS
IN EUROPE
(Olgierd Wyszomirski)

10.1. Introduction

The prerequisite for efficient and economically effective urban transport is the implementation of appropriate organizational solutions.

The monopolistic practice whereby a publicly-owned enterprise acts, on behalf of the public authorities, as transport provider and operator at the same time has demonstrated many shortcomings of the solution. The concept of competition in providing urban transport services has been adopted and various solutions introducing competition in public transport have been developed. A certain evolution of the adopted solutions can be seen under the influence of internal and external conditions.

In Poland, in the early years of the previous decade, competition in urban transport organized by public authorities was introduced in some cities following the European trends. In most cities competition from independent carriers operating outside the public transport system appeared. It is an unfavourable phenomenon reflecting the weakness of systems organized by public authorities. Specific changes in the way transport is organized are necessary, which require, however, that appropriate formal and legal conditions be put in place.
10.2. Factors causing changes in urban transport systems in Europe

A basic factor determining changes in the organization of urban transport systems in Europe was the development of individual motoring, leading to a fall in the efficiency and economic effectiveness of public transport operations. In an effort to reduce the share of cars in urban transport by encouraging their users to use public transport services, system changes have been made in public transport organization aimed at increasing its efficiency and economic effectiveness. A possibility of providing an integrated transport offer in the urban area, and even on a broader scale, in the whole region, covering all carriers, including railway operators is considered to be an important goal.

The most important and still binding legal act in respect of public transport which sets the framework for system solutions for its organization is Regulation No 1191/69 of the EEC Council of 26 June 1969 on the action by Member States concerning the obligations inherent in the concept of a public service in transport by rail, road and inland waterway, amended by EEC Regulation No. 1893/91. The Regulation sets the general framework for providing public services and granting specific compensation from public funds. Compensation granted in accordance with those rules is not regarded as public aid and is exempted from the obligation to inform the European Commission thereof.

Regulation No. 1191/69 along with the amending regulation No. 1893/91 permits Member States to selectively refrain from following it. The only European Union countries that have applied for consent to partially exclude the application of the regulation in question for municipal, suburban and regional transport are Germany and Austria. This means that those countries have decided not to follow the specific requirements related to granting public aid to carriers, leaving themselves a possibility of continued direct co-financing of their operations.

The fact that most of the EU countries failed to effect significant changes in the public transport organization within the regulatory framework set by the said regulation, particularly in the situation providing a possibility of an exemption from the obligation to apply it, made the European Commission prepare a new draft regulation at the threshold of the new century. The essence of this regulation was to precisely define the conditions for granting compensation to carriers from public funds and granting exclusive rights to provide transport services. Pursuant to the draft new regulation, all organizational solutions

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2 Ibidem, p. 11.
should provide for contracts of specified duration awarded by way of public tender procedures, with minor exceptions determined by safety reasons or negligible value of the services.

The prepared draft new regulation evolved with time towards diluting the restrictions concerning employment of public-owned carriers. In its 2005 version, the draft provides a new regulatory framework for public transport which determines the possible solutions in respect of urban transport organization systems.

The purpose of the Regulation of the European Parliament and of the Council COM (2005) 319 on public passenger transport services by rail and by road is to define the scope of intervention by authorities in the public passenger transport sector in accordance with the Community laws.

The draft regulation defines the conditions on the basis of which competent public authorities, when imposing obligations to provide public services or awarding a contract to provide them, compensate the service providers for the incurred costs or grant the exclusive right to provide the services.

The following rules of contracting public services are formulated in the draft Regulation COM (2005) 319:

- a contract is required for exclusive right to provide public services or compensation (irrespective of its nature) to be granted;
- the provision of public services at prices according to maximum tariffs defined by public authorities for all passengers or for some passenger categories may also be subject to contract award;
- the public authorities of the member states may exclude from the scope of the Regulation the rules of compensating carriers for providing public services at prices stipulated in the maximum tariffs for pupils, students, apprentices and persons with reduced mobility on condition that the competent EU authorities are notified thereof.

The corrected draft Regulation COM (2005) 319 forms the regulatory framework determining the urban transport operations providing public utility services. Pursuant to the draft regulation, public authorities may choose the solution concerning the organization of their public transport. The public authorities may decide whether they will provide the urban transport services through their undertakings or whether they will commission the task to an independent operator or operators. The creation of such legal possibilities is the European Commission’s response to the European Parliament’s request to respect the freedom of choice of territorial units. In the contract executed with the operator, local governments may define the tasks for operators and finance those tasks.

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10.3. Model description of modern urban transport systems in Europe

Specific model solutions in urban transport organization have been developed under the influence of the factors presented above.

Deregulated and regulated transport models may be distinguished depending on the degree of regulation. In the deregulated transport model, regulation is reduced to a minimum that may be deemed necessary from the point of view of the public authorities’ intention to ensure transport service of a standard required by the inhabitants. On the other hand, the regulatory scope in the regulated transport model is wide. The essence of a deregulated transport model is to encourage competition. The regulated transport model may be based on the monopoly of one carrier or on competition of carriers.

Modern solutions in regulated transport use competition as a mechanism affecting the efficiency and productivity of the provided transport services. Competition may take the form of the whole market being awarded for a specified period of time to the tender winner. However, the market may also be divided into segments, each of which is tendered for separately. If the latter is the case, there may be a few or more operators in the market, depending on the number of segments and the results of the tenders.

Urban transport organization systems based on competition cover more and more areas in Europe. As the systems are implemented, the relations between the public authorities and the carrier change substantially. The place of local carriers is taken by international operators operating under contracts executed for relatively short periods of time. They cannot be sure whether the contract for the next tendering period will be awarded to them. Hence, there comes a problem of covering the investment outlays in the contract period. The nature of contracts is the reason why relations with the public authorities are formalised. The requirements set in contracts are precise, and exhausting efforts are required from the carriers to fulfil them. Carriers aim at maximizing profits in the given conditions defined by the contract awarded in a competitive process.

We may distinguish between the British, the French and the Swedish models of urban transport organization, the respective names referring to the country in which each of them has been implemented on the widest scale.

The British urban transport system, which covers the territory of the whole country except London and Northern Ireland, is characterised by:

- unlimited access to the market by carriers that fulfil the specified technical requirements;

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- the service which to a considerable degree is organized by carriers competing on the market (preparing timetables and tariffs for their services);
- the regulatory scope for transport operations defined by public authorities that is limited to the necessary minimum;
- operation of an entity fulfilling regulatory tasks of organizing, to a limited extent, the transport service; (determining social entitlements to reduced fares and refunding them, ordering the services from carriers that would not be provided by them otherwise, sale of system tickets);
- the dependence of the financial situation of carriers on the number of passengers carried;
- strict quantitative and qualitative controls of the services covered by regulation by the public transport provider.

The regulatory scope for transport operations in the presented model depends on the transport service quality level resulting from independent operations of the carriers competing on a given market. If the quality is low a greater regulatory scope is required to provide the inhabitants with a higher quality of services. When extending the regulatory scope it should be remembered that too great a scope of regulations in that model may entail ineffective operations of carriers and allocating too many funds for organizational and management activities of public authorities.

The entity organising the public transport service in a given area on behalf of the public authorities operates at the level of a transport authority appointed for the whole metropolitan area and composed of politicians. That entity is the executive body of the authority. The scope of its operations results from the objectives and tasks defined by the urban transport authority.

An important feature is the unlimited access of carriers to execution of transport tasks. Owing to this, the supply of services is growing. The offer of each of the carriers may, to the necessary degree, be integrated by the urban transport authority executive body.

The fact that the service is organized to a considerable degree by carriers opens up their initiative to compete for passengers. It may have a positive effect on the quality of the provided services.

An important issue from the point of view of the quality of services are system tickets which are issued by the urban transport executive and which make it possible for passengers to travel within the coordinated area by any means of transport, whatever the operator, including the railway service. It is also the quantitative and qualitative controls of the provided services that has a positive effect on their quality.
The French urban transport organization and management system which covers the territory of the whole country except Paris, Marseille and La Rochelle is characterised by the following:

- access to the market for a specified period of time for only one carrier – the winner of the tender covering the whole system;
- a wide regulatory scope for transport operations defined by public authorities (adoptering the tariffs);
- operation of an entity fulfilling regulatory tasks to organize the transport service to a limited extent (preparing objectives for timetables);
- the transport service is to a large extent, organised by the carrier on his own (preparing timetables, sale of all types of tickets);
- the financial situation of the carrier depends on the number of passengers carried;
- strict quantitative and qualitative controls of the services by the public transport provider.

A basic limitation of the French urban transport organization and management system is the scope of competition. The scale of the undertaking under the contract restricts competition to a small circle of big carriers prepared to provide services on a large scale. An advantage of the system is the carrier’s participation in organising the transport offer and making the carrier’s economic and financial situation depend on the number of passengers. It is also important from the point of view of the quantity and quality that the services are subject to strict control by the public transport organizer.

The Swedish urban transport organization system, which covers the territory of the whole country, is characterised by following:

- access to the market for the carriers that have won tender procedures to provide services for specific segments (lines or groups of lines);
- a wide regulatory scope for transport operations defined by public authorities (adoptering the tariffs);
- operation of an entity fulfilling regulatory tasks whose exclusive task is to organize the transport service (preparing timetables, sale of all tickets);
- the financial situation of carriers does not depend or depends to a small extent on the number of passengers carried;
- strict quantitative and qualitative controls of the services by the public transport provider.

The operation of an entity whose exclusive task is to organise transport services, on the one hand, permits the public authority to fully achieve its goals by means of a transport offer, on the other hand however, limits the initiative of carriers by reducing their role most of all to the performance of services.

An advantage of the system is that usually a larger number of carriers of different size have access to the urban transport market organised by public authorities. Such a system is able to absorb carriers who, without having the possibility to access the market organised by public authorities would otherwise operate independently outside the integrated transport offer. An important element of the system is the control of the quantity and quality of services by the provider representing the public authorities. Owing to such control it is possible to effectively enforce a high standard of services in accordance with the order under the contract.

In addition to the presented systems, a traditional system – not based on competition in providing services – also functions in Europe. Having in mind the country in which the system is used to the greatest extent, it can be called German. It is characterised by the following features:

- the functioning of a special-purpose union of municipalities conducting transport policy and an executive unit of the union integrating the transport offer;
- employment of municipal carriers by their owners, who subsidise their services directly;
- distribution of the revenues from sales of integrated tickets among carriers by the union;
- the union’s function for municipal bus and tramway enterprises is the role of a settlement centre.

The German system cannot be considered fully modern due to the absence of competition and the related lack of tender procedures for transport services provided as public service. Certain modern traits can be found only in developing a solution to offer integrated services over large metropolitan areas and in regions as part of regulated transport service, notwithstanding the fact that municipal carriers are not employed by the transport provider acting on behalf of public authorities.

10.4. New trends in urban transport organization systems in Europe

Individual urban transport systems in Europe undergo an evolution under the influence of various factors. In general, the changes are going in the direction of quality improvement of the transport service, as a factor determining the com-

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petitiveness of urban transport with respect to individual motoring and improving productivity owing to the mechanism of competition for transport services.

In the British system, which is deregulated in its essence, the regulatory scope has been extended. The basis for this was the government Green Paper on public transport which was published in 1996. The paper started laying more emphasis on the quality of public transport in order to increase its role in urban transport. Long- and short-term planning has become the basis of the activities of urban transport authorities and their executive bodies with respect to developing the transport offer.

The government has initiated “a statutory partnership for quality” to encourage local public transport authorities to provide such improvements as dedicated bus lanes or passenger information systems on condition that the carriers invest in new rolling stock. Moreover, the government set the framework for creating “quality contracts” to improve the transport service standards.

Urban transport Authorities have taken action in respect of:
- gradually improving the offer to eliminate shortages in commercial services;
- introducing the requirement to participate in integrated ticket systems;
- the carriers being obliged to operate easily accessible and user friendly vehicles;
- implementing solutions making it easier for small carriers to stay in the market;
- coordinating contract validity periods in a manner conducive to the network nature of services for contracts awarded under tender procedures;
- strengthening the control over carriers that do not respect the adopted rules;
- including the whole railway network in the integrated service system.

In the French system specific solutions have been used to facilitate its functioning. These solutions are the following:
- the carrier is the operator of a system based on public ownership of the infrastructure and has specified obligations in respect of providing employment;
- contract periods are limited to 5-6 years;
- a very detailed and extensive contract is executed detailing the rights and obligations of the parties;

12 Ibidem, p. 81.
– a portion of the commercial risk is transferred onto the carrier.
Contracts between the appropriate public authority or an association of public authorities in a given area include most of all\(^\text{13}\):
– definition of the scope of provided services (routes, frequency);
– fares;
– rules for financing the provided services;
– obligations of both parties towards the passenger.
In the Swedish system the evolution is heading towards\(^\text{14}\):
– precise detailing of the requirements for the carrier at the tender procedure stage;
– executing the so called “net contracts” with carriers in which the remuneration is fixed depending not only on the number of vehicle-kilometres but also on the revenues from ticket sales on a given line or a group of lines and on the quality of travelling.
A good example of the trends occurring in the Swedish system, used also in Denmark, are the solutions adopted in Copenhagen, where\(^\text{15}\):
– full competition among carriers has been implemented, exposing the municipal carrier to competition with private entities at first, and privatising the carrier afterwards;
– the list of requirements to be fulfilled by the carrier has been largely extended;
– much space has been left for flexibility in case of a change in the transport offer;
– not only was a system of penalties applied but a system of incentives to motivate carriers was also introduced which, basing on passenger satisfaction, differentiates very good passenger-oriented carriers from just proper carriers fulfilling only the minimum requirements.

The trends occurring in the Swedish system are also visible on the example of Frankfurt am Main, as a city in Germany in which it has been resolved, unlike in other cities in Germany, to break the local monopoly of the municipal company in respect of the transport and to introduce competition. Under the adopted solution, cooperation between the transport authority and the carrier is based on long-term contracts (5-6 years with a possibility of extending them by 2-3 years). The operator receives a fee determined in the tender procedure, to be reviewed depending on the change of fuel prices and wages. In addition to this,


\(^{15}\) M. Wolański, Model współpracy organizatora transportu publicznego z prywatnymi przewoźnikami w aglomeracji Kopenhagi. “Transport Miejski i Regionalny” 2006, No. 5, p. 36.
a system of rewards and penalties based on service quality control and customer satisfaction surveys is used\textsuperscript{16}.

A more typically German urban transport organization system is implemented on other territories of the former German Democratic Republic. In 1998 the Upper Elbe Transport Union was established in Dresden. In order to execute provider tasks, the limited liability company under the name of the Public Transport Union was established. The main task of the Union is to integrate passenger transport in the city, in the conurbation and in the region. The Union has focused its activities on a coordinated and comprehensive information and ticket system providing easily available and user friendly tickets. An important goal of the Union is to use various means of transport to ensure appropriate flexibility of transport in the region\textsuperscript{17}.

10.5. Status and suggested directions of change in the urban transport organization in Poland

The restructuring of urban transport systems was commenced in some municipalities in Poland along with the system reform. However, the traditional system based on the publicly owned carrier’s monopoly has been maintained in most cities.

It was the Swedish model that was used to the largest extent when restructuring the urban transport organization systems. Currently, the model finds application in most big cities and in some smaller ones. However, it does not exist in its pure form. Most of all, publicly owned entities prevail among carriers employed by urban transport authorities, which makes it difficult to manage the system. Effective instruments of enforcing high quality services are lacking.

Another modern urban transport organization system used in Poland is the French model. As is the case with the Swedish system, it does not occur in its pure form. Its application in our country consists in a tender procedure being organised by the public authorities to provide service for the whole network, where the procedure is prepared in a manner preferring the existing municipal carrier. It is only in single cases that privatisation of a urban transport enterprise was successful using the French model. While implementing this system, the so-


\textsuperscript{17} K. Ringat, Tworzenie związków transportu publicznego dla integracji miejskiego i regionalnego transportu publicznego w Niemczech [in:] Integracja lokalnego i regionalnego transportu zbiorowego. Szanse i bariery. Materiały konferencyjne. Izba Gospodarcza Komunikacji Miejskiej, Kielce 2005, pp. 9 and 10.
olutions adopted in practice in France which would increase the effectiveness of its functioning are not used.

The British urban transport system in principle does not find application in Poland. Few cities have decided to commission the service to independent carriers competing with one another. However, no transport provider that would regulate the system in a specified scope has been appointed in those cities.

The smallest effects in our country, regardless of the organization system used, have been achieved in respect of urban transport integration, both in urbanised areas and in regions. Comprehensive results, such as those in the presented modern transport organization systems in Europe, have been achieved nowhere.

There are barriers on the way to restructuring urban transport in Poland, which would ensure the functioning of efficient and productive systems on the scale of cities, conurbations and regions. These include:

– the social and political barrier resulting from the lack of social consent to privatising municipal carriers;
– the financial barrier related to the lack of funds to co-finance the restructured system, particularly in respect of integration of subsystems;
– the legal barrier resulting, on the one hand, from the lack of a good regulatory framework for restructuring, and on the other hand, from the binding laws that hinder the functioning of restructured systems and prevent achieving the desirable effects.

With the need to overcome the legal barrier in mind, we might propose the adoption of a public transport law based on the following general assumptions with respect to urban transport18:

– the urban transport provider defines the scope of municipal transport services provided upon the order of public authorities;
– the public authorities define the fare price level and the scope of reductions and fare-free entitlements;
– the general rule for ordering services are tender procedures (exceptions from that rule are defined in the draft Regulation of the European Parliament and of the Council, COM (2005) 319);
– the tender procedure covers alternatively:
  • the price for services, in the event that the carrier receives payment for operations and the ticket sales revenues received on the basis of a tariff adopted by public authorities are the provider’s income;
  • the expected amount of refunding for the loss of income due to reductions and free travel entitlements in the event that the revenues from

sales of tickets received on the basis of a tariff adopted by public authorities are the carrier’s income, as well as the expected subsidy with respect to lines (connections) that are loss-making despite the refunding mechanism;

– the carrier operating in the municipal transport system earns income:
  • regardless of the number of carried passengers – payment for travelled vehicle-kilometres (the market risk is totally with the provider);
  • depending on the number of carried passengers – income from sales of tickets plus the reimbursement for reduction and free travel entitlements plus subsidies to unprofitable connections (the market risk is with the carrier);

– except for the municipal transport system, the urban transport services market is open in the scope defined by the road transport law (permits);

– except for the municipal transport services, the urban transport services market is not covered by aid from public funds (co-financing from public funds);

– permits to provide services in urban transport are granted by the transport provider;

– outside of the municipal (communal) transport services market there is freedom to provide services at market prices on the basis of a permit with a possibility of unrestricted access to the infrastructure (a condition to obtain a permit is to subject the timetables to the transport provider’s coordination, agreeing upon the rules of using the railway stations and stops, conducting ticket sales on the basic of cash registers printing tickets in a strictly defined format).

10.6. Bibliography


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11.1. Introduction

Development of a city should be perceived as a continuous process of a system striving to reach equilibrium. Such system is characterised by high complexity because it involves a number of diverse functional subsystems. Since these functions are interconnected, their coordination becomes crucial so that underdevelopment of one does not result in limiting others.

The necessity of reconciling opposing goals of economic development, environmental protection and social issues is a dilemma facing local authorities having limited resources to carry out the tasks assigned by the legislator.

One of the fundamental urban sub-systems is transport, which is composed of collective and private transport components. Appropriate shaping of the relation between the two in the context of entire urban population plays a great role in determining spatial attractiveness and quality of life. This is of particular importance in view of the following facts:

- cities of the European Union produce approximately 75-85% of EU GDP;
- about 80% of EU citizens live in cities;
- creation of a high-quality urban spatial environment is a priority of the Lisbon Strategy.
11.2. Transport situation in Polish cities following EU accession

Dynamic development of private car ownership in Poland and its consequences for the functioning of cities and metropolitan areas call for redefinition of the instruments creating mutual relations between public transport and private car use. The main premises for such action are the processes taking place in Polish cities and their high dynamics, which makes the traditionally used tools of strategic management (most importantly spatial planning) largely ineffective.

Two opposing processes are currently taking place in Polish cities. The first is the continuing suburbanization resulting from extensive spatial development in which the number of suburban dwellers increases at the cost of central city areas. The process has become known as internal deconcentration and relies on maintaining a number of essential contacts with the core city and its centre. Daily commutes to work and school are considered the most significant form of these contacts as those locations can usually be found in city centres. Development of public transport and private car use has made possible everyday trip from the suburbs, in which development was less dense and more extensive. Creation of new residential high-standard developments in city outskirts or in neighbouring administrative areas is characteristic of this process. The traditionally perceived process of residential suburbanization is accompanied by retail suburbanization, meaning locating large-area retail facilities in city peripheries or in neighbouring administrative districts of lower level of urban development. Growing mobility of city “users” is the response to the process of “diluting” urban settlement structure and to inefficient spatial planning solutions. Private car use is the necessary factor which intensifies this process. As a result, urban transport intensity increases not only due to the growing area and population, but also to substantial changes in the spatial structure. One of the effects of this process is the growing distance between traffic origins and destinations.

The phase of suburbanization entered by cities of Western Europe after World War II proved to be especially harmful to urban transport networks. As an example one can cite the withdrawal of tramways and trolleybuses from the streets of British cities - a direct effect of suburbanization. Fixed costs were spread over a potentially smaller number of users and a greater area. This led to the overloading of existing transport infrastructure, deteriorating accessibility of city centres and reducing the advantages of suburban living. Today, attempts to

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2 C. Rozkwitalska, Uwarunkowania transportowe intensyfikacji zagospodarowania terenów zurbanizowa-
rnest the proper role of environment-friendly urban transport are made in many European cities.

The second process is connected with the phase of reurbanization. Traffic congestion which has a concrete economic value (“time lost in traffic jams”) becomes the reason why a growing number of city dwellers chose to live closer to their place of work. Structural economic changes make location of business activity less of a disturbance than in the industrial era and do not constitute additional cost for adjacent residential neighbourhoods. For this reason attempts are being made to end the crisis brought to city centres by suburbanization and deurbanization. Demographically, the share of city centres is on the increase while economically city centres become locations of high-end services and intensive recreational and tourist development emphasising the heritage of the place. This allows for identifying an ensuing process in the development of a given city - its reurbanization. Greater concentration of residential and commercial services takes place leading to overburdened transport systems and environmental pressure on city centres. Therefore, city centre revitalization strategy should prioritize measures aimed at supporting sustainable mobility. The greater the intensity of city centre utilization, the higher the number of its users, which is a source of increased mobility requirement. In this case it is possible to satisfy the demand by urban transport and environmentally friendly modes of individual transport without being forced to deepen environmental conflict.

The described processes should be reflected in the programming of adequate urban transport policy instruments.

11.3. Integrated approach to mobility management

Increasing expectations of quality from city transport services result in greater expenditure to satisfy them. Without the use of restrictive transport policy instruments towards private car use, the aspirations of city dwellers and their authorities for high quality of urban life and environmental will not be realized.

Therefore, public authorities are expected to implement an integrated approach with a wider than in the past consideration given to city transport policy in:
- development of transport infrastructure;
- city traffic management;
- development of public transport;
- financing of public transport;

spatial planning.

The integrated approach is based on giving priority to the needs of urban transport, radically limiting private car use in city centres. However, economic constraints may cause providing “door-to-door” transport service over the entire area of the city to be ineffective. In this case, the private car should be treated as an element of an integrated transport system, which may provide additional passengers streams from areas of low population density and lower number of transport intensive functions.

The achieved effects are usually of a medium- or long-term nature, since:
– the measures deal with an area which is exceptionally highly saturated with technical infrastructure;
– their consequences affect a large group of interested parties, who place private interest over common good5;
– European cities differ in the powers and tasks they are obliged to fund, depending on the local government and public finance systems in force in a given country.

Table 24. Fundamental differences between the cities of Western versus Central and Eastern Europe in the context of planning mobility measures

<table>
<thead>
<tr>
<th>Description</th>
<th>West-European cities</th>
<th>Central &amp; Eastern European cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial structure</td>
<td>Developed</td>
<td>deep transformation, suburbanization</td>
</tr>
<tr>
<td>Spatial change dynamics</td>
<td>low or medium</td>
<td>medium or high</td>
</tr>
<tr>
<td>Predominant development areas</td>
<td>central (revitalization)</td>
<td>peripheral</td>
</tr>
<tr>
<td>Linear transport infrastructure</td>
<td>developed</td>
<td>under construction, the development level below the rapidly growing needs</td>
</tr>
<tr>
<td>Transport node infrastructure</td>
<td>occurrence of bottlenecks, integration nodes</td>
<td>none or deeply underdeveloped</td>
</tr>
<tr>
<td>Degree of urban transport subsystem integration</td>
<td>medium or high</td>
<td>none or low</td>
</tr>
<tr>
<td>Prevailing measures</td>
<td>soft</td>
<td>hard (requiring investment)</td>
</tr>
</tbody>
</table>

Source: own study.

One should also be aware that not all the solutions which are being implemented in the cities of Western Europe will bring similar effects in the cities of Central and Eastern Europe. This is due to the fact that in the 1970s West-

5 That is why a city is frequently defined as public-private space, where conflicts are of permanent nature and state of equilibrium is never reached. See T. Markowski, Zarządzane rozwojem miast. Wyd. Naukowe PWN, Warsaw 1999.
European cities had already been affected by the “vicious circle of urban transport”\textsuperscript{6} and since then have taken a number of measures aimed at returning to a more balanced modal split.

Fundamental differences which should be taken into account in the planning of solutions based on the experience of West-European cities are presented in Table 24.

11.4. Sustainable urban mobility

Mobility management is an important issue in creation of a sustainable city transport systems in West-European countries. It concentrates mainly on “soft measures” (requiring no investment), such as introduction of various charges for the use of transport infrastructure and creation of transport plans. Investment measures are aimed mostly at increasing the efficiency of the existing transport infrastructure.

Introduction of economically effective and quality improving urban transport solutions in Poland is not possible without providing a number of comprehensive solutions in the widely understood area of urban mobility, covering all functional city zones. As the example of West-European cities shows, it is a long-term process including both investment measures (e.g. fleet, infrastructure), as well as “soft” measures aimed at shaping attitudes, promotion of partnership between various organizations, training and education on the adverse effects of basing on private car use in urban transport.

Attempts to change mobility behaviour of residents should take into account their diverse needs and expectations. Mobility management means implementation of strategy and actions aimed at satisfying transport needs of the widest possible group of city users\textsuperscript{7} (individuals, as well as businesses and institutions) which are based mostly on more effective use of public and private transport modes (e.g. carsharing).

Promotional activities play a special role in such management. They facilitate communication with the most important parties on the demand side, including:

– large companies;
– public institutions;


\textsuperscript{7} Sustainable Urban Transport. Final Report from the European Project Trendsetter. CIVITAS. Environmental and Health Protection Agency, City of Stockholm on behalf of the Trendsetter cities: Graz, Pécs, Prague, Lille and Stockholm 2006, p. 38.
- educational sector;
- individuals.

The importance of large companies to sustainable mobility results from the fact that they involve a large number of commutes of obligatory nature and because of the number of employees and their defined working hours they are an easily accessible target group. Examples of selected initiatives with the participation of large businesses in the countries of Western Europe indicate that they consider sustainable mobility projects to be an element of their long-term public image campaign.

Traditionally understood urban transport policy concentrates mostly on supporting mass transport, making only marginal use of the instruments influencing private car use. As a result, measures supporting development of mass transport were not consistent with investment policy aimed at quantitative development of road infrastructure which only strengthened the competitive advantage of individual motorists.

Further development of car ownership observed after Poland’s accession to the EU has resulted in decreased competitiveness of urban transport systems which until then had been considered as the most economically effective. Fig. 36 presents the percentage of costs covered by tickets sales of the Gdynia public transport system in the years 1995-2006 against the growing private car use. Based on this information it can be concluded that urban transport without the support of instruments restricting private car use is not able to compete with it in the long run. Consequently, it is necessary to use a wider scale of instruments.

Fig. 36. Economic situation of public transport in Gdynia (percentage of costs covered by ticket sales) against the growing car use

Source: own work based on internal materials of Gdynia City Hall and Public Transport Authority in Gdynia)
limiting car use, especially in city centres. Parking fees remain a popular instrument, however, the key aspect is the purpose of its introduction, as well as the level of parking fees and the scope of exemptions. The basic aim of paid parking should consist in limiting private car use, with forced vehicle turnover being a side effect.

Adhering to the principles of sustainable urban mobility finds reflection first and foremost in a different placement of accents in a city’s urban transport policy.

Basic issues which should be taken into account in urban transport policy are the following:

– accessibility – internal and external;
– mutual relations between public and private transport;
– role and significance of individual public transport subsystems in providing urban transport services;
– transport as an area of economic and political activity.

High degree of accessibility of a city may be considered as an advantage, but one the consequences of which include greater traffic intensity and higher demand for transport infrastructure. Good accessibility of city centre to private motor vehicles may seem to be an advantage to the inhabitants of other city districts, but it only strengthens the irrational use of the most valuable, in economic and urban planning terms, part of the city. Furthermore, social expectations of private car users put political pressure on city authorities to invest in road infrastructure. However, it should be added that crossing a certain level of motor transport development results in the appearance of additional vehicles whose owners previously had not made trips due to limited traffic capacity of the infrastructure. It is a phenomenon known as suppressed demand, and it results in very small or negligible improvement to city transport condition in the event of infrastructure investments not being supported by appropriate transport policy measures based on the principle of sustainable development.

In urbanized areas, transport needs may be met individually or through public transport services. Mutual relations of the two systems are shaped by appropriate transport policy which should base on the principle of sustainable development. In the case of public city transport it entails taking action aimed at increasing the attractiveness of public transport, as well as walking and cycling in relation to private motor vehicle use. This results from the fact that public city transport consumes three to five times less energy per passenger than the private car. Increasing the attractiveness of public transport without implementation of instruments aimed at limiting car use is strategically ineffective and is not

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able to provide - in a long-term perspective - a proper division of city transport tasks in accordance with the principles of sustainable mobility

11.5. Transport plan as an instrument of managing sustainable mobility

Attempt at categorizing EU countries based on their level of acceptance and execution of urban mobility plans was made in one of the quoted studies \(^{10}\). The following were pointed out as the countries where:

– mobility management appears directly in documents of national importance – the United Kingdom, the Netherlands (e.g. full government support of mobility plan implementation for businesses) and Belgium;

– indirect support of mobility management at the national policy level (e.g. Italy, Sweden, France, Germany and Austria);

– there is practically no support for mobility management (e.g. Spain, Portugal and the Czech Republic). In these countries priorities connected with transport systems concentrate mainly on infrastructure development.

Plan of sustainable urban transport is a fundamental instrument of managing sustainable mobility at the level of cities. The basic characteristics of the document are \(^{11}\):

– coverage of entire city;

– coverage of all types of transport within the city;

– taking into account environmental, social and economic aspects;

– promoting public transport, cycling and walking;

– the target group consists of the entire city population.

Implementation of the plan at the city level may be considered in terms of \(^{12}\):

– means for ensuring long-term planning of city urban transport development – regular reporting and monitoring systems should be implemented to allow comparison with other cities;

– framework set of instruments facilitating definition of measurable goals and quality criteria;

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– support instruments for measures fostering interoperability and intermodality of various transport modes, taking into account both passenger and cargo transport segments.

An efficient, integrated transport system based on public transport may also be considered in a wider perspective of a “city product” within functional urban structure. From this viewpoint such a system constitutes a part of city’s offer to its users (e.g. inhabitants, tourists, investors). In certain cases it becomes an important element of the city’s image. As an example, one can indicate trolleybuses which are rare in certain European countries, so cities using them gain a strong identity element.

11.6. Innovative mobility solutions - the NICHES project

The NICHES (New and Innovative Concepts for Helping European Transport Sustainability) Project – completed in 2006, was aimed at creating a set of most promising solutions in the widely perceived area of urban mobility. In particular, the project was to increase the quality of natural environment, competitiveness of public transport and quality of life in urbanized areas.

The project resulted in the development of twelve solutions which are presented in Table 25. They can be classified into the following four categories:
– new seamless mobility services;
– innovative approaches in city logistics;
– new, non-polluting and energy efficient vehicles;
– innovative demand management strategies.

The presented concepts differ in the period of implementation, investment and operational costs, as well as the level of participation by various interested parties, public and private.

In attempting to implement the solutions listed in Table 25 into Polish realities, the previously described differences between Polish and West-European cities should be taken into account. In the opinion of the author, the measures which would prove the most effective in Polish cities are:
– Joint procurement of Clean Vehicles;
– Space Management for Urban Delivery;
– Public Bicycles;
– City-wide Campaigns.
<table>
<thead>
<tr>
<th>Concept</th>
<th>Category</th>
<th>Characteristic</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Lift-Share</td>
<td>new seamless mobility services</td>
<td>Matching services that bring together people who are travelling in the same direction, aiming to encourage individuals to share private vehicles for particular journeys. Based on use of advanced technologies (specialised software, the Internet).</td>
<td>liftshare.com, pendler-netz.de</td>
</tr>
<tr>
<td>Public Bicycles</td>
<td>new seamless mobility services</td>
<td>System of free bicycle rental in urban areas, characterised by fast and easy access to everyday users, especially in city centres.</td>
<td>Vienna, Lyon, Stockholm</td>
</tr>
<tr>
<td>Call-a-bus Services</td>
<td>new seamless mobility services</td>
<td>Demand responsive transport service based on reservations in advance, recommended for low density areas</td>
<td>MultiBus (Germany), PubliCar (Switzerland)</td>
</tr>
<tr>
<td>Space Management for Urban Delivery</td>
<td>Innovative approaches in city logistics</td>
<td>Attempt to increase effectiveness of using city infrastructure in urban goods delivery by employing modern technologies, infrastructure modernization and setting aside special zones available during specific time of day.</td>
<td>Barcelona</td>
</tr>
<tr>
<td>Inner-city Night Delivery</td>
<td>Innovative approaches in city logistics</td>
<td>Deliveries to inner-city retailers and shops during the night hours (10 p.m. – 6 a.m.)</td>
<td>Barcelona</td>
</tr>
<tr>
<td>Alternative Solutions for Home Delivery</td>
<td>Innovative approaches in city logistics</td>
<td>Optimization through delivery to nodal locations instead of doorstep delivery or specifying the time of delivery with the use of cellular phone services and other methods</td>
<td>DHL PackStation (Germany)</td>
</tr>
<tr>
<td>Policy Strategy for Clean Vehicles</td>
<td>new non-polluting and energy-efficient vehicles</td>
<td>Provides long term stability for clean vehicle users and aims to increase their numbers</td>
<td>Stockholm</td>
</tr>
<tr>
<td>Biogas in Captive Fleets</td>
<td>new non-polluting and energy-efficient vehicles</td>
<td>Use of biogas in city servicing vehicles aimed at reducing pollution</td>
<td>Lille, Göteborg</td>
</tr>
<tr>
<td>Joint procurement of Clean Vehicles</td>
<td>new non-polluting and energy-efficient vehicles</td>
<td>Organising joint procurements for purchase of alternatively fuelled vehicles in order to lower their unit prices and spread the technology among general population</td>
<td>Sweden</td>
</tr>
<tr>
<td>Transport Management Associations,</td>
<td>Innovative demand management strategies</td>
<td>Shaping public-private partnership to increase the quality of transport system</td>
<td>Canada</td>
</tr>
<tr>
<td>Road Pricing Schemes</td>
<td>Innovative demand management strategies</td>
<td>Placement of fees and taxes on car users in order to increase the competitiveness of public transport. The revenues should be invested into increasing the quality of public transport services</td>
<td>Stockholm, London</td>
</tr>
</tbody>
</table>
City-wide Campaigns | Innovative demand management strategies | Building long-term awareness through events and activities with participation of private partners, encouraging local citizens to participate in sustainable mobility issues | Nottingham


The above measures are of relatively detailed nature, relating to certain, rather narrow, market segments. Their effectiveness is highly dependent on overall solutions in shaping urban mobility and the priorities selected.

11.7. Bibliography

Chapter 12
WHY THE BICYCLE?
(Maja Włoszczowska)

Motto
“A lorry is crossing the Millennium Bridge in Wroclaw and its driver spots an attractive woman walking by. He stops the lorry and asks “Would you like a lift, miss?” to which she answers with an ironic smile “No thanks, I’m in a hurry”…

12.1. Introduction

We have all heard this old joke and must have more than once been in the situation of the lorry driver, when because of traffic jams, an opportunity for making a potentially very interesting acquaintance was lost. Unfortunately, it is much more than that that we lose or miss because of traffic jams - precious time, good mood, health, fuel, important appointments, even jobs. It seems that every major street gets jammed, effectively paralyzing everyday lives of the inhabitants. The increasingly heavy motor traffic, brings growing pollution (70% of urban pollution comes from car use), rising noise levels and irreversible changes in the natural environment. Numerous teams of scientists keep working at the problem, creating highly sophisticated physical models, making computer simulations and continually inventing new logistics solutions. Without doubt, this is a right road to pursue. However, it is not the only one… As it is often the case, the cure for whatever troubles us is much simpler than we might think. In the case of urban traffic jams, it takes the form of our old friend… the bicycle. Furthermore, the bicycle turns out to be the right cure for many more ailments of our civilization.

Cycling is a healthy and efficient way of travelling. Unfortunately, promoting this means of transport is made difficult by lack of appropriate infrastruc-
ture, of consistent cycle-promoting policy, and last but not least the ignorance on the part of car drivers. On the day of the World Naked Bike Ride, demonstrations against anti-cycling and anti-environmental policies of municipal authorities are held all over the world, under the slogan of: “zero pollution transport solution”. There is a constantly growing number of organizations fighting for the rights of cyclists, putting pressure on authorities and promoting cycling. Unfortunately, the effects are still not quite satisfactory.

This paper presents fundamental advantages of the bicycle as a means of transport, major problems encountered by cyclists in Polish cities, examples of effective solutions employed by our West-European neighbours, as well as several other issues regarding innovative solutions in urban cycling.

12.2. Bicycle vs. bicycle

The history of the bicycle dates back to the early 19th century. In Poland, as early as 1886, the Warsaw Society of Cyclists was founded, bringing together cycling enthusiasts. Among them were such famous figures as Bolesław Prus or Henryk Sienkiewicz. At the time, a bicycle was a luxury item that it no longer is today.

The end of the 20th century was a real bicycle boom, which has led to a tremendous variety of cycling vehicles. Nowadays, we can choose, among others, between mountain bicycles, road bicycles, track bicycles, trekking bicycles, bmx bikes or classic city bicycles, among others. These various types differ significantly from each other, as do their purposes. Of course one may go city cycling on any one of these bicycles, however some of them are more fit for this particular use than others. The classic city bike, often known as the “Dutch bike,” is equipped with many appliances which allow us to move relatively safely in urban traffic and to maintain the bike easily in unfavourable weather conditions. Its basic characteristics are as follows:

- geometry which ensures upright posture of the cyclist;
- bent handlebars providing comfortable resting support for the hands;
- hub gears (located inside the hub of the rear wheel), “torpedo” coaster brakes;
- large (28 inch) wheels;
- chain and rear wheel cover, as well as full mudguards;
- red reflectors, dynamo and bell;
- luggage carrier, kickstand;
- solid lock (preferably U-lock).

Bicycles of this type rule the streets of most bicycle friendly European towns. They also make up the majority in bike rentals, which successfully ope-
rate at our West-European neighbours, and are slowly beginning to appear in Poland as well (e.g. in Cracow). It is quite obvious that due to financial constraints and because of the popularity of cycling as a form of recreation, relatively few people in our country invest in equipment built especially for city cycling. However, it is often enough to make do with any bike at hand, providing it with good lighting and a solid lock, to be able to use it to commute to work, school or shop, leaving frustrated car drivers far behind.

12.3. Bicycle in transport system – facts and figures

Quite frequently, exact figures and facts appeal to our imagination better than anything else. With this in mind, let us take a look at transport and cycling statistics.

The number of passenger cars in Europe continues to grow, even though at different rates for particular countries. According to the data of the DG for Transport and Energy of the European Commission\(^1\), in 2007 the number of passenger cars in the EU-27 reached 229.8 million, which constitutes a 41% increase over 1990. In countries of the EU-15, the increase was somewhat lower (33%), but in the new member states it amounted to 124%, exceeding 220% in Latvia and Lithuania, 174% in Romania and 177% in Poland. The developed nations have reached a certain level of saturation with passenger cars, with the rate of increase below 20% (Sweden, France, Germany). According to the data of the Polish Central Statistical Office (GUS), there were 19.5 million vehicles (including 14.6 million cars) on Polish roads at the end of 2007\(^2\). However, the road system itself has not been expanding anywhere close to the rate which would ensure trouble-free driving of these vehicles.

Unfortunately, we do not use our cars solely for the purpose of covering longer distances. It turns out that 30% of car trips in Europe are shorter than 3 km, and 50% are shorter than 5 km. And it is precisely the kind of distances over which the bicycle in most cases is a significantly faster mode of transport than the car!

At the same time, there are two bicycles in an average Polish household, and 60% of Poles do ride a bicycle, at least on an occasional basis. In the first place, however, the bicycle is used for the purpose of recreation (76%).

In Europe 82% of the population believe that the issue of environmental protection is of foremost importance, with as many as 64% stating that bicycles

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should be treated preferentially in relation to cars (13% have no opinion). The bicycle enjoys a wide support of the public also in Poland, which is shown in Fig. 37 presenting the results of quantitative research for the 'City for Bicycles' Project of the Polski Klub Ekologiczny prepared by the BBS Obserwator.

Unfortunately, despite such widespread support, cycling accounts for only 1 to 1.5% of all trips in Polish cities, compared with 10% of all trips in Berlin, which is a larger city than Warsaw. There are certain cities where the situation is even better despite "theoretical" obstacles to cycling (such as, unfavourable climate or undulating terrain) which should well be expected to have a negative impact on the popularity of cycling (see Table 26).

Table 26. Share of the bicycle in total urban trips in %

<table>
<thead>
<tr>
<th>City</th>
<th>Country</th>
<th>Population (thousand)</th>
<th>Bicycle trips (% of the total)</th>
<th>...and all despite ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam</td>
<td>Netherlands</td>
<td>742</td>
<td>20</td>
<td>hot climate</td>
</tr>
<tr>
<td>Parma</td>
<td>Italy</td>
<td>176</td>
<td>19</td>
<td>cold</td>
</tr>
<tr>
<td>Ferrara</td>
<td>Italy</td>
<td>132</td>
<td>31</td>
<td>mountainous terrain</td>
</tr>
<tr>
<td>Vasteras</td>
<td>Sweden</td>
<td>115</td>
<td>33</td>
<td>streets with 7% slope</td>
</tr>
<tr>
<td>Basel</td>
<td>Switzerland</td>
<td>230</td>
<td>23</td>
<td>damp</td>
</tr>
<tr>
<td>Bern</td>
<td>Switzerland</td>
<td>128</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Cambridge</td>
<td>United Kingdom</td>
<td>100</td>
<td>27</td>
<td></td>
</tr>
</tbody>
</table>

12.4. Benefits of the bicycle as a means of urban transport

There are many reasons why the bicycle is such an underestimated means of transport in our country and they will be discussed later. Let us now focus on numerous mutual benefits (for cities and the cyclists) of a higher share of bicycle transport in cities.

12.4.1. Benefits for the cyclists

In recent years, the popularity of cycling as a leisure activity has significantly grown in Poland. This is certainly very encouraging, as cycling is not only fun, but also an effective way of keeping in good health. Doctors generally recommend cycling as a form of physical activity to all, regardless of age. Recreational cycling is inadvisable only in the cases of serious cardiovascular disease, degenerative disorders of the spine and large joints, and advanced pregnancy. The benefits, however, are too numerous to mention. For people in good health, they include among others, improved blood circulation, increased lung capacity, burning of fatty tissues, shaping the muscles of legs and buttocks, strengthening of knee and ankle joints, or greater resistance to stress (through rise in endorphin levels). Cycling is also a great cure for serious conditions. It is recommended for diabetics, people recovering after a major surgery (e.g. liver transplant) or from skeletal and joint injuries. Cardiologists consider cycling to be a first rate “medicine” against atherosclerosis.

Obviously, commuting by bicycle to work or school does differ from cycling for reasons of health or pure recreation. However, in all cases the element of “body movement” is there, which by itself brings noteworthy health benefits, since as demonstrated by research, the actual amount of pollution inhaled by cyclists is significantly lower than in the case of car drivers. (see Table 27). Savings present another argument in favour of the bicycle – starting from the cost of fuel and parking to health care expenses. However, the most important factor

Table 27. Maximum average concentrations of air pollutants inhaled during one hour by cyclists and drivers on the same route and at the same time of the day (in g/m³)

<table>
<thead>
<tr>
<th>Pollutant type</th>
<th>Cyclists</th>
<th>Car-drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>2670</td>
<td>6730</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO₂)</td>
<td>156</td>
<td>277</td>
</tr>
<tr>
<td>Benzene</td>
<td>23</td>
<td>138</td>
</tr>
<tr>
<td>Toluene</td>
<td>72</td>
<td>373</td>
</tr>
<tr>
<td>Xylene</td>
<td>46</td>
<td>193</td>
</tr>
</tbody>
</table>

is that the bicycle is quite simply the most mobile means of transport, capable of getting through traffic jams, detours, roads closed to motor traffic and generally allowing us to come “straight to the front door” of the chosen destination. It is reliable (breakdowns are rare and delays nonexistent) and fast. With the same amount of energy, we can travel four times the distance that we would cover on foot. The area available for cyclists is sixteen times bigger and this tremendous difference does not have a negative impact in terms of pollution, noise, taking up land or costly investment. In urban conditions, the bicycle frequently turns out to be a faster means of transport than the car, too (see Fig. 38).

![Fig. 38. Comparison of travel speeds of various modes of transport in urban traffic. The bicycle frequently proves to be as quick as the car (time measured “door to door”).](http://ec.europa.eu/environment/archives/cycling/cycling_po.pdf)

Finally, one should also notice that the bicycle is a mode of transport available to practically anyone - children, senior citizens, persons with no driving license or those without access to public transport. It improves mobility and independence of these social groups. Research carried in the United Kingdom has shown that by driving our children to school we not only lose precious time, but do not establish in them the healthy habit of physical exercise in the first place. In this way we raise a generation where obesity and fragile bones are common. In this respect, cycling to school is the optimum solution, obviously provided there are safe cycle lanes and sufficient parking space.
12.4.2. Benefits for the city, the public and the environment

Widespread use of the bicycle as a means of urban transport benefits not only the cyclists, but even more so, the whole community. It is difficult to mention all of the benefits, but the most significant are the following:

– a reduction in traffic jams and the economic losses they generate;
– greater street and road capacity (see Fig. 39);
– better quality of life in cities – lower noise and pollution levels;
– space economy (roads, car parks) and less land under asphalt, consequently less expenditure on city roads and funds available for green and recreational areas;
– possible reduction in the number of public transport stops – the so-called “Bike and Ride” system;
– city centres more attractive with less motor traffic;
– numerous benefits for businesses – more personnel and deliveries get on time, more productive workforce (cyclists are more fit, both physically and psychologically, they take fewer sick leaves, boosting productivity and corporate image). Cyclists are often more valuable customers than motorists – they reach most shops more easily, and although they buy less, they come more often. A research in Strasbourg has shown a 30% increase in retail trade in the city centre after a pedestrian zone was introduced and transit traffic moved out. For larger shops, cycling customers also mean smaller parking space;
– protection of historical monuments and vegetation;
– lower energy dependence, so non-renewable energy sources are saved.

The bicycle is without any doubt the most environment-friendly means of transport (see Fig. 40). In view of the fact that environmental pollution and en-


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Energy source depletion are the most serious problems of the 21st century, we should strive even harder to increase the role of cycling in urban transport.

### 12.5. Basic problems

#### 12.5.1. Attitudes

Despite all the benefits of switching from car to bicycle, not many people decide to take the step. Obviously, one of the main reasons is lack of appropriate infrastructure (which will be discussed next) however, our mindset represents an equally great problem. The bicycle is commonly perceived as an outdated mode of transport, used mostly by poor students, children at play or for sport. For instance, if a company executive uses a bicycle as a means of transport, it tends to bring ironic smiles among employees and puts the executive at the risk of losing respect, while in fact the opposite should be the case.

In an era of economic growth and general wealth, societies become increasingly drawn to comfort. We go shopping by car in order to avoid carrying the purchased goods, forgetting that all it takes is attaching a basket to our bike. We
are increasingly sensitive to unfavourable weather conditions, unaware that with appropriate cycling clothes and equipment, we will not get any wetter than when walking under an umbrella. It seems that the biggest of our problems is simply laziness and being used to a seated lifestyle.

These attitudes may be changed by nationwide campaigns aimed at raising environmental awareness of the public as well as highlighting the benefits of using the bicycle as a means of transport and informing the public about amenities for the cyclists. Cycle lanes should be made available, too. Spreading information about healthy lifestyle and popularizing recreational cycling can both make the bicycle “trendy”, thanks to which people might become more willing to use the bicycle on a daily basis.

The attitude of car drivers, who consider bicycles to be “second-class” vehicles limiting their freedom, constitutes a separate problem. Some of them seem not to notice that they share the road with a cyclist, which unfortunately leads to many accidents. It goes without saying who suffers more in such a collision…

In Poland, cyclists account for 13% of road-accident fatalities, with significant portion occurring in large city centres. Of course, sometimes the cyclists are at fault, commonly disregarding traffic laws and usually getting away with it. For this reason, it would be desirable to have the police exercise regular checks not only of cycling facilities but also of the cyclists themselves and how they respect traffic regulations. The persistent problem of bicycle theft remains hard to eliminate. Apart from policing activity, the solution may lie in properly designed bicycle stands which until now has been an exception rather than a rule…

12.5.2. Infrastructure and organisation

Much is currently being said about problems of cycling infrastructure and one can see some response on the part of local governments. Cycle routes are being constructed, which is definitely appreciated by city dwellers. Unfortunately, most of them are cycleways of recreational nature and are located in city outskirts. At the same time, pro-cycling investment in cities of Western Europe has a completely different purpose consisting in improving the safety of drivers, cyclists and pedestrians. Each carriageway, on which vehicles can travel with speeds in excess of 30 km/h is equipped with a cycle path or at least a cycle lane painted on the pavement. The cycling paths create a cohesive, inter-connected system and their construction is very often connected with the limiting of car traffic especially in the hearts of city centres in which many pedestrian-only zones can be found.

Unfortunately, in the centres of Polish cities cycle paths are still a rarity. Furthermore, the existing ones do not meet any set standards, sometimes making cycling even more difficult. This stems from substandard technical design, poor quality of construction and dangerous traffic patterns. Cyclists must frequently
struggle with inappropriate pavement, lack of lighting, collision-prone intersection, and last but not least dead-end pathways left unfinished when the money had run out... Safe parking facilities are also scarce, while transporting a bicycle on public transport remains impossible in many cities. The common excuse by city authorities is of course lack of funds. However, the fact is that according to specialists, the cost of creating a uniform and efficient network of cycling routes is roughly the same as the cost of buying two trams, which certainly is not a huge sum when compared with car infrastructure expenditure.

The biggest problem in Poland is lack of consistent cycling policies (we are the two black sheep of the European Union in this respect, together with Spain). The same rules of cycle route development, cycling infrastructure pilot projects and efficient methods of funding should be used all across the country. Only a few local authorities in Poland have the position of cycling policy coordinator. The city of Gdańsk is probably the most positive example, since it was the first city to embark on a comprehensive programme of cycling routes construction. Between 2002 and 2006, the Gdańsk Cycling Infrastructure and Promotion Project was successfully implemented. What makes the project special is the fact, that it was practically entirely carried out by NGOs (Obywatelska Liga Ekologiczna from Gdańsk, as well as the Polski Klub Ekologiczny – the organization looking after the Cities for Bicycles network). Partnership cooperation with the authorities of the city of Gdańsk has brought positive results, which is now a valuable source of information for other cities investing in cycling infrastructure.

In the area of pro-cycling policy, we can also learn from our western neighbours. The position of “Cycling Officer” can be found in the authorities of most cities in Germany or the neighbouring Austria. In the city of Salzburg, for example, a full-time position has been set up in the City Hall. The Cycling Coordinator is placed in the Building Directorate, and reports directly to the Building Director. The responsibilities include, among others, planning and preparing programs for construction of cycle tracks and lanes, supervising the infrastructure under construction, organizing cycling forums, co-editing maps of cycling route networks, organizing promotional campaigns and conducting public consultations.

Effective pro-cycling policy involves cooperation of a few sectors of administration (urban planning, public works, public transport, education, the police), as well as cooperation with the private sector, nongovernmental organizations and the public. Cycling co-ordinator can effectively mediate between all of them. Another important task of the coordinator lies also in identifying possible sources of funding for cycling projects. Grants for that purpose may be obtained within the framework of policies regarding safety, education, tourism, sports and recreation, the environment and heritage protection.

Even with a relatively small number of investment projects, it is possible to significantly improve conditions of bicycle use in cities. A set of non-investment organisational solutions, which allow substantial increase in the quality of pro-
cycling investments under way and even greater safety and comfort of cycling, was created during the implementation of the Gdańsk cycling project mentioned above. This is the so-called “Bicycle package” for municipalities, which constitutes the basic element of proper management of pro-cycling policies in towns and cities. It is available on the web site of the Miasta dla rowerów organisation.

The tables below (see Table 28 and Table 29) present the most important elements of proper cycling policy management in cities and essential amenities for cyclists.

Table 28. Essential elements of proper cycling policy management in cities

| Public participation | By decision of the mayor, a team should be set up with the aim of establishing communications, thus making planning and monitoring of activities more efficient. The team should include decision-makers from most important city hall departments and municipal institutions, responsible for: investment and repair, traffic engineering, strategy and development etc., as well as experts and an organized representative team of cyclists (non-governmental organizations). It is important that the decisions to set up the team be made by the mayor - it being a clear expression of political will. The task team constitutes a forum of active and open cooperation of the authorities with organised representation of the public. It is a horizontal structure at the level of the city hall. The team does not have decision making powers (i.e. it is no substitution for departments and their managers), but facilitates the decision making process by taking into consideration opinions of the interested parties and the experts. |
| Standardization | At present general regulation regarding technical conditions to be met by cycle tracks and lanes are not satisfactory. In order to ensure quality, the city hall should adopt technical and construction standards as the basis for activities implementing pro-cycling policies and include them in the procurement specifications of each tender for the construction or design of bicycle tracks and lanes, as well as other investments or repairs which may have an effect on cycling. |
| Audit | Numerous investment and repair projects carried out by local governments affect urban cycling. None of such projects should adversely affect cycling conditions. For this reason, all relevant projects and decisions should be consulted regarding their compliance with technical and quality standards, as well as with pro-cycling policy (and in a wider context, also transport and urban planning) of the municipality. |

Source: website of the “Cities for Bikes” Project - carried out by the Executive Board of the Polski Klub Ekologiczny.

Table 29. Fundamental elements of cycling infrastructure and other amenities for cyclists

| Cycling paths & lanes | – Appropriate surface (preferably smooth asphalt or concrete)  
– Width 1.5m for a one-way path and 2m for a two-way path  
– Entrance and exit points ensuring that cyclists do not have to countersteer and other unclear manoeuvres, brake to under 12 km/h or rear the bike  
– Curve radiuses appropriate for the designed speeds  
– Safe intersections (small roundabouts, crossings of perpendicular streets placed on top of speed-bumps with STOP signs or traffic lights, road width immediately in front of traffic lights reserved for cyclists only)  
– Making it impossible to park a car on cycle paths  
– Slopes to 6%  
– Appropriate lighting and clear signage |

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12.6. Cycling innovation and public cycling traffic systems

Holland is the country which can be proud of having the most developed cycling infrastructure in the world, often referred to as the “Cycling Paradise.” Over twenty thousand cycle paths and routes cover the Netherlands with a dense network. They are very well marked, quite frequently completely separated from motor traffic, with their own bridges, tunnels and bicycle ferries. There are more bicycles than people in Holland, yet 1.3 million new bicycles are still sold every year. The bicycle is the hand luggage of the Dutch and the main means of transport. Bicycle rentals can be found in practically every town, with many places (e.g. “De Hoge Veluwe” National Park) where bicycles are made available free of charge. It goes without saying that bicycles can be readily transported on trains. Cycling trips of a few days are a standard offer of travel offices. Obviously, Holland is special in that its terrain and climate are exceptionally favourable to cycling. Nevertheless, the Dutch example is being followed by all European countries, with thousands of cycle paths and other cycling amenities constructed every year.

12.6.1. The Bike & Ride System

The B & R System is an excellent way of tying cycling with public collective transport, very effective at covering longer distances where the bicycle alone is not an entirely adequate mode of transport. It entails cycling to a transfer point from which the trip to a chosen destination is continued by public transport. The Bike & Ride system effectively expands the operational range of trains or the underground and makes cycling more appealing. It is exceptionally popular in the Netherlands, Germany and France. In 1995, in the North Rhine-
Westphalia a program aimed at creation of 100 cycling stations was launched “100 Fahrradstationen in NRW”). The program has been carried out in 50% so far, with 52 stations in NRW, with a joint capacity of 16,400 bicycles. In addition, the region has implemented an Internet-based cycle-journey planner, thanks to which cyclists can receive information about access to public transport and consult a detailed schedule. The Bike & Ride system has found wide support also in the United Kingdom. In the county of Kent, the construction of attended bicycle parks next to railway stations has resulted in increasing the role of bicycle in everyday commuting (coupled with a reduction in car use).

12.6.2. The French “Vélib” project

The system of bicycle rentals in French cities is gaining increasing popularity. Following the construction in 2005 of nearly 350 cycling stations making over 3000 bicycles available in the cities of Lyon and Villeurbanne (Vélo’v), the authorities of the French capital also decided to go ahead with a similar programme. The Vélib Project was launched on July 15th, implementing the biggest system of urban transport cycling in Europe. Over 10,000 bicycles were placed in 750 points in the city (according to the plan, these figures are to rise to 20,000 and 1450 respectively). Both projects are financed by a French outdoor advertising company JCDecaux. Using the bicycles in Paris is free of charge up to 30 minutes, with 1 hour costing one Euro. After one hour the rates grow exponentially (e.g. you have to pay 71 euro for 10 hours), which is to ensure that the bikes remain in constant use. The Vélib system is very flexible and convenient to use – the bicycle may be returned at any of the stations which on average are located 300 metres from one another. During the first two weeks of its operation, each of the bicycles was used on average by 30 people a day and not a single one was stolen!

Similar projects were launched in other European cities: Barcelona (Bicing), Brussels, Copenhagen, Stockholm and Vienna. Other systems functioning on a wide scale include also German “Call a Bike” (Berlin, Frankfurt, Cologne, Stuttgart, Munich, Karlsruhe) and the British OYBike.

The benefits of locating bicycle rentals in a city are self-explanatory – a decrease in motor traffic, fuel consumption, traffic jams, pollution and noise, and increased mobility of the inhabitants. Obviously, electronic identification of system users is required for effective prevention of theft and vandalism.

Polish local authorities have also announced their plans to introduce Bike & Ride systems, as well as bicycle rentals. However, a lot remains to be done before they are actually put in practice. The situation is most encouraging in the cities of Gdańsk and Cracow (the latter is to launch a network of bicycle rentals next year, with the bicycles being made available to those Cracovians who do not have their own bikes).
<table>
<thead>
<tr>
<th>City</th>
<th>Bicycle use</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groningen</td>
<td>37</td>
<td>City policy completely integrated with the ideal of a bicycle-friendly city – from urban planning through policy making and transport planning. Between 1989 and 2000, Groningen spent about 23 million euro on cycling infrastructure.</td>
</tr>
<tr>
<td>Zwolle</td>
<td>37</td>
<td>For a number of decades, cycling has been treated as an honoured priority in the city; Zwolle is among the very best among Dutch cycle-cities with particular emphasis on expanding the infrastructure to make it quick, comfortable and attractive.</td>
</tr>
<tr>
<td>Veenendaal</td>
<td>32</td>
<td>The city which made bicycle an integral mode of transport vital element to its dynamic development (from 5,345 to 61,000 inhabitants). Located in the city centre is a system of secure, free bicycle parking, its cost of 60 million euro funded from the municipal parking budget (spread over time).</td>
</tr>
<tr>
<td>Enschede</td>
<td>31</td>
<td>Since 1975 a systematic plan of closing streets to car traffic has been implemented – difficult decisions and incredible effects – determination of politicians and city officials finds appreciation among citizens (after a certain period of time following implementation)</td>
</tr>
<tr>
<td>Munster</td>
<td>27</td>
<td>The 1980s (excessive problems with motor traffic) bring first contra-flow lanes, streets closed to cars, shared bus-bicycle lanes, signalling for cyclists. City transport policy gives preference to pedestrians, cyclists and public transport and is especially concerned with integrating the three elements.</td>
</tr>
<tr>
<td>Amsterdam</td>
<td>27</td>
<td>Pro-cycling policy is an integral part of planning and policy making with the regional transport plan being a prime example. The plan deliberately discourages car use (price of parking, road network geometry). Within the next 5 years, the cost of construction and renovation of bicycle parking in the city will amount to 37 million euro.</td>
</tr>
<tr>
<td>Odense</td>
<td>25</td>
<td>Innovative pro-cycling and transport policy in practice since the 1980s with the length of cycling routes amounting to 350 km. This “national cycling city” served as a test ground for examining the effectiveness of cycling projects: infrastructure (routes, parking) and promotional campaigns (television, radio, newspapers, magazines, special information programmes: “Bike to Work” and “Bike to School” projects).</td>
</tr>
<tr>
<td>Copenhagen</td>
<td>23</td>
<td>130 km of cycle paths in 1934, introducing cyclist into proximity of intersections (improving safety), numerous cycling plans as documents of local law e.g. Cycling Policy Plan 2002-2012.</td>
</tr>
<tr>
<td>Freiburg</td>
<td>22</td>
<td>Pro-cycling policy is strongly integrated with urban and transport planning. Despite the existence of a 500 km cycling network, intensive work on its expansion is in progress. Integration of cycling and car infrastructure. Investments into bicycle parking – from 2,200 racks in 1987 to 8,600 in 2005.</td>
</tr>
<tr>
<td>Ghent</td>
<td>15</td>
<td>In 1993 a city official starts active pro-cycling activity in the Transport Planning Department. Soon after he becomes Mayor. Numerous projects follow, which bring expected results (Cycling Plan, Car Free City Centre, opening contra-flow lanes for bicycles on 500 out of 700 one-way streets in a short period of time, numerous promotional campaigns).</td>
</tr>
</tbody>
</table>

Table 30 presents many other innovative solutions which have been successfully employed in European metropolitan cites in order to make cycling a more efficient mode of transport, improving the quality of city life.

12.7. International projects promoting pro-cycling policies of cities

City transport is not just the problem of local authorities. Due to pollution of the environment it has become a problem of global scale. As a result, it is not surprising that increasingly often international initiatives aim at popularizing cycling as an alternative mode of transport. European Commission’s Directorate General for Environmental Protection issued a brochure entitled “Cycling - the Way Ahead for Towns and Cities” (Luxembourg 2000) which gives advice to local authorities in the area of conducting effective pro-cycling policies.

The “UrBike – Expanding Cycling Policies of Cities” Project, concluded in 2006, was a large-scale undertaking covering information campaign, preparing concepts and documentation of cycle paths, lobbying, reports and analysis of urban transport etc. Nine European cities participated in the project: Florence (Italy), Seville (Spain), Frederiksberg (Denmark), Dresden (Germany), Budapest (Hungary), Xanthis (Greece), Mesa Yitonia (Cyprus), Tallinn (Estonia), as well as the Polish city of Kielce. The budget of the entire project amounted to 1.5 million euro and was implemented within the framework of the Interreg III C initiative, financed by the European Commission. It was mainly aimed at facilitating exchange of experience on cycling policies and promotion of cycling as a mode of transport.

The initiative of the European Cycling Federation – the EuroVelo Project – had the nature of a typical investment task. Its program calls for the construction of twelve long-distance cycleways running across Europe, with the total length of 60,000 km. The routes are built based on the existing networks of local tracks and roads, combining them into a single system. Five of these routes pass through Poland. The goal of EuroVelo is to develop bicycle tourism throughout Europe and to encourage people to use the bicycle rather than the car more often. Giving cycle paths the status of EuroVelo element is supposed to help with obtaining funds and political support for construction and ensuring proper quality. Until now, 20,000 km of cycle routes making up the EuroVelo Project have been completed.
12.8. Bibliography

6. Website of the *Miasta dla rowerów* project carried out by ‘Zarząd Główny Polskiego Klubu Ekologicznego’ (Board of the Polish Ecological Club) (www.rowery.org).
Chapter 13
INNOVATIVE TRENDS
IN FREIGHT ROAD VEHICLES
(Krzysztof Szałucki, Andrzej Letkiewicz)

13.1. Introduction

Innovative solutions in freight road vehicles cover means of transport cycle and cargo cycle. The main direction of changes in freight road vehicles consists in reducing environmental impact by reducing noxious emissions in exhaust fumes. In cargo cycle, innovativeness of freight road vehicles aims at adapting means of transport to transporting cargo that requires strict specialisation and unification useful in intermodal transport.

13.2. Energy and environmental reasons behind innovation in propulsion

Innovation in freight road vehicles should be considered from the point of view of complementary production cycles of transport: means of transport cycle, which in this case is the cycle of freight road vehicles and the cycle of the object carried - in this case the cargo.

Development and innovativeness of solutions concerning freight vehicles in road transport are mainly caused by the necessity to reduce harmful environmental impact of this mode of transport. The directions of the measures undertaken refer to improvement of the currently applied technical solutions and looking for new solutions that would change the technology radically. The directions of overall changes refer to abandoning oil as the basic source of energy
and using nuclear, solar, water or biomass energy. The scope of available solutions can be presented in the way shown in Fig. 41.

Four basic directions of innovation can be identified in freight road transport today. Applying design solutions in diesel drive units aimed at improving their efficiency and reduction of noxious substances produced by the combustion of diesel fuel is the first one. The second consists in looking for technical solutions that do not directly concern diesel drive units but enable reduction of fuel consumption (mainly in power transmission and suspension systems). Thirdly, the solutions aim at redesigning drive units in such a way that would allow the use of other types of fuel, such as CNG, LPG and ethanol. Fourthly, it is possible to apply solutions aiming at reduced use of diesel unit (diesel engine) as a propulsion unit and replacing it with units making use of other types of energy (currently, due to some limitations, hybrid solutions, that is diesel unit plus electric unit) are used.

The first area of innovative solutions applied in freight transport vehicles consists in looking for construction and material properties used to build drive units that would enhance engine efficiency and response. The following can be examples of modern solutions in this respect:\footnote{J. Merkisz, Wpływ aspektów ekologicznych na rozwój silników spalinowych. In: Inżynieria maszyn. Vol. 8, Zeszyt 4; Ekologia transport. Ed. by J. Merkisz, Agenda Wydawnicza Wrocławskiej Rady FSNT NOT, Wrocław 2003, p. 10.}:

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Fig_41.png}
\caption{Alternative sources of motor vehicle propulsion}
\end{figure}

– solutions concerning homogeneous mix combustion system with direct fuel injection;
– solutions concerning modern injection feed systems that would include multi-point injection and variable valve timing gear.

Combustion of fuel in diesel engines leads to emission of noxious substances (e.g. COx and NOx), which are produced mainly in the process of incomplete oxidation. One of the factors contributing to complete combustion consists in looking for combustion chamber design solutions that will enable achieving the same composition of the fuel-air mixture throughout the chamber during the feeding cycle. In current solutions, when a portion of fuel is injected at the end of the suction stroke, two different zones appear, filled in a different way – a zone of fuel-air mixture and a zone of other substance the features of which do not allow complete combustion\(^2\). The composition and proper fuel–air relation in the entire combustion chamber enables, first of all, equal distribution of gas load, and secondly, equal and complete combustion of fuel particles, which results in lower emission of incompletely oxidized substances.

Apart from combustion chamber design, there is another way of solving the problem of complete combustion of fuel-air mixture, namely solutions in feeding and control of the cycle of opening and closing of the valves and supercharging of inlet air.

Common rail is a diesel engine injection system in which injectors are controlled electronically, and a computer decides about the amount of fuel to be injected. The name common rail comes form the main rail providing fuel to all fuel injectors at the same time, in exactly the same way as it happens in petrol engines. Common rail system introduces multi-phase injection: the main portion of fuel is preceded by a pilot portion, thanks to which the pressure in the cylinder grows considerably more slowly and consequently the engine is less noisy, and works more smoothly. One injection can consist of up to seven portions. The injection pressure in the systems is 1600 bars. The latest solutions concern injection systems with piezocrystalline injectors which are characterised by a much faster response than in the case of traditional electromagnetic injectors. It enabled reducing emission of noxious fuel components by up to 20%. Work is in progress on the fourth generation, which will enable a further reduction of impurity of exhaust gases thanks to better control and increase of injection pressure\(^3\).

Variable valve timing gear is the name of systems that are to switch timing gear phases, that is the time of opening or closing of the valves, depending on propulsion unit load and its rotational speed. It is one of the most effective

\(^2\) K. Lejda, P. Wó³, Wpływ charakterystyk wtrysku paliwa na emisjê NO\(_x\) ze silników o zapłonie samoczynnym. (in:) “In¿ynieria Maszyn”. Vol. 8, Fascículo 4, Ekologia transport. Pod redakcj¹ J. Merkisza, Agenda Wydawnicza Wroc³awskiej Rady FSNT NOT, Wroc³aw 2003, p. 94.

\(^3\) Special report: Superdiesle – http://auto.gazeta.pl/auto/1,71462,2410107.html.
methods of performance enhancement without supercharging, while maintaining fuel consumption economics.

Gas turbocompressors use the energy of engine exhaust gases to increase pressure of the air fed into combustion chambers. In modern engines, before compressed air is fed, it is cooled in an additional air cooler – intercooler – to increase density. This enhances injected fuel combustion conditions, thus increasing the power, the torque and the response of the engine.

Looking for an optimum engine load depending on working conditions of the means of transport is another area of research connected with making road transport more environment friendly. The solutions in this field consist in replacing classical solutions (friction coupling and manual gearboxes) with hydrokinetic coupling and automatic gearboxes. The use of hydro-mechanic box in the drive system enables traction properties enhancement, in hard working conditions in particular. In traditional solutions with manual gearboxes, the engine works in unfavourable areas from the point of view of fuel consumption and big dynamic overloads of the power transmission system appear, which obviously shortens its lifetime. This is why the work on hydro-mechanic gearboxes control comes down to optimisation of their work, aiming at elimination of these two unfavourable phenomena, intensifying in the running up phase in particular. Apart from the obvious mechanical match, the structure of the power transmission system requires of selection of adequate technical parameters, functional characteristics, development of programmes controlling the matching of individual sub-systems.

The growing content of electronics in all areas of life has its consequences also for the solutions combining all possible efforts of optimizing the work of the power transmission system. Development and construction of EDC – electronic diesel control - can meet many requirements concerning environmental protection. In combination with other electronic devices controlling the work of other sub-systems, the system helps to reach the optimum level of combustion in the engine, which prolongs its life.

Replacing diesel fuel with ethanol constitutes yet another area, developed since 1979. The Swedish Scania is the leader in this field and has launched an ethanol powered vehicle production centre in its plant in Ślupsk, Poland.

Research on equipping lorries with hybrid power transmission system is in progress. It is possible to use alternative propulsion, the fuel engine and the electric motor, thanks to the use of the surplus power of the fuel engine to charge batteries. Electric motors are used to start the vehicle, to accelerate and in...

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other moments of big power demand. Since electric motors can work as generators, hybrid construction also enables energy recovery during braking phase (recovery)\(^7\).

The conditions of environmental protection and increasingly popular innovative thinking presented above come down to the integration of environmental activities by legislative bodies of the European Union. Their efforts materialize in the form of Euro series emission standards for engines (since 1992) as well as the new EEV (Enhanced Environmentally Friendly Vehicle – since 1999).

Innovativeness of Euro series engine standards consists in reducing emissions of the following pollutants:

- carbon monoxide (CO);
- hydrocarbons (HC);
- nitric oxides (NOX);
- dusts (PT);
- smog in exhaust gases.

The level of what is required by individual standards can be presented in the way show in Fig. 42.

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**Fig. 42. Requirements for exhaust gases reduction according to Euro 1 – 5 standards**  
*Source: Own study based on ETC materials. Berlin 2006, p. 1.*

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Table 31. Timeline of Euro standard official certification and registration

<table>
<thead>
<tr>
<th>Standard</th>
<th>Official certification</th>
<th>Registration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro 1</td>
<td>1992</td>
<td>1993</td>
</tr>
<tr>
<td>Euro 2</td>
<td>1995</td>
<td>1996</td>
</tr>
<tr>
<td>Euro 3</td>
<td>2000</td>
<td>2001</td>
</tr>
<tr>
<td>Euro 4</td>
<td>2005</td>
<td>2006</td>
</tr>
<tr>
<td>Euro 5</td>
<td>2008</td>
<td>2009</td>
</tr>
</tbody>
</table>

Source: Own study.

Innovation dynamics of Euro standards implementation is at a stable level, and the generation cycle is now 5 years. New official certifications and registrations of Euro standards appeared at the times shown in Table 31.

Table 32. Normative dependencies of Euro and EEV standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Carbon monoxide weight (CO) g/kWh</th>
<th>Hydrocarbons weight (HC) g/kWh</th>
<th>Nitric oxides weight (NOX) g/kWh</th>
<th>Dusts weight (PT) g/kWh</th>
<th>Smog in exhaust gases m-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro 3 (2000)</td>
<td>2.1</td>
<td>0.66</td>
<td>5.0</td>
<td>0.131</td>
<td>0.8</td>
</tr>
<tr>
<td>Euro 4 (2005)</td>
<td>1.5</td>
<td>0.46</td>
<td>3.5</td>
<td>0.02</td>
<td>0.5</td>
</tr>
<tr>
<td>Euro 5 (2008)</td>
<td>1.5</td>
<td>0.46</td>
<td>2.0</td>
<td>0.02</td>
<td>0.5</td>
</tr>
<tr>
<td>C (EEV)</td>
<td>1.5</td>
<td>0.25</td>
<td>2.0</td>
<td>0.02</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Source: Own study.

The EEV standard is treated by vehicle manufacturers community as the most restrictive and aiming at the pattern set for Euro standards. The dimension of innovative trends included in those requirements can be presented in the form of normative dependencies shown in Table 32.

13.3. Design innovations in lorries

Development and innovative solutions concerning improvement of lorry cargo handling cycles should come down to building freight road transport oriented systems\(^8\). Innovative thinking in this area means the development of production technology and infrastructure facilities, which are at the disposal of:

- transport operators, performing transport service for the cargo, working as intermediaries between shippers, forwarders and hauliers;

logistics providers, performing road transport of cargo to build comprehensive systems of supply and distribution for client companies. The degree of upgrading of such cycles of transport objects in freight vehicles comes down to changes and adaptations of vehicle bodies. With the assumption of division of those bodies by basic transport technologies: unified, specialised and universal, one should pay attention to the process of standardization of loading units and bodies, resulting from the activities of the European Committee for Standardisation. Freight road vehicles go towards the spread of solutions based on universal technologies adapted to the requirements of multimodal transport systems, so as to:

- minimize transhipment time of loading units within intermodal chains;
- maximize the safety of transport and of the loading units in transit;
- propagate the standards of transporting European intermodal loading units.

12.4. Bibliography


11 Ibidem, p. 83.


Chapter 14
INNOVATION IN TRANSPORT AND GROWTH
OF COMPANY VALUE IN TL MARKET
(Danuta Rucińska)

14.1. Introduction

Innovation is the phenomenon and practice undertaken in all areas of public and business life in the contemporary world. It is a measure of the level of modern economy and development of civilization. Introducing innovation determines the capacity of business organizations to function and survive in the competitive market.

J. A. Schumpeter pointed out to the significance of innovation as a factor of dynamising economy when, at the beginning of the 20th century, he put forward his theory of innovation\(^1\) based on the teaching of M. Kondratiev. Many researchers and pragmatists\(^2\) have been dealing with the problem. Also the Lisbon Strategy stressed the importance of research on and development of innovation\(^3\).

Innovation is very important component of economic and social capital. It contributes to development and increase in the value of each activity and each organization. Innovative companies are learning economic organizations, able to create and effectively implement market, technical and organizational innovations helping to achieve strategic objectives in a competitive environment\(^4\).

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Transport activity, a complementary component of any economic and social activity\(^5\), has a special role in innovation policy and innovativeness.

Throughout its development, transport has always been perceived as a precursor of spreading and diffusion of inventions and changing them into epoch-making innovations. They usually reflected the advancement of science and technological progress in the given period of time. Historical transformations of individual modes of transport and their markets provide spectacular examples in this respect\(^6\). Rapid development pace of science and technology contributed to technical and technological transformations of the ways of moving, to imitating and use of the then modern solutions. Ways and techniques of covering distances, their infrastructural conditions and solutions supporting the efficiency of individual modes changed in time. Progress anticipated in this area constituted the basis for forecasting their development, their markets and technical conditions of transport activity\(^7\).

Innovation is an unquestionable factor of growth of the value of economic organizations. In modern management, it is a continuous process that takes into consideration new trends in science and technology, and accompanies change introduction. It also refers, *inter alia*, to the Japanese philosophy of constant improvements (streamlining) *kaizen*\(^8\) and to Total Quality Management (TQM). Innovations creating real basis for fast development of the transport mode and improvement of market position of TL sector companies have a special role to play in transport. They include innovations in the field of:

- techniques and technologies used, IT solutions and systems in particular;
- design and construction of infrastructural facilities;
- shaping structures and resources of the organization;
- broadly interpreted market offer, from product to comprehensive customer service;
- innovative management solutions and practices.

Innovations create a basis for increased productivity and value of the company for its shareholders, employees and partner market environment, shaping the so-called system of values and providing everyone with a complex benefit bundle. A characteristic of innovations in the TL sector is that they are mode-specific.


\(^{6}\) D. Rucińska, *Cykle ekonomiczne w transporcie*. Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk 1992, p. 50 and the following.


\(^{8}\) Projects and solutions of *kaizen processes*, that is effective use of tools and maintaining changes in processes and resources of an organization are implemented by KAIZEN Global Company, including KAIZEN® Institute Polska.

Like in the history of transport, in TL market today technological innovations determine competitive advantage in the markets serviced and increase the value of the companies functioning in the market. The essence of economic value of innovation is connected with the need of constant search of the most effective (optimum) solutions, investing in them and incorporating innovative processes into everyday management practices in transport. So the area and scope of innovation develops – from movement techniques and technologies to coherent, innovative impact on other elements of market environment, management and functioning of companies.

There are many barriers to innovation in the modern TL market, which limit market efficiency of businesses and economic growth of organizations. The most difficult to tackle are limitations in the field of finance, technology and IT, and problems in establishing cooperation between participants of the market. They are often hard to overcome in everyday practice, as they require a fundamental reorientation of companies towards pro-innovative behaviour, although the awareness of human and organizational resources of companies more and more often translates into tangible, market successes of companies in a spatially and economically determined scale. This is confirmed by, inter alia, the results of the polls by Strategos company\textsuperscript{10}, carried out in big American companies of various sectors, the transport sector included.

International corporations and TL sector companies considered to be innovative systematically improve the methods of managing the innovative process. Polish companies operating in the market studies can benefit from effective assimilation of western experience. The companies of the sector functioning in Poland, with partly or totally foreign capital, turned out to be more willing to create innovations in comparison with companies with Polish-only capital, setting a positive example in this respect.

14.2. Innovation as an element of transport policy

Innovation in economy is an important element of European 21st-century economic policy. Due to the role of transport in shaping spatial and socio-economic links, the problems of innovation acquire a special meaning to the policy of functioning and shaping the development of this area of economy. The significance increases in the light of globalization and integration of operations and markets, in which modern techniques of physical movement and handling of people and objects, thanks to efficient communication are an unquestionable ba-

sis for making them more dynamic. In this respect, the significance of innovation for operation of transnational companies in the TL sector is an element of their significance and competition in the markets serviced. In this context, the problems of innovation acquire an unlimited dimension both subject and object wise. It covers all the areas of functioning of these organizations. As P. Niedzielski noted, transport companies should be characterised by high capacity for innovation, for undertaking new activities consisting, inter alia, in offering services tailored to the individual preferences of their customers\textsuperscript{11}. Innovative activities should soon provide tangible benefits to the organizations and their stakeholders.

The Lisbon Strategy 2000 drafts a wide range of European innovation policies in economy. The main objective of European innovation policy is to create by 2010 in the EU member states the most competitive economy in the world. The document called the Green Paper on Innovation sets the common framework for innovative policies in individual Member States and draws attention to the necessity of shaping innovative attitudes of societies and companies, in the context of:

– forming the foundations for innovation-promoting activities for investment in research and development;
– more dynamic research on development and popularization of progress;
– seeking ways of effective implementation of innovative techniques and technologies;
– integration of innovative activities (creating clusters) and practices;
– promotion of innovative activities and development of innovative culture\textsuperscript{12}.

Long-term effects of Lisbon Strategy implementation include:
– building information society (knowledge-based);
– success in internal market;
– creating pro-development climate for companies;
– creating flexible job market to enhance social cohesion;
– protecting the environment\textsuperscript{13}.

In EU transport policy a special role of innovation was presented as a means to acquire macroeconomic and microeconomic benefits in the form of:
– development of the European TL market;
– creating a common system of mitigating the environmental impact of the sector;
– creating a single pan-European transport network;

\textsuperscript{11} P. Niedzielski, Polityka innovacyjna..., op. cit., p. 8.


\textsuperscript{13} Ibidem.
– development of modern transport sub-systems stimulating progress of integration processes;
– harmonization of modern transport of the Community.

The most important microeconomic benefits of innovation in transport include:
– competitiveness of European companies in the global TL market;
– free movement of transport services;
– liberalization and deregulation of corporate activity in EU market;
– meeting the requirements of the free movement of persons and goods.

Innovative solutions in transport will contribute to the implementation of major priorities of European transport policy and the achievement of development objectives of the Community. These, according to the White Paper of 2001, are as follows:
– balanced modal split;
– greater capacity of transport infrastructure;
– greater influence of the user on the development of transport;
– meeting the requirements of integration and globalization.

One must remember, however, that many TL sector companies operate in the strongly-competitive global market. Most of them represent global, transnational corporations of strong economic and market position. Operating in the global market unconditionally requires investing in innovation, better-quality offer and competitive market expansion. Such activities will be necessary in the process of shaping company value of modern TL enterprises.

14.3. Factors of company value growth in 21st-century TL sector

Structural changes in the world’s economy affect repositioning of the approach to value management in a business organization. Most recent technologies and innovations of the 21st century affect development of global economy\(^{14}\). It is also reflected in socio-economic development in a spatially limited scale of regions and markets, bringing innovative transformations into business practice and the offers available on the market. The TL sector is also undergoing significant transformations.

The literature of the subject mentions many factors shaping company value.\(^{15}\) The growth in the value of modern entities in the TL market is based on the value added to the services offered and providing benefits to the participants of the market. E-revolution and innovative solutions in the TL sector, based on information technologies, are the modern carriers of opportunities to create value of transport companies.

Traditional transport service, its attributes and features are complemented with additional values. Intangible assets in the form of signs identifying the companies, logos, intellectual capital and property, human resources and their creativity, the so-called service “interface”, favourable customer relations, use of information technologies and common interests connected with them are becoming more and more significant. Development of traditional companies of the TL sector was based on investment in fixed assets, possession of infrastructure and superstructural objects, road and rolling stock, service distribution networks. The latest research indicates that over 78% of market value of modern companies comes from their intangible values, from effects of innovative implementations and solutions, which include, inter alia: transformations of the existing corporate culture, open market communication, availability of resources, risk taking.\(^{16}\)

J. Gallende and J. M. Fuente distinguish a few elements determining innovativeness of a company, such as, inter alia, effectiveness and synergy of activities between marketing and R+D, good internal communication within the organization and promoting integration of knowledge thanks to the collective efforts of the staff\(^{17}\). According to A. Hargadon and R. Sutton, the essence of innovative process consists in perfect organization, perfect internal communication and proper attitude of the staff\(^{18}\).

The vision of desired value growth constitutes the basis of technological change in organizations, changes in managing them, building new corporate cultures and often new production profile. In modern companies of the TL sector the value is more and more often built by capital mergers and strategic alliances, by separating the function of transport provider from operational activity (service provision), various forms of outsourcing that enable separation of some activities from the core business. To support themselves economically, many companies in the TL market (aviation, maritime, road, postal, courier, logistics)
operate within transnational and strategic alliances. Horizontal or vertical community of interest of TL companies with companies from other sectors, e.g. IT, are an innovation in the modern market. They enable the use of, inter alia, virtual possibilities of distribution of services and supplies, looking for new customers and sale of services via the Internet, monitoring of transport of goods and mail, creating new supply chains and effecting payments for the services bought. They also make market monitoring possible, doing market research, shaping relations with the environment and multi-dimensional analysis of the TL customers. Such activities result in new business processes like: market-to-sell, make-to-receipt, procure-to-pay, which more and more often are separated from the core business. Such activities cause the disintegration of the traditional value chain in a company, contributing to the implementation of new practices in managing its assets and to value optimisation.

Referring to e-technologies and solutions that can be used in modern transport, one can hardly specify in one paper all the technologies used, the IT systems and software. Their diversity in various transport modes and companies should be omnipresent in everyday work if administrative and operational activity of an organization is to be rationally planned and controlled. In Poland, however, in a society whose knowledge and IT saturation is far from what could be desired in the 21st-century, the tool called the Internet is used in ca 10% of companies operating in the TL market, whereas 85% transport companies in the West use the Internet tools for transport and traffic management. Modern TL companies must be prepared for dynamic market response, for creating unique, competitive offer providing the customers with extraordinary values, with the biggest possible reduction of the costs incurred. They thus have to redefine the existing supply chains and trading conditions, which requires careful and continuous verification of the existing scope of operations, quality of the offer, service range, and providing updated information about benefits to service users. Competitive markets require new strategies, including marketing strategies, of boosting company value as well as integrated activities, business scenarios, including ones based on e-investments perceived as new carriers of values. In the 21st-century, such solutions are the most important source of competitive advantage of a TL company in the marketplace.

14.4. Innovative marketing factors of value creation in European TL market

The tool-kit of value marketing provides instruments to those TL sector companies that have defined their active mission in the market. Understanding the

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specific nature of new markets and customer requirements; customer involvement in the process of developing a wide offer of useful services, should in the light of the necessity to implement innovative solutions be the supreme principle of company success.

Building competitive services by Polish TL companies should be based on the principles of modern eurobranding of services, developed and verified by eurocustomer, as the value of a brand is based on the value created and assessed by the customer. It is a “self-propelling” mechanism. Customers choose services of strong brand image, which, they think, is desired information and a guarantee of their high quality, as well as certification of identity and responsibility of the producer. The better service the customer gets, the higher the level of his/her satisfaction with the services provided and the more powerful capital of the brand for the service provider. In such a context, a brand can also have a TL services identification, guarantee and promotional function, which in particular refers to their producers in the Euromarket. This is an unquestionable source of building competitive advantage in the scale of the industry, and of international market success of the company. Spectacular examples are provided by transnational courier companies (de facto transport-logistics companies), big carriers in the market of road and air transport services, and less frequently of rail origin, which includes LCC – Low Cost Carriers and big, modern hub airports. Another perfect example is provided by Polish TL market, in which big players of global and European TL market - DHL Express (courier company), Kuehne+Nagel (offering mainly logistics services of storage), Trade Trans Ltd., CTL group, Schenker Ltd. - companies with international, Polish and mixed capital, operate successfully.

Polish TL companies, unfortunately, in most cases build their brand from scratch. From the point of view of developing or implementing business strategy, the decisions in this respect are of strategic significance, and in most cases they are innovative activities. For obvious reasons, they are burdened with the decisions on new choices and programmes of running effective operations, taking into consideration the conditions of the international market. In the near future they will require intellectual and financial involvement. Unfortunately, they will also be burdened with the risk of success of high brand capital. However, one should point out to the inevitability and necessity of undertaking such activities, necessary to create competitive position of Polish TL companies in the Euromarket, to increase the interest in Polish TL services, to acquire new customers, to acquire producers thanks to confidence in the new brand, favourable prices and increasing the value of cash flows. It is an objective risk of shaping position in the face of market turbulence.

Transport companies must build differentiating advantage in the Euromarket. The essence of this market phenomenon consists in creating conditions and providing opportunities to involving interest in unique services. Market advantage of brands should be a starting point in using this marketing instrument and
increasing the value by Polish entrepreneurs. Expecting potential benefits from increasing the satisfaction of service buyers, one should actively try to be modern, to develop novel and exceptional offers of services, individualized programmes of customer and goods services, improve operational procedures of activity, flexibly introduce changes adapting the scope of the services provided to the needs of the customers, as the measuring of economic effects of TL companies in the Euromarket is based on calculation of benefits to the customer, and, together with the brand valuation, they constitute the leading strategic problem for many companies.

Building strong bonds between Polish TL providers with Eurocustomers can, unfortunately, be hindered by the regulations connected with liberalization tendencies in European trade policy, the ever-increasing use of information systems improving the creation of new, effective service distribution channels (telemarketing, sending orders by e-mail, the Internet) and growing competition in the traditional markets. Effective use of information on the clients and implementation of CRM – Customer Relations Management is the basis for establishing lasting relations in the TL market.

The proposal of values and benefits from buying the services offered is the most important thing from the point of view of TL company customer. It can result from the uniqueness of services project, favourable conditions of implementation and degree of customization, its price and adequacy to the quality of the service, quality of customer service, possibilities of monitoring how it is provided, marketing communication, scope of after-sale services, the provider’s image or the contacts existing so far. It is these elements that in the 21st-century decide about the form of market relations based on partner relations and values. Polish TL providers must remember about them. According to D. Norton and R. Kaplan, the authors of the balanced scorecards of company assessment, published in "Financial Times", it is difficult also for many western companies. For instance, Sous West Trains company annually receives 40 thousand complaints about the lack of proper attention of the American carrier to passenger service.

And finally, it is the capacities and abilities of the companies for taking market opportunities and creating conditions for value chain growth thanks to the proper engagement of the assets held that decide about the value chain for Polish TL companies. In this case, the quality of material and human resources, expertise included, reliability and responsibility of management are important.

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22 "...probably in ca 70 % of companies, management teams do not have proper understanding of customer needs ..." following: R. Shaw: *Nowe spojrzenie...*, op. cit., p. 105 and 23.
23 The problems were drawn to attention in t-s-l sector customer satisfaction survey carried out under supervision of H. Brdulak in Zakład Transportu Międzynarodowego i Logistyki w Kolegium Gospodarki Światowej. WSE, Warsaw 2001 and in Ranking of TL companies. Supplement to "Rzeczpospolita" daily No 2/2007 of 14th June, 2007.
In this context, the operation of TL companies should focus on improving efficiency and capacity to conduct the core and auxiliary operations. It means innovative approach to improving operations, management of distribution logistics and launching services on the market (marketing and sales), developing good offer of after-sale servicing, systematic acquisition of orders and customers, improvement of handling technologies of goods and passengers, proper management of infrastructure and human resources. The desired structure of value chains results from the needs of the market, the values for the service buyers delivered by the enterprise and absolute adjustment of the services provided to the expectations and aspirations of the customers. Innovative modifications of internal, organizational structures of companies, more and more competent staff and their abilities to improve production and servicing processes will also be important.

Summing up the above considerations one must say that it will be the conditions and criteria of shaping value chains by Polish TL sector companies according to the principles of value marketing that will determine their market position. Value marketing provides strong grounds for creating innovative offer of services, improvement of operational efficiency and establishing and maintaining lasting relations with customers.

### 14.5. Bibliography


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Chapter 15
FACTORS INFLUENCING MODAL SPLIT
AND CONSTRUCTION OF INTERMODAL CHAINS
(Włodzimierz Rydzkowski, Marcin Hajdul)

15.1. Introduction

Analyses of recent trends in freight modal split in Europe illustrate the dominant role of road transport (Fig. 43 shows that road accounts for 46% of intra-EU tonne kilometres, while sea accounts for 40%, rail for 10% and inland waterways for 4%). This dominance has increased in the last decade. When only inland goods movements were taken into consideration (i.e. excluding sea), road’s share of tonne kilometres in Euro25 rised to 76% despite low figures in some individual countries.

![Figure 43: Goods transport by mode in EU 25 - 2004 (% of tkm)](source: European Commission, European Road Statistics 2006.)
Similar situation can be identified in passenger transport. Figure 44 illustrates recent trends in passenger modal split in Europe. The statistics confirms the dominant role of road transport (figures show that cars accounts for 74% of intra-EU passenger kilometres, while air and bus/coach each account for 8%, and rail for 6%). This dominance has increased in the last decade despite the fact that air transport shows the most rapid growth.

It is obvious that situation presented above should change, especially in freight transportation. However, despite the fact that the European Commission has been promoting alternative nodes of transport, the potential of rail, inland waterway, sea and intermodal freight transport has not been fully utilized. One of the idea to solve that problem is to differentiated charges and tolls which may influence mode choice and stimulate the use of intermodal chains. To analyze potential impact of differentiated charges the European Commission funded a project called Different – User Reaction and Efficient Differentiation of Charges and Tolls (no 019746) within 6th Framework Programme. The main objectives of the DIFFERENT project are:

![Fig. 44. The modal split of passenger transport in EU-25 in the year 2004 (%)](image)

Note: Air and Sea includes only domestic and intra-EU25 transport

– to improve the understanding of user reactions to differentiated prices;
– to develop a scientifically sound approach to determine efficient differentiation of infrastructure cost based charging schemes and methods to assess their impact on user behaviour;
– to analyse and demonstrate the benefits and effectiveness of differentiated charging and taxation schemes as a means to manage mobility, externalities, equity aspects and to obtain revenues and recover infrastructure costs;
– to provide policy recommendations in general and, in particular, for the Common European Transport Policy.

However, ones should remember that not only charges and tolls have an influence on modal shift and better utilization of intermodal transport, but also other factors, as well. In this connection the aim of this paper is to present and analyse different factors which influence modal split and the use of intermodal chains and present examples how differentiated charges can change modal shift in European regions.

15.2. Factors determining choice of transport mode

Each transport mode differs from other modes because it has specific features which influence the demand for and supply of services rendered in this mode of transport. Consequently, mode-specific features determine the role of a given transport mode in the whole transport system. The development of transport and technological developments in the area of transport, as well as economic development and the resulting changes in the size and structure of transport needs, lead to changes in the demand for and supply of transport services. Those changes may be observed over many years.

Depending on various conditions, the needs regarding transport change, whereas technological and organizational development results in changing profiles of transport modes. At the same time, general economic and social criteria determining transport development processes change as well. Thus, the position of particular transport modes in the whole transport system differs in different periods of time.

Factors influencing the position of transport modes in supplying transport needs of the market may be divided into two groups, namely factors which exert direct and indirect influence. The first group includes transport costs and mode-specific features.

The mode-specific features, such as fleet and network characteristics (in given conditions) in particular, influence the utilization of a given mode, hence determine the choice of the mode.
The factors in this group are:
– accessibility of transport modes;
– system of roads and road extension index, which influence carriage distance;
– fleet characteristics, such as load carrying capacity and freight space index.

The other group of factors include:
– necessary outlays to develop and ensure smooth operations of different transport modes;
– consumption of natural resources and influence upon natural environment.

Outlays on the development and smooth operations of a given transport mode influence both the supply of its services and, indirectly, the modal choice. First of all, the outlays belong to important factors influencing the transport policy, including investment policy, which determines the supply of transport services and the technological advancement of particular components of a given transport mode, hence, the characteristics of the latter in given conditions. They, in turn, influence the size and structure of demand for the services rendered by the transport mode and the modal choice. The modal choice is also determined by prices of transport services, the latter being connected with the costs incurred.

Facing the problem of limited resources, the consumption of natural resources and the influence upon natural environment become the main criteria for selecting methods of developing transport. That is why those factors will exert stronger and stronger influence upon the modal split in transport (and also upon technological development in different transport modes) through determining investment policy which, in turn, influences the supply of transport services rendered by particular modes of transport.

Economic policy, including transport policy, as well as geographical and historical conditions determine the supply of transport services and the technological advancement of infrastructure and fleet. The latter influence, as it was mentioned above, the size and structure of demand for services rendered by different transport modes, hence the choice of a given mode.

The supply of transport services also exerts impact upon transport costs. The factors which influence transport costs include infrastructure charges, which depend on the transport policy of the state. Transport costs, in turn, influence prices.

The interdependencies are presented on Fig. 45.
Charges for transport infrastructure use are an economic instrument in:
– fiscal policy, as well as
– transport policy.
The fiscal function of the charges is to gather funds for reimbursement of outlays on transport infrastructure construction and maintenance costs, as well as generating profit for investors.

The pressure of investment needs regarding transport infrastructure, on the one hand, and the scarcity of budget resources, on the other hand, result in the situation in which the financial responsibility for the development and maintenance of transport network is more and more often born not only by all taxpayers, i.e. the whole society, but also by the direct user of transport. This assumption is in line with the declaration adopted at the 3rd Pan-European Transport Conference in Helsinki regarding European transport system. That is why, besides public credits and budget subsidies, various charges for using transport network are used for financing transport infrastructure development.

The charges for using transport infrastructure are, however, not only used as an economic instrument of fiscal nature. The charges are often used for attaining other transport policy goals, such as:

– regulating the size of carriages on a given route,
– influencing the structure of carriages (transport means, domestic and international carriers, etc.),
– relieving alternative connections.

Additional effects may be achieved through differentiating the charges.

It also happens, however, that excessive fiscalism may produce results unfavorable for transport policy, such as low utilization of new infrastructure or excessive utilization of alternative facilities (the use of which is often free of charge), hence, limiting the favorable effects of a given investment, such as:
– reducing the unfavorable influence upon the environment (decreasing safety risks, reducing pollution as a result of smooth traffic flow),
– reducing transport costs, resulting from shorter transport distance (thanks to e.g. building tunnels, bridges or better connections), transport time (owing to shorter distance or eliminating congestion)\(^1\).

Charges for infrastructure use are often introduced on roads of the highest quality. However, because of priorities of transport policy, such as diminishing the unfavorable environmental impact of transport or eliminating congestion, such economic instruments regulating access to high quality infrastructure, e.g. highways, are not used in some countries.

Charges are more and more often introduced for using newly constructed facilities aimed at eliminating bottlenecks or creating new connections. The benefits from using those facilities are considerable, so the users agree to incur the additional costs. Yet, the decision to use toll roads it is not easy to take. Planning their costs and economic effectiveness, carriers seldom take into account external costs, and it is difficult to assess the cost of additional time lost. That is why the system of charges for using such facilities has to be gradually adjusted to the expectations of customers so as not to discourage them from using the new infrastructure. Periods of promotional prices are also well-justified since they encourage customers to try to use the new offer. Additional effects may be achieved through appropriate differentiation of charges.

Taking into consideration how complex the process of harmonizing transport charges in the European Union countries is, it should be organized in a number of stages.

15.3. Examples of How Differentiated Pricing May Influence Mode Use, Including Use of Multimodal Chains

The problem of infrastructure access charges as a factor determining transport mode choice is very complex, as it was mentioned earlier. The complexity of the problem derives from different methods of handling the issue, as well as from the vast number of regulations in this respect and the number of charges themselves. Examples was divided into two groups. First group of the examples presents general solutions in such countries as Germany, Austria, Switzerland, Holland and UK. Second group shows different examples of existing intermodal chains and analyze of advantages of established connections.

Below selected solutions from different European countries were presented:

– in Germany, in 1994, the law was passed which allows for constructing (and operating) bridges, tunnels and mountain passes in the PPP system with refinancing the charges; in 1995, charges for heavy-load trucks (over 12 t) using highways were differentiated depending on the time factor; in 2004, charges were to depend on the distance covered and they were to be levied by means of GPS/GSM technology, including the possibility to levy the charges manually;

– in Austria, in 1997, charges were introduced (based on time) in the network of motorways and fast traffic roads for trucks and cars, provided there are not special charges, e.g. for mountain passes; in 1999, a system of charges was prepared for trucks (based on distance) which was to be synchronized with the introduction of similar charges in Germany (in Germany the introduction of such charges was delayed, so in Austria the charges were introduced as of January 2004; the revenues from the charges are invested solely in operating and developing the road network as well as refinancing the system operations),

– in Switzerland, since 2001 there have been charges for all trucks with gross weight over 3.5 t in the whole road network (the charges are based on the distance covered);

– in Holland, there were plans to introduce charges for all domestic and foreign trucks in the whole road network in 2006/2008, the charges were to be calculated by the on-board-unit (in a truck) called "mobimeter", using many ITS (Intelligent Transport Systems) elements, the mobimeter should not only calculate the charges but also provide information on traffic conditions (dynamic route planning); ensure safety of traffic and protection against theft, alarm system and reports on the vehicle condition; finding parking lots as well as hotels and restaurants, (including calculation of fees); the objective of the system was to replace financing of the road net...
work from taxes with financing it by actual users, as a fair system of sharing costs by those who create both internal and external costs (the system has not been introduced so far but it may be implemented in the future);
– in the UK, in 2004, there was a competition held for the best electronic system of collecting charges imposed on trucks in the whole road network, the objective was to introduce a fair system of sharing external costs and, first of all, reducing congestion (congestion is expected to drop by 40%).

Switzerland has a very consistent policy regarding combined transport. In 1994, they introduced the requirement for transit carriages to use rail transport, the requirement being stipulated in the constitution (art. 84). Transit routes through Switzerland are the shortest routes for about 50% of all carriages between Europe and Northern Italy. Dramatic deterioration of natural environment made Switzerland to resort to radical methods and to force transit transport to use combined modes.

The steps taken include:
– modernization of railroads and increasing its carriage capacity,
– introducing very high taxes for heavy trucks, the taxes will rise gradually as of 2007 depending on the increase in the accepted weight of trucks,

Fig. 46. Structure of rail and road transit between Northern Europe and Italy through the Alps (in 2002 – not accounting for the weight of containers, swap bodies, semitrailers and trucks)

- increasing the accepted weight of trucks used in combined transport,
- decreasing road charges for heavy trucks used in combined transport,
- ban on heavy trucks traffic on Sundays and in the night,
- subsidizing rail carriages in combined transport,
- subsidizing combined transport operators,
- financial support of construction and operations of intermodal terminals,
- supporting the development and use of rail infrastructure³.

The effects of this consistent policy, which was implemented some years ago, are very favorable. In 2002, over 76% of North-South transit traffic in Switzerland was serviced by rail transport, whereas the rail transport share was much lower in other countries e.g. in France 25% and in Austria 27% (see Fig. 46).

15.4. Bibliography


³ Ibidem.

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16.1. Introduction

Quality has become a buzzword for freight as well as for passenger transport. We shall only consider freight matters, passenger transport depending on very different analysis and explanations.

Addressing this issue requires a previous theoretical questioning: what is the nature of freight transport? Is it a manufacturing activity or a service? What are the consequences of the nature of transport on the production of transport, the organization of the market, the regulation of the industry, the management of firms?

We shall therefore successively approach the nature of transport, transport as a service relationship, the role of quality of service in freight transport, the management of quality and the new qualitative preference of shippers, before our general conclusion.

16.2. The nature of transport

To start with, one must consider the very process of freight transport: is it an intangible operation? Indeed, transport is not a good, it apparently does not modify transported goods (in fact, it does, since it changes their position in space and time!), it cannot be stocked, and some wrongly say it is not productive.
Still, from a technological viewpoint, transport is a manufacturing activity, a physical operation involving heavy production means: manpower, fixed public capital (infrastructure) and private capital (rolling stock, warehouses, handling facilities, etc.), energy. Transport is a process, not a product.

The production of transport can take place according to two basic schemes: in-house, when a “shipper” (i.e. a firm the activity of which requires transport to be operated) carries out transport with its own means (this is called “own account” transport); or out-sourced, when the shipper asks an outside specialized company (a “carrier”) to provide it with the necessary transport operation (this is called “third account” transport). In the later case, transport is considered as a service. The industry of transport and the market of transport therefore cover only a part of total transport operation, the one that has been outsourced by shippers according to their arbitrage in matter of “make or buy” (see Fig. 47).

![Fig. 47. Transport activity, inside and outside market](source: own study)

Concerning a process and not a product, transport production and transport consumption are fused into a single process, they take place at the same place and at the same time (whereas the production and consumption of a product is usually split into two separate events). This characteristic has obviously important consequences on the organization of transport. Considering its market, the fit of supply and demand is particularly difficult and imperfect, since it should be achieved exactly at any moment and in any place. In fact, market is chronically in an imbalance position and to a certain extent over-capacity is necessary, so as not to face the opposite, but much more problematic situation, i.e. shortage and bottle-necks. To make demand and supply match as little badly as possible,
different intermediate agents (freight-forwarders, brokers, etc.) play a noticeable role. The difficult adjustment of the market also explains a part of transport regulation which, to a certain extent, aims at reducing competition, or at least destructive competition, e.g. through the strict divide between own account and third account transport.

Given the production and consumption of transport are confused (i.e. simultaneous), this impedes such adjustments as over-production during the slack season so as to satisfy exceeding demand during the following high season. Such a possibility allows a stabilized level of production so as to fulfill a fluctuating market, but applies only for a non-perishable good (see Fig. 48). For transport, which is a process, this smoothing is impossible and the capacity of production (considering infrastructure, manpower and rolling stock) is fixed by the peak traffics one must be able to treat, resulting in over-capacity meanwhile (see Fig. 49).

Fig. 48. Production and consumption of a good
*Source: own study.*

Fig. 49. Production and consumption of transport
*Source: own study.*
At last, one notices that the nature of transport, implying that its production and consumption must happen in the same place, explains that transport (and logistics) cannot be off-shored to low wage countries, as manufacturing can be, at least for final distribution operations.

16.3. Transport as a service relationship

The third party carrier therefore appears, on the one hand, as an industrialist like others, from a technical viewpoint (apart from the fact that infrastructure, which is part of transport productive equipment, mostly belongs to public capital). On the other hand, a carrier does not possess and does not sell products coming out of his own activity, given he produces and sells a process, applied to objects belonging to his customers. This explains, notably, the importance of responsibility issues in the transport business, with a great concern for accidents, law, dispute, insurance, etc.

From a contractual and organizational point of view, the carrier is involved in a service relationship with his customer, the shipper. The shipper belongs to agriculture, manufacturing industry or services (and particularly to wholesale and retail trade), he decides about transport usefulness, if not about its practical details. He purchases a process, not a product, to be applied to his own product. He therefore entrusts a third party supplier with his product, which often requires that he keeps certain knowledge and control of the process: actually, if transport operations are outsourced, their effects remain in-house, as they apply to the product. The service relationship can be represented by a simple diagram, a triangle, since the direct relationship between shipper and carrier only makes sense when it includes the processing of an object (the consignment), which is the third apex of the triangle.

On the Fig. 50 generic terms for service relationship are written in light type, whereas terms specific to transport are written in bold. The relationship between the carrier and the shipper is double. It is a normal commercial relationship, setting quantity, price, payment conditions, etc. between a seller and a buyer. In the same time, it is a technical relationship, so as to carry out the co-production of transport, given both parties take part to the proper conception and implementation of transport. This requires the mutual appropriateness of vehicle and consignment (size, packing, temperature, etc.), the availability of adequate handling equipment for loading and unloading, the making of an appointment in space and time for pick up and for delivery, and a rigorous coordination of activity programs of shipper and carrier.

The service relationship in freight transport evolves, and tends to become more long-lasting and complex. A new transport contract, for a big batch of op-
operations, is no longer concluded right away. A preliminary phase of preparation allows the conception of an original and adequate technical solution before its commercial negotiation, and big transport and logistics groups have for that purpose developed an in-house consultancy capacity. When the implementation of the contract begins, a monitoring process is usually set up, so as to develop a learning process on the basis of performance indicators, problem solving and results sharing strengthening the cooperative involvement of the shipper and of the carrier in the transport control.

This trend is even stronger when the content of services shifts from mere transport to more comprehensive logistics operations. Shippers show new requirements in the nature and performance of services, adequate to more sophisticated and demanding management methods such as Just-in-time, whereas carriers broaden the scope of their supply so as to meet their customers’ needs.

As a whole, the tightening of service relationship between shipper and carrier increase the importance of quality of service.

16.4. Freight transport and quality of service

The issue of quality of service raises some difficulty, for its definition and for its implementation. The problem starts with the very notion of service, before considering its quality. A service is a process, it cannot be described and measured like a product: the knowledge of a service requires the description of the actual

Fig. 50. Transport service relationship
Source: own study.
operation it results from, whereas a good can be described independently from the upstream process that generates it. Once this issue accepted, one can call “quality of a service” the degree of adequacy of the actually provided service with the scheduled (theoretical) program it is supposed to fulfill.

In this respect, the usual measure units of freight transport are poor (whether one uses tons or ton-kilometers does not make much difference), as they do not include transport key characteristics such as speed, safety, punctuality, flexibility, etc. The appraisal of this quality belongs both to the carrier and to the shipper, involved in the bilateral relationship of transport production and consumption.

The measurement of quality can rely on the assessment of the process, according to its technical content: one can check the proper condition of vehicles, measure the lead-time, the frequency of transport, the punctuality of picking up, etc. Or it can rely on the assessment of the result, considering integrity of consignments, reliability concerning delivery address or punctuality of delivery, completeness of consignment (no missing parcel in a range of expected deliveries, e.g. when several spare parts are necessary to repair a machine), accuracy of documents (bill of lading, invoice, etc.) and finally flexibility (both for short range response to unexpected events and for long range innovation).

Quality is of course specific to each transport operation, its definition has to be determined according to criterions and their weightings have to be set by the shipper and depending on his products. Some of these criterions are measurable and others more subjective. They correspond to an expected level of performance, and the comparison of actual adequacy with theoretical “quality” sets the rate of success or of failure, at least when the operation is recurrent and enables a statistics measurement.

Total quality does not exist (or it would have an infinite cost), a tolerable rate of failure is set, implicit or explicit, according to an economic appraisal. Optimum quality is not maximum quality, a trade-off is set between logistics requirements and utility one the one hand, corresponding costs on the other hand, according to different levels of quality (see Fig. 51).

![Fig. 51. Optimum level of quality](source: own study.)
On the market of transport services, differentiation of supply is a way to escape over-competition ruling the market of banal haulage, and encompasses lead time (express vs. standard service), spatial cover (regional, national, continental, global networks), additional logistics operations (warehousing, packaging, inventory management, etc.), IT (tracking, tracing), etc. and of course the level of “quality” in the achievement of theoretical performance. But carriers often complain that they hardly succeed in raising their tariff to reflect an additional quality: what is shipper’s willingness to pay for quality?

16.5. Quality management

As a key topic for production and competition, quality is in itself a concern and is the object of active management. So as to cope with it, one relies on passed experience to manage the future, through performance measurement relying on various indicators and allowing an actual monitoring process, to identify and solve problems so as to anticipate forthcoming issues...

If total quality does not exist, the aim is to reduce risk down to an acceptable level, whether one is able to make a comparison of benefits and costs of quality and of its control, or relies on a feeling of “confidence”, including the quality of service and the quality of the supplier (carrier or logistics contractor).

Quality is reciprocal, it results from the behavior of both the supplier and the customer (a consignment can be delayed because it was available too late for picking-up, damaged because the packaging was fragile, etc.). One can measure the carrier’s quality toward the shipper (through the frequency of failures), but also the shipper’s (and consignee’s) quality toward the carrier (with about the same criterion). One can check, on this issue, how strongly quality takes place inside the service relationship, the co-production of transport by shipper and carrier, which sometimes can be called a partnership.

An active management is all the more necessary as the quality of transport can receive no preliminary control, no preventive test as it is the case for the quality of goods. Being a process, produced for new at every time, transport shows its defects only when they occur and therefore when they are consumed by the shipper. When a defect appears, the consignment is inevitably affected.

Quality of service has always to be produced, re-produced, made better in an ever-lasting learning process. This probably explains the role of intermediate agents and of consultants, so as to introduce into organizations a cross-section function such as logistics, and to reduce uncertainty and diminish direct and hidden costs due to insufficient quality. A usual practice, in this respect and in spite of its bureaucratic aspects, is certification.
16.6. New qualitative preference of shippers and organization of transport

A new flexible production model has become to-day's paradigm, at international level, whether one calls it “lean production”, just in time or otherwise, characterized with less inventory, no buffer stocks, etc. It necessarily develops adequate transport requirements.

These changes take place together with the expansion of international production and trade (globalization), where manufacturing goods represent a growing share of world trade compared with raw materials: from 1950 to 2003, world production was multiplied by 7 (agricultural goods by 3.5, raw materials by 4 and manufactured goods by 11), world trade was multiplied by 23 (agricultural goods by 6, extractive products by 9 and manufactured goods by 46). The need for sophisticated logistics rises consequently (see Fig. 52).

Dealing with logistics flows, this results in a stronger demand for reliability, a systematic use of tracking, tracing and EDI. The growth of e-commerce strengthens these trends. Logistics organization then obeys new performance criterion which result in different technology and new cost split. In traditional “push” systems, the major expense was on inventory, even if firms did not always reckon it... In the new “pull” system, more transport and information system expenses allow lower inventory costs.

Consequences and requirements on the transport system are strong: increase in volume, change in structure of goods, smaller, more numerous, more urgent and unpredictable shipments, on a larger territory. In terms of “quality of
service”, expectations focus on reliability, lead-time (feeding the success of express parcel industry), flexibility, etc. These elements can be linked together: the choice for express is not always a matter of speed but of safety (reliability), particularly for “sensitive” products. The response of transport system is adequate to this production model, with a thinner segmentation of supply, according to differentiated qualitative demands.
The importance of quality of service can justify a complete organizational choice, involving control and ownership issues. Two main models of transport supply to meet demand can be identified: a transversal supply (for numerous demands), where transport as a commodity (from the shipper's viewpoint) and obeys network economy; or a specialized supply, tailored for specific demand and tightly involving the shipper as much as the carrier into a stable relationship.

Parcel service is a model for transversal supply, as parcel networks simultaneously treat thousands of different customers, in an integrated network comprising physical operations such as pick up, consolidated haulage and delivery, and a lot of information technology. This principle can exist for road transport, but also for other modes, and for multimodal combinations, and shows a high growth rate.

Table 33. Two types of transport: market (1) and organization (2)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle</td>
<td>Scheduled transport</td>
<td>Transport on request</td>
</tr>
<tr>
<td>Business</td>
<td>Multi-customer</td>
<td>dedicated</td>
</tr>
<tr>
<td>Layout</td>
<td>network</td>
<td>lines, shuttles</td>
</tr>
<tr>
<td>Economy</td>
<td>Economies of scope</td>
<td>economies of scale</td>
</tr>
<tr>
<td>Differentiation</td>
<td>Standard service</td>
<td>customised</td>
</tr>
<tr>
<td>Frequency</td>
<td>Regular</td>
<td>recurrent</td>
</tr>
<tr>
<td>Ownership</td>
<td>Third account</td>
<td>own account</td>
</tr>
<tr>
<td>Market or planning</td>
<td>Transport as a commodity</td>
<td>transport as a co-production</td>
</tr>
<tr>
<td>Control</td>
<td>Carrier's control</td>
<td>shipper's control</td>
</tr>
</tbody>
</table>

Source: own study.

266
Table 34. These two models receive implementations in various transport modes:

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>LTL, parcel</td>
<td>FTL</td>
</tr>
<tr>
<td>Maritime</td>
<td>lines, containers</td>
<td>tramp, bulk</td>
</tr>
<tr>
<td>Rail</td>
<td>wagons</td>
<td>block trains</td>
</tr>
<tr>
<td>Intermodal rail-road</td>
<td>historical operators</td>
<td>Newcomers</td>
</tr>
</tbody>
</table>

Source: own study.

Specialized systems remain very strong for road transport where own account is important or even predominant in terms of fleet, staff, tonnage, value of production. This type of organization is growing for railways and intermodal transport, where newcomers on the market are often the dedicated subsidiary of one single shipper (a manufacturer in chemistry or steel industry, a shipping company, etc.). Own account is not necessarily obsolete!

16.7. Bibliography

2. Questions clés pour le transport en Europe (Key issues on transport in Europe). La Documentation Française. Paris 2009.
Chapter 17
TRENDS IN WORLD SHIPPING
INCLUDING THE BALTIC SEA REGION
(Janusz Żurek)

17.1. The state of world economy and its impact
on the global shipping market

The world economy of the present decade is characterised by a relatively high
growth rate. The years 2004-2006 showed an average growth rate of 4.5%. The
GDP growth rate in 2006 was 1.6% in Japan, 2.7% in the Euro zone, 3.0% in the
US, 4.6% in South Korea, 3.2% in Brazil, 6.5% in Russia. The highest growth rate
was noted in China and amounted to 10.4% and in India 9.2%\(^1\). Forecasts for
2008 indicate a slightly slower rate in all the listed countries with the exception
of Brazil – 3.5%, and in Japan – 2.3%.

The US dollar has clearly lost to other leading currencies on international
currency markets in 2006 primarily as a result of a deep trade deficit. The Euro,
on the other hand, strengthened its position. A further drop to the USD was ex-
perienced by the Japanese YEN, however, this was a minor drop of approxi-
mately 0.1%.

The trends in global economy seem to confirm the evident relations be-
tween the financial and the shipping sectors. The dynamic global processes con-
tribute to the development, including the growing role of transnational corpora-
tions and direct investments of various nature and scope.

Globalisation is more and more clearly shaping economic relations and cre-
ating additional interdependence of the global shipping market and world
trade. World trade volume and its pattern are, to a large extent, defined by
a group of several countries referred to as B.R.I.C, i.e. Brazil, Russia, India and

China, which play a significant role in the trade pattern. Also the projected con-
tinued economic revival of Central and East European countries will primarily
contribute to trade development both within and beyond the European contin-
ent (the share of shipping in total transport within the EU is estimated at 40%).

World Bank forecasts for the next 25 years estimate that developing coun-
tries will reach an average economic growth rate of 6% and will double that of
the developed nations, whereas world trade should grow threefold. This fact
provides grounds for the statement that the temporary – though falling – ship-
ning surplus (see Table 35) will be more efficiently used. In the long run, the
fleet must adapt to the difficult to the hardly predictable global changes, which
generally bring not only growth but also an environmental shock.

Table 35. Surplus capacity of the world fleet in 1990, 1995, 2000 and 2005 (million DWT)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Surplus tonnage of world fleet</td>
<td>63.7</td>
<td>50.8</td>
<td>18.4</td>
<td>7.2</td>
</tr>
<tr>
<td>Surplus tonnage of tanker fleet</td>
<td>40.9</td>
<td>28.8</td>
<td>13.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Surplus tonnage of dry bulk carriers fleet</td>
<td>19.4</td>
<td>17.9</td>
<td>3.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Surplus tonnage of general cargo fleet</td>
<td>2.1</td>
<td>2.0</td>
<td>1.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Surplus fleet tonnage for shipping unitised cargo</td>
<td>0.5</td>
<td>0.7</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Source: Based on Review of Maritime Transport 1997, United Nations 1997, p. 44-45; Review of Maritime Trans-

All forecasts should be treated with great caution and full awareness of ope-
rating in a complex and evolving environment that is difficult to foresee. It is
hard to project explicitly the development of currency exchange rates, reactions
of the financial market, etc. To a large extent, they decide on the success of the
forecasts. Who could have foreseen oil prices of USD 50 per barrel in 2006 and
a soar to USD 70 per barrel as a result of changing exchange rates!

At the end of 2006, the dry bulk market continued to develop, creating an
exceptionally good environment for quick return on invested assets. This is sup-
ported by very high time charter rates for capesize ships operating on Atlantic
roundabout journeys. These rates rose from USD 33 200 in early 2006 to USD
67 800 later that year. Rates also grew for panamaxes by 95% and for handymax
type vessels by 73.4%. This exceptional surge in rates on the market resulted
from growing demand primarily owed to the rapid development of Chinese In-
dian economies, clearly showing their presence on the global market.

The tanker market experienced varying trends. Dropping rates primarily af-
fected VLCC and suezmax tankers. This resulted from reduced demand for im-
ported oil and the necessity to look to own strategic resources. The container
market suffered a slight withdrawal in 2006 for ships with loading capacity be-
low 2700 TEU.
17.2. World seaborne trade and the merchant fleet

The volume of global trade flow shipped by sea is gradually but regularly growing reaching 6.9 billion tonnes by the end of 2006. Estimates for the end of 2008 put the trade volume at 7.5 billion tonnes. A favourable factor for world trade development is the progressing globalisation and liberalisation, which contribute to market development, and create opportunities for developing countries, with their relatively modern engineering and technological solutions, to join in international trade.

Global trade growth rate for oil cargoes is assumed to reach 2.9% in 2007 and 3.1% in 2008, with dry bulk cargo figures 4.0% and 3.5%, respectively.

Growth of shipped volumes is noted in all cargo groups. In 2006, compared with 2005 liquid bulk cargo volumes grew by 2.3% and dry bulk cargoes by 6.8%. Shipment of general cargo and containerised cargo grew by 5.7% (see Table 36).

Growing oil shipments resulted mainly from the rising demand for oil from other than OECD countries. Russia has become the leader in oil production (9.4 billion barrels per day in 2006).

When it comes to group of countries, the clear leaders in oil production are the OPEC countries (29.5 billion barrels per day in 2006). Angola, which is a new OPEC member, plans to increase its oil output by 0.25 billion barrels per day in 2007.

<table>
<thead>
<tr>
<th>Year</th>
<th>Crude oil</th>
<th>Oil products</th>
<th>Iron ore</th>
<th>Coal</th>
<th>Grain</th>
<th>Bauxite and alumina</th>
<th>Phosphates</th>
<th>Other cargo</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>1190</td>
<td>336</td>
<td>347</td>
<td>342</td>
<td>192</td>
<td>52</td>
<td>35</td>
<td>1438</td>
<td>3932</td>
</tr>
<tr>
<td>1995</td>
<td>1415</td>
<td>381</td>
<td>402</td>
<td>423</td>
<td>196</td>
<td>50</td>
<td>30</td>
<td>1815</td>
<td>4712</td>
</tr>
<tr>
<td>2000</td>
<td>1608</td>
<td>419</td>
<td>454</td>
<td>523</td>
<td>230</td>
<td>53</td>
<td>28</td>
<td>2280</td>
<td>5595</td>
</tr>
<tr>
<td>2001</td>
<td>1592</td>
<td>425</td>
<td>452</td>
<td>565</td>
<td>234</td>
<td>51</td>
<td>29</td>
<td>2305</td>
<td>5653</td>
</tr>
<tr>
<td>2002</td>
<td>1588</td>
<td>414</td>
<td>484</td>
<td>570</td>
<td>245</td>
<td>54</td>
<td>30</td>
<td>2435</td>
<td>5820</td>
</tr>
<tr>
<td>2003</td>
<td>1673</td>
<td>440</td>
<td>524</td>
<td>619</td>
<td>240</td>
<td>63</td>
<td>29</td>
<td>2545</td>
<td>6133</td>
</tr>
<tr>
<td>2004</td>
<td>1754</td>
<td>461</td>
<td>589</td>
<td>664</td>
<td>236</td>
<td>68</td>
<td>31</td>
<td>2690</td>
<td>6493</td>
</tr>
<tr>
<td>2005</td>
<td>1784</td>
<td>495</td>
<td>652</td>
<td>710</td>
<td>251</td>
<td>73</td>
<td>31</td>
<td>2666</td>
<td>6662</td>
</tr>
<tr>
<td>2006</td>
<td>1814</td>
<td>517</td>
<td>711</td>
<td>755</td>
<td>262</td>
<td>75</td>
<td>31</td>
<td>2818</td>
<td>6982</td>
</tr>
<tr>
<td>2008</td>
<td>1917</td>
<td>555</td>
<td>789</td>
<td>821</td>
<td>280</td>
<td>82</td>
<td>31</td>
<td>3033</td>
<td>7507</td>
</tr>
</tbody>
</table>


Chinese economy is one of the major importers of oil. The demand for oil in China will grow by 0.45 million barrels per day and will reach 7.6 million barrels per day in 2007. Oil consumption in the US will also grow by 9.35 million barrels per day in 2007, compared with the 21.1 million barrels per day in 2006. The consumption of oil in Europe (16.3 million barrels per day) should remain stable. Oil consumption will also grow in Asian countries (excluding the Central East) by 0.5 million barrels per day, as compared with the 25 million barrels per day in 2006. The growth in industrial output of OECD countries contributed to the development of bulk cargo shipping, creating a favourable environment for effective use of the available shipping capacity. The Far East countries have the biggest share in industrial output growth. At the end of 2006, industrial output in Japan grew by 4.8%, in North Korea by 2.3% and in China by 14.7%. For comparison industrial output in the US grew by 3% and in the Euro countries by 4.0%.

The year 2006 features a significant increase in dry bulk freight. Shipping volumes grew from 2,514 million tonnes in 2004 to 2,814 million tonnes in 2006. This growth was generated primarily by the growing demand of the Chinese market for iron ore and coke. Iron ore shipments by sea grew from 652 million tonnes in 2005 to 711 million tonnes in 2006, and coal from 710 million tonnes in 2005 to 755 million tonnes in 2006. Australian, South African, Columbian and Canadian exporters have largely contributed to this trend. The main coal consumers include China (Chinese coal exports show a falling trend – China is becoming a net importer), Japan, South Korea and Italy. Coal shipment volumes in 2007 are expected to increase by 4.7%. Approximately 80% of coal shipments are realised under contracts of carriage.

Shipping volumes of grain also grew from 251 million tonnes in 2005 to 262 million tonnes in 2006.

The volume and structure of the world carrier fleet is strictly linked with the changes in the pattern and volume of seaborne international trade.

The development of shipping is both the consequence and a condition for increase in world trade flow. If the international shipping market experiences a shortage of tonnage in a given period, i.e. the demand exceeds the supply, the shipping industry cannot boost seaborne trade. This situation means an oversupply of cargo volumes, which will in part omit sea shipment due to lack of available tonnage but may have an impact on shipping by creating the need for additional tonnage and additional investments. When tonnage supply in a given time period exceeds or corresponds to the demand for shipment services, shipping can accelerate seaborne trade. Increased turnover may result from both expanding sales or purchase markets or intensified acquisition on the markets already serviced.

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3 Ibid. p. 42.
4 Ibid. p. 45.
Table 37. World fleet size in the 1996-2007 period and in 2010 (in million DWT at the beginning of the year)

<table>
<thead>
<tr>
<th>Years</th>
<th>Tankers</th>
<th>Chemical carriers</th>
<th>Dry bulk carriers</th>
<th>Multipurpose bulk carriers</th>
<th>Other ships</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>261.0</td>
<td>9.5</td>
<td>241.3</td>
<td>20.7</td>
<td>140.9</td>
<td>673.4</td>
</tr>
<tr>
<td>1997</td>
<td>265.1</td>
<td>10.0</td>
<td>250.0</td>
<td>17.3</td>
<td>149.1</td>
<td>691.5</td>
</tr>
<tr>
<td>1998</td>
<td>268.5</td>
<td>11.0</td>
<td>260.7</td>
<td>16.9</td>
<td>155.3</td>
<td>712.4</td>
</tr>
<tr>
<td>1999</td>
<td>273.2</td>
<td>11.9</td>
<td>260.4</td>
<td>16.1</td>
<td>160.9</td>
<td>722.6</td>
</tr>
<tr>
<td>2000</td>
<td>276.0</td>
<td>13.5</td>
<td>264.8</td>
<td>15.2</td>
<td>166.7</td>
<td>736.2</td>
</tr>
<tr>
<td>2001</td>
<td>281.3</td>
<td>15.0</td>
<td>274.0</td>
<td>14.6</td>
<td>169.3</td>
<td>754.3</td>
</tr>
<tr>
<td>2002</td>
<td>274.9</td>
<td>15.0</td>
<td>287.4</td>
<td>13.8</td>
<td>174.7</td>
<td>765.9</td>
</tr>
<tr>
<td>2003</td>
<td>278.8</td>
<td>15.4</td>
<td>295.0</td>
<td>12.6</td>
<td>181.2</td>
<td>783.0</td>
</tr>
<tr>
<td>2004</td>
<td>287.9</td>
<td>17.3</td>
<td>303.3</td>
<td>12.2</td>
<td>189.6</td>
<td>810.3</td>
</tr>
<tr>
<td>2005</td>
<td>304.1</td>
<td>18.0</td>
<td>320.7</td>
<td>11.7</td>
<td>200.5</td>
<td>855.0</td>
</tr>
<tr>
<td>2006</td>
<td>326.9</td>
<td>19.2</td>
<td>341.9</td>
<td>11.7</td>
<td>213.3</td>
<td>913.1</td>
</tr>
<tr>
<td>2007</td>
<td>344.4</td>
<td>21.4</td>
<td>365.1</td>
<td>11.3</td>
<td>232.0</td>
<td>974.3</td>
</tr>
<tr>
<td>2010</td>
<td>420.9</td>
<td>•</td>
<td>421.2</td>
<td>7.6</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>


The size of the world shipping fleet shows a regular upward trend. In the 1990-2006 period, tonnage in DWT terms rose by 45%. This trend is the consequence of a regular growth in the number of new constructions as well as the growth of individual vessels’ size. (see Table 37).

Table 38. Use of capacity by world fleet in 1990, 1995, 2000 and 2005

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>World shipping fleet tonnes/DWT</td>
<td>6.1</td>
<td>6.3</td>
<td>7.3</td>
<td>7.4</td>
</tr>
<tr>
<td>Thousand ton-miles /DWT</td>
<td>26.0</td>
<td>27.5</td>
<td>28.5</td>
<td>30.3</td>
</tr>
<tr>
<td>Tanker fleet tonnes/DWT</td>
<td>6.0</td>
<td>6.6</td>
<td>7.3</td>
<td>6.7</td>
</tr>
<tr>
<td>Thousand ton-miles /DWT</td>
<td>30.8</td>
<td>34.4</td>
<td>34.5</td>
<td>32.4</td>
</tr>
<tr>
<td>Dry bulk carriers tonnes/DWT</td>
<td>3.3</td>
<td>3.2</td>
<td>4.6</td>
<td>5.0</td>
</tr>
<tr>
<td>Thousand ton-miles /DWT</td>
<td>18.8</td>
<td>18.7</td>
<td>23.9</td>
<td>25.2</td>
</tr>
<tr>
<td>Multipurpose/combined bulk carriers tonnes/DWT</td>
<td>6.3</td>
<td>7.4</td>
<td>7.9</td>
<td>8.4</td>
</tr>
<tr>
<td>Thousand ton-miles /DWT</td>
<td>36.0</td>
<td>38.5</td>
<td>38.5</td>
<td>41.1</td>
</tr>
<tr>
<td>General cargo vessels and container carriers tonnes/DWT</td>
<td>9.1</td>
<td>9.5</td>
<td>10.5</td>
<td>11.5</td>
</tr>
<tr>
<td>Thousand ton-miles /DWT</td>
<td>26.0</td>
<td>27.7</td>
<td>28.3</td>
<td>33.6</td>
</tr>
</tbody>
</table>

Analysing world fleet in terms of vessel type, we can note the continuous development in the tanker fleet adapted to the carriage of oil and petroleum products, including specialised ships, i.e. chemical carriers.

Dry bulk carrier tonnage is also on the rise but multipurpose bulk carriers show a minor drop in tonnage. Tankers and dry bulk carriers form the largest group in terms of tonnage, constituting 77% of the global tonnage.

Also ships for carriage of unitised cargo are enjoying dynamic development, particularly vessels specialising in the carriage of cellularised containers, i.e. container vessels. The drive to reduce operational costs is one of the most important incentives for owners to order bigger container vessels.

New developments in ship structure, carriage techniques and technologies with continuous improvements in the process, are factors contributing to better use of the available tonnage, the potential capacity use ratio. However, it should be emphasized that the ratio depends on the given market conditions determined by the size and structure of demand and supply. Thus, it does not provide comprehensive grounds as to the use of shipping opportunities provided in reality by the shipping potential (see Table 38).

17.3. Orders for new tonnage as a shipping trends indicator

A detailed study of orders for new constructions shows the trends for the next 3-4 years in terms of vessel size and structure.


While analysing the order book structure according to vessel type, we must note a significant increase in the number of tanker tonnage ordered; from 88.1 million DWT at the end of 2005 to 129.2 million DWT in 2006, whereas orders for bulk carriers rose from 69.0 million DWT to 75.4 million DWT. Forecasts provide for further growth in oil consumption, up to a level of 93.7 million barrels per

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7 Ibidem.
day in 2011, compared with 83.3 million barrels per day in 2005, i.e. by 12.5%. The projected growth is the consequence of the economic boom in China, India and Brazil. Further oil consumption growth is also projected in the US and in Europe. Only in China, due to the growing number of cars, oil consumption will rise from 4.7 million barrels per day in 2001 to 10 million barrels per day in 2011.

Optimistic projections of oil consumption favour growing orders for tankers. A record number of suezmax tankers, i.e. 104 ships, are on order today with most of them becoming operational in 2009. The tanker market will further be supplemented by 102 VLCC tankers, which should come into operations in the years 2009-2010.

The order books, at the beginning of 2007, contained mostly 80-120 thousand ton tankers and 200-320 thousand tonne vessels. The size of the portfolio showed in these tonnage groups 25.5 million DWT and 49.2 million DWT respectively. According to Fearnley’s estimates, as of 1.01. 2010, 1446 tankers will be operated in the 25-50 thousand DWT range, 857 tankers in the 80-120 thousand DWT range and 551 tankers over 200 thousand DWT. In tonnage terms, tankers over 200 thousand DWT are the dominating group, with total tonnage amounting to 1632 million DWT, and in the group 80-120 thousand DWT the total tonnage amounts to 89.3 million DWT.

It is estimated that in view of new orders and partial scrapping of the fleet operated today the tanker fleet at the beginning of 2010 should reach 421 million DWT.8

We can note clearly falling interest in multipurpose/combined bulk carriers, above all because of the high construction price and rising operational and maintenance costs, which is confirmed in the forecasts. In 2006 and at the beginning of 2007, the order books in world shipyards did not note an order for this type of vessel. Also in the years 2008 and 2009 no such orders are expected. Both the tonnage and number of ships in this group fall from year to year. Estimates for the beginning of 2010 project the fleet of multipurpose bulk carriers to number approximately 80 ships of 7.6 million DWT.

An opposite trend can be seen in the case of dry bulk carriers. The order book for this type of ships has been growing and at the beginning of 2007 claimed 911 ships totalling 75.4 million tonnes. Orders for these ship types are dominated by 60-100 thousand DWT units (total tonnage 17.4 million DWT), 150-200 thousand DWT (17.8 million DWT) and over 200 thousand DWT (16.7 million DWT). According to Fearnleys projections, the number of newbuildings and tonnage volume will continue to grow and is estimated to reach 6,906 ships totalling 421.2 million DWT in 2010.9

Equally dynamic development is enjoyed by liquid and natural gas carriers. This trend results from the growing demand for the carriage of this cargo world-

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9 Ibid. p. 71:
wide as an important energy source for the developing industry. The order book for LPG ships at the beginning of 2007 was filled by 184 ships totalling 7.1 million m$^3$. Order book structure shows the predominance, in terms of the number of vessels, of ships below 50 thousand m$^3$ (113 ships totalling 1.4 million m$^3$), whereas larger tonnage over 50 thousand m$^3$ included 71 ships totalling 5.7 million m$^3$. LPG newbuildings constitute slightly more than 47% of the fleet capacity in operation in comparison with 17% in 2004. The gas carriage market is continuous to develop and further orders are expected, which should reduce the average age of operating ships and increase the safety of carriage. As of 1 January 2007, the order books showed 141 vessels of total capacity of 23.5 million m$^3$ with both the number of ships and tonnage dominated by vessels over 100 thousand m$^3$. Within this capacity, range the order book showed 137 ships totalling 23.3 million m$^3$.

In 2006, a clear trend of ordering bigger LNG vessels appeared. Among others, Nakilat – a shipowner from Qatar – ordered 9 ships of 260 thousand m$^3$ each. Of the 39 LNG vessels on order by Qatar, 36 are in the range from 210 to 260 thousand m$^3$. This sudden surge in individual ship tonnage will immediately increase the shipping capacity of the ships in operation. It is estimated that in 2010 the average LNG capacity will grow to 144 thousand m$^3$ in comparison with 126 thousand m$^3$ in 2006.

Growing interest can be observed in the construction of specialised vessels, mainly chemical carriers. The order books of shipyards specialising in this type of construction reached 3.3 million DWT in 2006, indicating an increase of 1.0 million DWT over 2005. In 2006, chemical carriers under construction constituted 32% of the tonnage in operation compared with 17% in the previous year. Construction costs of this kind of ships are very high due to the use of stainless steel, the numerous holds and pumping systems. It is Japanese shipyards, above all, that specialise in the construction of this type of ships having full order books up to the year 2012. Construction of these vessels was also initiated in South Korean SLS shipyard, which is executing an order for a series of chemical carriers of 43 million tonnes. In Europe, chemical carriers are built in the shipyards Factorias Vulcano, De Poli, Aker Florø and in Szczecin.

Interest in ordering ro-ro ships dropped from 30 in 2005 to 15 in 2006. The average age of ro-ro ships is approximately 20 years. Nearly 60% of the ships are aged over 20 and 43% are over 25 years old. The vessels on order are bigger and faster, their structure is better adapted to various cargoes such as trailers, lorries, heavy duty equipment, etc. Key shipyards interested in such construction are in Europe, but as of 2000, the Chinese shipyard Jinling has also been successful in building this kind of ships.

Vehicle shipment market has improved considerably in the years 2005-2006. Orders for car carriers grew from 150 ships for the carriage of 830 thousand ve-

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vehicles at the end of 2005 to 168 car carriers at the end of 2006 with a total loading capacity of 943 thousand cars. New orders are placed by big car corporations, *inter alia*, Pure Car Truck Carriers. Car carrier capacity lies in the range of 4300-7000 cars. Forecasts predict a revival in car shipments, due to the developing Chinese and Vietnamese automobile markets. Car shipments in the years 2006-2015 are estimated to reach 19 million vehicles as compared with 15 million in 2006\(^1\).

The cruise passenger market dominated by several huge owners, who provide 80% of berths on board ships, is developing rapidly. The biggest owner is The Carnival Group, which provides approximately 46% of all berths available. The next Owner is Royal Caribbean Cruise Line with approximately 22% share and Star Cruises /Norwegian Cruise Line – approximately 10%. The Mediterranean Shipping Company is very active in Europe. The owner is planning to increase the cruising tonnage to 12 passenger ships in 2009 offering in total approximately 23000 berths. In 2006, interest in orders for passenger cruisers continued to grow. There are 13 passenger cruisers on order totalling 1048700 GT with 27400 berths and 13600 cabins\(^2\).

Major qualitative changes are taking place on the container transport market. The characteristic trend is to build bigger container vessels for ocean voyages closely interlinked with dedicated or commercial feeder services. This group of ships is dominated by 720-1200 TEU vessels\(^3\). The order books for container vessels have swelled from 4.3 million TEU at the end of 2005 to 4.7 million TEU by the end of 2006\(^4\).

Keeping in mind the economic aspect of operating container vessels, owners order ships of bigger loading capacity to reduce the costs per slot. Individual container ships have been growing, from 4500 TEU in the early 1990s to 14000-15000 TEU a mere 15 years later. VLCS container fleet, i.e. ships over 7500 TEU numbered 147 ships in operation and 160 on order.

In the years 1988-2006, the number of container vessels and their capacity developed from 1156 ships of 1 494 766 TEU to 3949 ships of 9 574 035 TEU. Figures projected for the beginning of 2010 should reach 5195 ships of 13 992 469 TEU\(^5\).

In the next three years, i.e. 2008-2010, the container fleet is estimated to reach an average growth rate of 14% and the annual cargo volume increase of 10 million TEU.

Among 25 leading container vessel operators, AP Möller-Maersk, with a fleet of 1.76 million TEU as of the beginning of 2007, is the leader followed by Medi-

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14 Ibidem, pp. 6-7.
15 *Shipping and Shipbuilding Markets 2007.* Barry Rogliano Salles, p. 82.
Maersk Line clearly dominates the container shipping market with a 16.8% share as of 1 January 2007. Maersk placed an order for 8 container vessels of 14300 – 15000 TEU which are to become operational starting January 2008 to sail between the Far East and Europe. The fourth vessel in the series entered the market at the beginning of 2007.

An order was also placed by Hanjin for the construction of 5 container vessels of 10 thousand TEU in the Samsung shipyard. The price for each vessel is agreed at USD 135 million. Such orders are also projected by operators like COSCO, CMA-CGM, MSC and ZIM.

The position of the French operator CMA-CGM group and MSC in the container shipping market is strengthening. MSC has increased its market share from 8.6% to 9.5% and CMA-CGM from 5.6% to 6.5%.

Considerable activity can be observed of Far East CHKY operators embracing Hanjin, K-Line, COSCO, Yang Ming, holding a 13.8% share of the market. A significant position on the container shipping market is also held by operators of the Grand Alliance, i.e. NYK, Hapag Lloyd, OOCL, MISC, i.e. their market share is 12.8% and operators of the New World Alliance, i.e. APL, Sundai, MOL with a market share of 9%.

A characteristic trend in container shipping is the concentration of container operators towards strengthening the position of a group of operators that facilitates market control and contributes to operational effectiveness on the market by providing container space.

This trend is connected with the division of operators into those operating globally and those providing them with feeder services. This market division, aimed at improving operational efficiency of the available capacity, is closely linked with shipping logistics and will continue to grow. The alliances referred to above control approximately 75% of the world container fleet.

17.4. Baltic Sea Region as an important segment of the global market

The Baltic Sea Region (BSR) is one of the most dynamically developing regions worldwide.

Geographically, the BSR embraces the following countries: Estonia, Latvia, Poland, Germany, Norway, Sweden, Finland and Russia. The economic growth
The rapid development of countries in the BSR results, to a significant extent, from the inflow of foreign direct investments. Availability of own resources for investment is in many of the post-communist countries clearly limited and many of them struggle with a current account deficit. In this situation, foreign direct investments are of great help in developing the economy of these countries. In terms of the in-coming investment ratio per resident the leading country attracting such investments is Estonia. However, in terms of absolute values Poland is the most attractive country for foreign investors thanks to both its size and the natural resources.

Maritime transport plays a significant role in trade. Approximately 50% of all foreign trade is by sea. Maritime transport also plays an important role in trade turnover of the BSR with countries outside the region, in 2003 its share reached the level of 76%.

The share of maritime transport in total shipments in 2003-2020 is estimated to grow by 64% and in absolute figures should reach 471 million tonnes, with the combined share of road and rail transport reaching 27%, i.e. approximately 272 million tonnes.

The development of the BSR is closely linked with sea ports and maritime shipping, which provide a link between the economies of the countries in the region with the rest of the world and are an opportunity of participating in the dynamic globalisation processes.

Trade relations within the BSR involve regular lines for shipping general cargo. External relations predominantly involve dry and liquid bulk cargo.

Regular shipping lines in the BSR are provided primarily by:
- Ferries, ro-ro and con-ro vessels,
- Container vessels of 300-1300 TEU, feeders joining BSR ports with West European container terminals in the area of the Baltic Sea and the North Sea and trade between BSR countries. This group includes such container operators as: Unifeeder, Team Lines, MSC, Maersk Line, ESF Euroservices, OOCL. According to figures for the beginning of 2006, these operators provided 83 container vessels with a loading capacity of 64 533 TEU.\(^\text{17}\)

Liner shipping and tramp shipping in the Baltic Sea is dominated by ships of gross tonnage below 10 thousand GT. The operating oil tanker fleet, due to draught restriction of 15.4 m, allow only for Aframax tankers of approximately 110 thousand DWT. Fully laden VLCC and ULCC tankers cannot enter the Baltic Sea.

The container fleet of BSR countries constitutes ca. 13% of the world fleet in terms of DWT, the tanker fleet 6.4% and general cargo fleet 11%.

Container shipping in the BSR can be assessed in three basic areas:

– deep sea shipping serviced by big container operators calling central BSR ports;
– feeder shipping cooperating with big container operators,
– short sea shipping between Central European ports under dedicated feeder services run by deep sea operators such as Maersk or MSC, or commercial feeder services offered by such operators as Team Lines and BCL.

Container shipments in the BSR and related container fleet structure remains in line with the major world trends. In the BSR, 134 container ships were operated in 2006 totalling 88.4 thousand TEU, ca. 660 TEU on average.

With the beginning of 2007, 18 operators provided services in the BSR, above all Unifeeder and Team Lines. They operate 62 container ships and their market share amounts to 46%. The second group comprises carriers cooperating with global container service providers, i.e. CMA, CGM, OOCL. The third group includes local carriers operating on short routes. These are BCL, IMCL.

More and more often BSR hosts container ships of bigger loading capacity. In March 2007, the Baltic Container Terminal in Gdynia handled a 4174 TEU container vessel and in April a 5029 TEU container ship. The container fleet in the next 10-15 years is expected to feature bigger vessels. Introduction of bigger container ships is restricted by port facilities, i.e. the depth of port basins as well as equipment and wharf length. In this situation 480-1000 TEU feeder vessels are assigned a crucial role in delivering containers to BSR ports handling big container vessels.

The structure of feeder vessels, until recently, was dominated by charter vessels on the market providing operational flexibility. With time, due to the fluctuating rates on the charter market, feeder operators are investing in tonnage, gradually replacing charter tonnage with own tonnage.

The shipment of dry cargo in the BSR is covered by multipurpose, general cargo, reefer ships. They are generally 2600 DWT ships which can call at most ports in the region.

On Baltic and on many North European lines, traditional passenger car ferries are replaced by ro-pax ships adapted to mainly to the carriage of trailers, roll on and roll off cargo and passengers. The Italian shipyard Fincantieri is building a series of four, the biggest to date, ro-pax vessels of gross tonnage 42500 with 500 passenger berths. They will be operated on the Helsinki-Travemünde line by the Finnlines.
In the BSR, as well as the entire European Union, short sea shipping has a special role to play in the future facilitating the shift of cargo transport from land to sea, mitigating congestion and improving safety of road traffic in land transport. Support of short sea shipping benefiting from Community funds and programmes such as Marco Polo II should be linked with the development of hinterland transport.

Development of short sea shipping is to be closely entwined with motorways of the sea, providing for the operation of appropriately equipped port terminals guaranteeing efficient vessel handling. Motorways of the sea are considered to be a substitute for land motorways and are developed to avoid congestions on land. Three key motorways are considered, i.e. the Baltic Sea motorway, Western Europe and South East Europe motorways.

The short sea shipping concept is propagated and supported by European Union funds as an important link of the European transport system, becoming one of the key tasks included in the development strategy of the Baltic Sea Region.

17.5. Bibliography

Chapter 18
TRENDS IN DEVELOPMENT OF SEAPORTS
(Stanisław Szwankowski)

18.1. Introduction

Globalisation of the world economy, integration processes in international trade and transport, constant large-scale development of containerisation and multimodal transport together with logistics cause changes in the functioning of seaports all over the world. At the same time they enhance the role and importance of seaports within the developing, global transport system. A significant element of these changes is the increase in competition between ports, particularly in such regions of the globe as Europe, highly developed economically and subjected to complex integration processes. Increased competition forces seaports, first of all, to improve the quality of their services and enhance efficiency, but also to apply certain standards of business operations, management and environmental renewal.

18.2. Seaports in international seaborne trade

The development of international maritime transport in the context of the world trade, which grows faster than the world economy, depends on effective use of the capacity of seaports. Since the mid 1980s, the turnover of the world cargo maritime transport has been growing moderately yet constantly (2-4% a year). The main cause of the growth is an increase in the transport of oil and petroleum products and container cargoes. In the period between 1990-2006, container handling in world seaports increased annually by 10.33% on average. In
In international freight there is a concentration of sea transport connections handled by the biggest vessels, calling at a smaller and smaller number of the largest seaports. A tendency to diversify the role and significance of particular seaports is more and more evident. In 2006, almost 30% of the total volume of sea freight was handled by the world's 20 biggest seaports.

Most of the turnover forecasts in seaborne trade, usually medium-term, do not go beyond 2010, and only some of them reach as far as 2020, as it is difficult to predict the real volume of maritime trade and its growth tendencies in future, because these factors are subject to cyclical changes in the world economy and structural adaptation processes occurring in individual countries. According to forecasts, the volume of cargo handled in world seaports by 2010 will grow by 6-8% as compared with 2006, with container turnover growing by more than 10%.

In the nearest future, the development of international maritime trade, and consequently the development of seaports, will result from closer regional integration of the developed countries in Europe, North America and Southeast Asia, and a significant growth in trade within regions, e.g. the Baltic Sea Region. According to forecasts for the period up till 2015, the turnover of the Baltic ports will increase from 540 million tonnes in 2005 to 635 million tonnes in 2010 and 735 million tonnes in 2015.

The share of containers in seaport throughput will remain an essential yardstick of their advancement and strong competitive position. The competitive contest between seaports, e.g. in Western and Central Europe, will keep focusing on the acquisition of well-paid container handling services.

18.3. Impact of structural changes in transport on the development of seaports

Tendencies in the world maritime trade are not limited to the growth of turnover volumes, or changes in their operational structures. An additional, now often essential, element of the complexity of the world maritime trade affecting the development of seaports is the constantly growing significance of the stan-

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standard of cargo delivery and passenger handling services. This requires seaports – links of land-to-sea supply chains – to adapt to transport clients’ higher and diversified quality demands.

Commodities transferred through seaports in international trade and passenger traffic in particular, are subject to growing competition from alternative transport routes which omit – partly or entirely – seaports. This situation, diminishing port throughput, more and more often occurs in European international trade and passenger traffic. Multi-modal land transport systems, transcontinental land bridges and cheap air transport are strong competition to transport via seaports.

Apart from the development of international seaborne trade, structural changes in transport are an essential factor influencing the development of seaports. These changes result from the adaptation of transport to the requirements of modern trade, but they are also a consequence of economic, social and political transformations in the development of countries, regions and continents.

For some time now, a particularly important element of structural transformations in transport (affecting seaports as well) has been the necessity to reduce the environmental impact of transport and to develop an environment-friendly modal split, thus limiting the negative impact on the quality of life. This is an important trend, because it may bring more tasks and further development to environment-friendly maritime transport, seaports included.

Europe, particularly Western and Central Europe, is still the main area of structural changes in transport in the world. For years, the major goals of these changes have been focusing on the problems which reflect the provisions included in the latest two documents on the EU transport policy in the first decade of the 21st century. In spite of the fact that they mainly refer to the EU countries, the documents are highly universal. One of them – the White Paper of 2001\(^3\) - outlines the directions of the EU transport policy up till 2010, the other one – the Green Paper of June 2006\(^4\) issued by the European Commission – refers to the EU future maritime policy.

Both documents treat maritime transport and seaports in a specific way. The White Paper, stressing the significance and relevance of the current goal of the EU transport policy, i.e. sustainable development, regards transport as comprehensive integration of all the kinds of transport, interrelated and mutually complementary. For the first time, the EU so clearly perceives maritime transport as an integral part of the transport chain, outlining a detailed policy of closely connecting shipping and seaports with the other transport modes.


Among the trends of the EU transport policy, activities aiming at sustainable development of particular modes of transport in Europe have gained a distinct priority. It is expected that cargo transport in Europe by 2010 will increase by ca. 40%, which will cause increased congestion in main European transport corridors. This problem should be relieved by redirecting part of the cargoes to railway, maritime transport and inland waterways, which will raise the share of these modes in cargo transport in Europe.

The main guidelines of the EU transport policy, relevant to seaports, are:

– promoting the development of short-sea shipping as a measure to remove bottlenecks in road transport and the degradation of natural environment they cause;

– providing maximum transparency of pricing and procedures in ports, in order to encourage cargo operators to make a better use of maritime transport;

– significant liberalisation of access to the market of port services;

– stimulating the activities of port authorities towards maintaining their public character, which would enable equal treatment of port operators and create conditions for competitiveness and better quality services;

– unifying the rules and the extent of public aid for seaports.

Generally speaking, policy for seaports aims at making them more competitive by their higher effectiveness and financial independence caused by resignation of government subsidies. The European Commission says that the only way to achieve this goal is to let ports become players in the free market game, without the State’s protectionism.\(^5\)

The European Commission’s Green Paper of June 2006 on the EU maritime policy confirms the EU preferences consisting in supporting the development of sea transport and seaports. Following the ESPO, the Green Paper states that the EU cannot function without its over 1,000 seaports through which 3.5 million tonnes of goods and 350 million passengers are transferred annually, which provides the total added value of ca. €20 billion. The EU seaports and port-related services give 350,000 jobs. The EU policy is to promote the road-to-water shift, therefore it also promotes the development of seaports, which operate within maritime transport, the most energy-efficient mode of transport. This is one of the reasons why the EU in its integrated transport system promotes the development of short-sea shipping, motorways of the sea (MOS), multimodalism and trans-European transport networks with the EU seaports as hubs. The Green Paper stresses that the EU is deeply interested in making sea shipping and seaports more competitive, as the EU economy is based on exports, trade volume increase and Europe’s geographical conditions. In order to achieve this competitiveness, it is necessary to guarantee seaports equal chances in international markets. This is particularly important because of the fact that competition be-


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between seaports and other branches of maritime economy occurs mainly on the global market.

It may be assumed that the provisions included in the Green Paper, as well as in the 2001 White Paper, will be used in the process of the development of seaports in order to make them more competitive and effective, all the more so as the environment in which they operate is increasingly open and aggressive. Progressive changes in the port sector structure and the growing competition between ports of a given region will constitute a great challenge for port authorities, terminal operators and other port service providers, because the problem is not just the volume of the port throughput, but – first of all – the quality, range and profitability of the services rendered.

Moreover, the development of seaports is determined by changes in sea shipping. The changes are focused in two areas:

- progressive growth in size and specialization of vessels;
- combining deep-sea transport and feeder transport (i.e. transhipment functions) in large seaports.

The growth of average ship size refers mainly to container tonnage. The increase in container turnover in international maritime trade and a tendency for further concentration of deep-sea container transport result in a greater share of big container ships. In 2006, ships bigger than 4,000 TEU constituted more than 47% of the world container fleet (as compared to 24% in 2000), with a share of ships of over 7,000 TEU growing the fastest (from 7.7% in 2003 to 18.4% in 2006). Judging from orders for ships placed in the world shipyards, this trend is going to continue in the nearest years: in the period up till 2010, vessels of the capacity over 4,000 TEU, and 7,500-10,000 TEU in particular, constitute the largest group. However, there will be a significant drop in the share of small container ships with a capacity of up to 1,000 TEU. This will cause further concentration of container traffic in the biggest ports and a necessity for the adaptation of many ports to handling bigger tonnage.

As far as other tonnage groups are concerned, i.e. tankers and bulk carriers, natural conditions and port infrastructure (accessibility) limitations hindered the growth of vessel size. However, even in these groups the share of big and biggest ships will be growing, e.g. during the necessary old fleet replacement. For example, the bulk carrier fleet is showing a greater share of vessels of 100,000-150,000 DWT and more, while in the tanker group – vessels of over 150,000 DWT. A dynamic growth can be also noticed in the fleet of vessels carrying liquefied gases, mainly LNG and LPG.

The Baltic Sea shallow entrance is an obstacle to the growth of ship sizes. This is important as far as the handling of the growing imports of Russian oil (120,000,000 tonnes in 2005, and ca. 200,000,000 tonnes in 2010) is concerned. The draught limit is about 15 m, which corresponds to 120,000 DWT. In order to

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enlarge loading capacity at minimum draught, special broad-beamed Baltmax tankers were designed (200,000 DWT, 15.4 m draught).

Traffic in the Baltic Sea is extremely intensive, therefore larger vessels with larger volumes of freight may contribute to a reduction in the number of voyages. Only one such tanker, plying between the Gulf of Finland and the European continent, can carry up to 7,000,000 tonnes of cargo annually.

The progressive growth of the share of large tonnage in all the main types of cargo vessels will result in the concentration of cargo carriage on main routes (i.e. ocean ones) with more extensive cooperation between deep-sea service and feeder service. For ocean ports, this would mean stronger competition for handling the biggest ships, while for ports rendering feeder services – it will be a chance to adapt to a rise in their cargo throughput.

18.4. A trend towards diversification of the role and significance of seaports

Seaports all over the world will soon have to operate in the environment of progressive globalisation, particularly in the areas of markets and strategies, technology, research and knowledge. This will mean stronger global competition and concentration of transport markets, technological progress, further economic liberalisation, and time and space compensation. The main determinant of transport globalisation processes, however, will be integration – in the wide sense of the word – within the sector.

All this will have a great impact on the development of seaports, leading, on the one hand, to diversification of their role and significance in the economies of the world, regions and countries, while on the other – to further diversification of their business operations, because it is impossible to oppose further diversification of the role and significance of seaports in the face of challenges brought about by globalisation and concentration of global supply chains. This will be in line with the economies of scale law, consisting in the concentration of transport services, port services included, in selected links of international supply chains. A tendency to concentrate transport services, as well as industrial, commercial and distribution services, in seaports results from the fact that international supply chains within which ports operate are highly capital-intensive; this tendency is also an effect of the competition between ports, where some of them want to gain advantage over others.

In Europe, relatively few efficient ports linked with European transport network (TEN-T) will be in the most advantageous situation. Other European ports may find their chance in counteracting the tendency of excessive concentration
of turnover with its congestion problems, pressure on natural environment and
the development of port hinterland infrastructure.

Therefore, seaports in the world are still clearly divided into three groups:
big, transhipment/distribution bases for the handling of oil, dry bulk cargo and
containers, located on main deep-sea routes (e.g. Rotterdam, Hamburg, Ant-
erwerp in Europe, Hong Kong and Singapore in Asia, Los Angeles and Houston in
North America); regional and feeder ports, located off the main routes (e.g. in
the Baltic, the Black Sea and the Mediterranean); and ship-to-ship transhipment
ports, handling mainly ocean container freight and functioning as intermediate
ports between big transhipment/distribution ports and smaller regional and
feeder ones (e.g. Felixstowe, Gioia Tauro, Bremen/Bremerhaven, Algeciras), the
latter becoming less and less numerous.

The main criteria qualifying ports for one of the three groups are:
– central, advantageous location within easy reach of main shipping routes
  and feeder ports;
– accessibility for the biggest ships in operation, with no limitations (tides,
  weather, ice), without delays caused by organisational inefficiency;
– business hinterland, with substantial transport requirement;
– efficient hinterland connections, both land and sea.

An analysis of these four criteria shows that seaports can have a limited in-
fluence on the change of their role and significance in the system of global or
continental (e.g. European) transport network.

Central, advantageous location is not enough for the port to be significant.
Two other criteria must be met as well: a broad business hinterland and good,
well-developed transport connections with this hinterland. This is why the big-
gest European seaports in the North Sea, for example, pay much attention to
their relations with their business hinterland, both by land and by sea. They are
connected with their hinterland through feeder links, thus developing their
functions as transhipment ports. While a dozen or so years ago the structure of
transport links between seaports and the hinterland consisted solely of land
modes (rail, road, pipeline) and inland shipping, now the significance of feeder
sea transport in this structure is growing systematically.

The functions of transhipment ports formed a distribution port – feeder port
system, developing quickly all over the world, particularly in big deep-sea con-
tainer ports in Northern Europe, Southeast Asia and the Mediterranean region.
This situation results from the fact that big ports, handling ocean container serv-
ices, “assemble” turnover from numerous smaller feeder ports, functioning also
as transhipment ports. For example, the biggest North Sea ports are constantly
activating their networks of feeder links with other European ports, the Baltic
ports included. The latter in turn, like Polish ports for example, attempt to
launch feeder services further on – to the eastern region of the Baltic Sea. In the
nearest future this tendency, with strong competition between ports, will keep
developing, guaranteeing transhipment ports an increase in turnover.

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18.5. Port business diversification

In the late 1990s, a seaport was commonly defined as a “logistic and industrial node in the global transport system with a strong maritime character and in which a functional and spatial clustering of activities takes place, activities that are directly or indirectly linked to seamless transport and transformation processes within logistic chains”, part of which are land-sea transport chains.

The development of seaports in recent years, especially of European ports with their business diversification under the influence of the logistics concept, causes the notion of the seaport to be extended by new elements. The essence of a seaport’s activities is well defined by the Green Paper of June 2006, according to which seaports are multifunctional coastal settlements, integrating activities performed on land and sea. This definition regards seaports as an essential element in the global logistic chain, a place for business activities and a potential place for housing and tourist facilities.

Therefore, a basic feature of the development of seaports in the nearest future will be growing diversification of their activities. Functioning in the global market and subject to competition and concentration processes, seaports must seek their chances in expanding their activities in such areas of services as transport, industry and environment, trade, distribution and logistics, tourism as well as in the development of port-city interface by revival of old port structures, adapting them to public and residential functions.

Stronger competition between ports, more intensive integration processes in transport, and – above all – the growing importance of the logistics concept in the world trade and transport constantly cause a change in ports’ business activities. They strengthen the port’s traditional functions, i.e. transport, trade and industry, and have impact on the development of other functions. Usually, there is a feedback between these two trends. The growth of transhipment services and bigger traffic, mainly container traffic, is a factor stimulating ports’ other business functions. Container ports are places where new industrial, commercial, distributional and logistic services develop best.

It is a well-known fact that a port cannot survive on the market carrying out solely traditional forms of activities, i.e. transhipping and storage (except some highly specialized ports). That is why ports, or more precisely port operators, are very much engaged in global logistics. They even take over management and control over the entire logistic chains.

Port operators seek various possibilities to improve the productivity of their capacity, even rendering services not related directly to port and sea traffic. The private sector in the port works according to the rule that it engages – usually

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for a limited time – in services for which there is a demand, obviously provided
that they are profitable for the port.

It is expected that seaports, together with cruise industry, aquaculture, re-
newable energy, submarine telecommunications and marine biotechnology, will
become sectors with the greatest growth potential in the future.

Maritime transport and ports are particularly important elements of logistic
chains, integrating national economies with the world economy. Their effective-
ness and efficiency is of primary importance for competitiveness in the globalis-
ing world. Therefore, the commercial nature of activities remains the main fea-
ture of seaports, as commercialisation trend makes it possible for seaports to ex-
tend their scope of services. As for now, many seaports, Polish ones included, do
not conduct fully commercialised activities yet.

A contemporary seaport is still a transport node in the global transport sys-
tem, but primarily it is a link of the global logistic chain. After a period of grow-
ing importance of ports as centres of creating added value, which was caused by
the rapid growth of containerisation, they were given a new scope of activities
by logistics. In recent years, ports have more and more often been developing as
logistics centres, and many of them offer logistic services directly within port ar-
eas or in distribution/logistics centres situated in adjacent areas.

A basic challenge set by logistics is to shorten and speed up all the processes
of the flow of cargo, services and information at every stage of the supply chain.
A need to rationalise trade and development of ports as land/sea logistic centres
also results from higher demand of transport users for a larger scope of port lo-
gistics services, and the large share of transport and storage costs in global logis-
tic costs.

Integrated logistic services are what is most expected, apart from tranship-
ment, from seaports in logistic supply chains. Many big forwarders in Europe,
the USA and Southeast Asia recognise the advantages of a larger logistic offer. It
can be stated that as for goods delivered within land/sea or inland chains (com-
parable in terms of price and quality of delivery), the degree of logistic handling
in seaports is the main determinant of the competitiveness of the whole trans-
port chain, seaports included.

All big seaports have distribution/logistics centres. They function as huge,
independent functional and spatial structures or companies dispersed all over
port areas, rendering various logistic services. In other ports, e.g. in Polish ones,
such centres are being established quickly. Their task will be to organise and op-
timise the distribution of export goods according to customers’ requirements, to
store export/import and transit goods, to process certain goods, and to coordi-
nate the information chain for all the participants of land/sea supply chains.

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18.6. Relations with port cities, revival of old harbour structures

Because of growing competition for space in and around seaports, and for equally important environmental reasons, the issues of effective port utilisation should be taken into consideration both in the whole process of spatial planning and in general public policies.

At present, the main problems of spatial development of seaports are related to diversification of their business operations and construction of multimodal terminals (mainly container ones) and distribution/logistic centres. In ports located in regions of active ferry and passenger ship transport (e.g. in the Baltic and the Mediterranean, and the coasts of Australia) there is also demand, although to a smaller extent, for the development of passenger and ferry terminals.

There are two trends in port spatial development: the development of their reserve areas, and more intensive utilisation of space within their existing boundaries. The fact that development expands spatially to new sites does not hinder the intensification of port transformations and concentration of investment activities within their existing boundaries. Many ports have limited possibilities of spatial development; some do not have space reserves, others encounter environmental constraints.

The biggest seaports are located next to port cities, many of which are old, with well-developed infrastructure and densely built-up coastal zone. High land prices and rents require rational management of port space, in its various forms and solutions.\(^9\)

In the process of functional/spatial development of seaports all over the world, intensive use of space is accompanied by an attempt to improve spatial order and the quality of the environment. A common philosophy of spatial development of many ports can be noticed; it consists in making use of reserves located within port limits and, in consequence, more intensive use of space and its better organisation through modernisation, restructuring and revival of certain spatial units, and minimizing the environmental effects of the development of the port and related industries.

A separate, very important trend in spatial transformations in ports, Polish ports included, is the revival of old spatial structures together with diversification of their functions. This process consists in re-activation of the port areas that were freed from typical port functions at the stage of rapid industrialisation of ports and development of maritime transport technologies, based on the use

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of big vessels. Land sites purchased in this way are usually located in city centres and have access to shallow port waters. Frequently, they are old city wharves with high-density but depreciated housing. The reason why old port grounds are penetrated intensively is their attractive location, manifested both in measurable functional values and unmeasurable yet highly-prized cultural values\(^{10}\).

There are two fundamental directions of transformation in developing, reforming and modernising old port areas: one is the utilisation of these areas and their restructuring for port functions (distribution/logistics and tourism), while the other is the use of these structures for urban functions (shopping centres, hotels, even residential districts, tourist and sports facilities). Both trends shape port-city interrelations, and occur side by side in many ports. The main problem exposed in these processes is the necessity to maintain a balance between the interests of the port and the city, and between social and commercial goals.

18.7. Bibliography


\(^{10}\) Współczesne metamorfozy miast portowych. [ed.:] M. Kochanowski, Politechnika Gdańska, Gdańsk 1998.
19.1. Introduction

Sustainable development means that the needs of the present generation should be met without prejudice to the possibility of meeting the needs by future generations. This idea, included in the Treaty of Amsterdam, is the supreme objective of the European Union, its entire policy and all its activities, as it refers to preservation of the capacity of the Earth to maintain life in all its diversity, and is based on the principles of: democracy, equality of genders, solidarity, lawfulness and respecting the fundamental rights, including the right to freedom and equal opportunities. It is to ensure the present and future generations constant growth of quality of living and well-being on the Earth.\(^1\)

Transport is the key factor of modern economy. There is, however, a permanent contradiction between the society, which needs to be more and more mobile, and public opinion, which is becoming less and less tolerant of the negative effects of excessively fast-growing transport and the consequences of the process: road traffic congestion, deterioration in acoustic climate, lower quality of the environment in which we live or poor quality of some transport services. Since the demand for transport keeps growing, the response of the Community cannot consist just in building new infrastructure and opening new markets. To meet the requirements resulting from EU enlargement and sustainable development, the transport system requires optimization. Modern transport system must be sustainable from the point of view of socio-economic aspects, as well as from the point of view of environmental protection. The White Paper on environ-

mental liability precisely details the position of the European Union on applying the principle “the polluter pays” and charging the ones causing external effects with the costs. Already in 5th Environmental Action Programme Towards sustainability: European Community Programme of policy and action in relation to the environment and sustainable development, transport was considered to be one of the most burdensome sectors of the economy, like energy, agriculture, industry or tourism.

19.2. Principles of sustainable development of transport in EU strategic documents

Transport is the basic factor of development of European integration and a condition for achieving its effects. Such an approach was reflected in the Treaty of Rome, establishing European Economic Community in 1957, where the so-called common community policy was adopted for transport as well as for agriculture.

In recent years, the economic and social policy-makers have considered sustainable development, that is the direction of creating a socio-economic system based on harmonious co-existence of man and the natural environment, to be the main objective of economic development. It requires setting out such ways of development that will enable a reduction of its growing environmental and social costs. A critical attitude to transport and its environmental impact surfaced as early as the late 1960s, initially with the objective of enhancing transport safety. The problem becomes even more alarming in the light of the fact that the most bothersome branch of transport – road transport – has been showing a growing trend during the whole period, both in terms of volume of cargo and transport work, as well as its share in the structure of freight and passengers carried.

Fig. 56 presents chronologically the key documents on transport and its sustainable development. Numerous legislative initiatives to reduce negative environmental impact of transport have emerged since 1992. Two important documents were published that year:


The Green Paper presented a versatile assessment of environmental impact of transport and suggested a strategy to counteract those negative effects. The aim of that document was to initiate public debate. And the White Paper considered aiming at reaching the state of sustainable mobility to be the most important task of the Community transport policy. It was to guarantee optimum functionality of the common transport market by performing economic and social tasks of transport and providing users with opportunities to make free choices of transport mode while respecting safety and environmental protection requirements.

The White Paper on Fair Payment for Infrastructure Use: A phased approach to a common transport infrastructure charging framework in the EU was published in 1998. The document was preceded by the so called Green Paper of 1995, Towards Fair and Efficient Pricing in Transport. Policy options for internalising the external costs of transport in the European Union. The last two Papers reflect the interest of the EU in external costs of transport and their internalization as a way to reach the state of sustainable development. The Green Paper emphasises the significance of using pricing as a tool to reduce external costs.

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The White Paper on European Transport Policy for 2010: time to decide, published on 11th September 2001, is the most important strategic document, which in the current decade sets the development directions of the transport sector. While identifying the policy objectives, the authors of the White Paper took into consideration both the conclusions of the Lisbon Strategy as well as the decisions of the Göteborg Summit. Enhancing its competitiveness in the world is the main objective of future development of European economy. The White Paper assumes promoting sustainable directions of transport sector development. As an essential element of modern economies, transport must face the contradictions between the society requiring greater and greater mobility and public opinion, which is less and less tolerant of delays, the deteriorating condition of the environment and the average quality of some services. According to the conclusions of the European Council in Göteborg, to meet the requirements of EU enlargement and sustainable development, transport system requires optimization. Modern transport system must be sustainable from economic, social and environmental point of view. That is why the policy must take into consideration actions aiming at reducing external costs of transport and dealing with the growing congestion in the transportation network. On the other hand, transport must face the growing mobility of the society in the enlarged EU. The policy document was accompanied by an Action Plan, a package of 78 instruments, grouped into 12 action areas, to enable attainment of the assumed objectives.

Keep Europe Moving - Sustainable mobility for our continent. Mid-term review of the European Commission’s 2001 Transport White Paper. Communication from the Commission to the Council and the European Parliament was published in 2006. The Communication contains an assessment of the achievements in implementing the assumptions of transport policy. It says, inter alia, that European transport policy must face the following new challenges:

- demand for transport is growing faster than expected, and its growth is bigger than that of GDP;
- today, the competitiveness of European economy requires, more than ever before, an effective and well functioning sustainable transport system, in which transport will be perceived as part of European growth and competitiveness;
- new challenges have emerged in connection with the latest enlargement;
- innovative and technological capacities have increased considerably;

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10 At its meeting in Göteborg (in 2001), the European Council adopted the first EU strategy on sustainable development (SDS). To complement those actions, the European Council defined the external dimension of the strategy in Barcelona - in 2002 - before the World Summit on Sustainable Development in Johannesburg.
new tasks have appeared in connection with globalization.

With the view that the objectives of European transport policy should be formulated more clearly, unambiguously and pragmatically, the document emphasises the significance of strengthened cooperation at European, national, regional and local levels, which should include effective implementation of common regulations and more effective ways of their enforcement. The document also points out to the necessity of pragmatic and cooperative linking of transport with other branches of economy, such as energy, natural environment and innovations. The consultations held as part of the work on assessment of the achievements of transport policy stressed the necessity of looking for new, alternative and innovative ways of financing transport investments, collecting fair charges and additional funds for transport and related areas. Attention was also drawn to the fact that geographic enlargement of the Union caused a considerable increase of diversity and that is why drafting new legislation should be preceded by detailed analyses showing a potential impact on each of the countries. Table 39 presents these areas of transport policy in which it is necessary to change the approach and shows the challenges that transport faces today.

Table 39. Conclusions from a progress review of the 2001 transport policy

<table>
<thead>
<tr>
<th>Transport policy area</th>
<th>Main challenges</th>
<th>Characteristics of the problem</th>
</tr>
</thead>
</table>
| **EU enlargement in 2004 and 2007.** | **Transport policy acquires all European dimension** | – Growing pressure on natural environment, in densely populated and industrialized area in particular;  
– Pollution, land use, congestion and road accidents are the main problems;  
– Availability of transport is the key issue for many member states.  
– It is becoming more and more necessary to differentiate approaches at various levels of authority: local, regional and national while providing for all European domestic transport market. |
| **Transport industry changed** | **Consolidation at European level takes place in air and maritime transport in particular** | – Domestic market contributed to creating competitive road transport, with growing share of railway transport.  
– The effects of globalization leading to establishment of big worldwide logistics companies can be observed in recent years.  
– More emphasis should be put on strengthening international competitiveness of multimodal transport and offering integrated solutions including various means of transport,  
– Focusing on solving the problem of “bottle necks” and weak elements in logistics chains.  
– At the same time, domestic market must still provide for living space for new companies and SME. |
<table>
<thead>
<tr>
<th>Innovations in transport</th>
<th>Transport is quickly becoming a branch of high technologies, which makes innovation research of fundamental significance to its further development.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thanks to increased research budget under 7th Framework Programme for Research and Technological Development (2007-2013), technical innovations in transport directly contribute to attainment of EU objectives in the area of competitiveness, environmental and social issues.</td>
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<td>- The work will focus on the following areas:</td>
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<td>- Improvement of quality of surface and air transport in terms of environmental protection,</td>
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<td></td>
<td>- Modernization of traffic management,</td>
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<tr>
<td></td>
<td>- Liquidation of congestion in European transport corridors,</td>
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<td></td>
<td>- Urban mobility,</td>
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<td></td>
<td>- Intermodality and interoperability,</td>
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<td></td>
<td>- Transport safety and protection</td>
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<td></td>
<td>- Intelligent transport system</td>
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<tr>
<td>Integration of transport and environmental policies</td>
<td>Necessity to take into consideration international environmental protection commitments in transport policy</td>
</tr>
<tr>
<td></td>
<td>- CO₂ emissions and duties resulting from the Kyoto Protocol constitute the biggest challenge.</td>
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<td></td>
<td>- Air quality, transport related noise and land use require constant attention and efficient monitoring system.</td>
</tr>
<tr>
<td>Integration of objectives of transport and energy policies</td>
<td>Transport policy must contribute to attainment of objectives of European energy policy</td>
</tr>
<tr>
<td></td>
<td>Transport is responsible for 30% of total energy consumption in EU. With the dependence on oil of up to 98%, high oil prices affect transport sector and force improvement of energy efficiency, introduction of solutions contributing to diversification of supplies and political measures affecting demand, and all those efforts must by supported by new, innovative technologies.</td>
</tr>
<tr>
<td>International context of policy changed</td>
<td>Enhanced safety and adapting to the requirements of global economy</td>
</tr>
<tr>
<td></td>
<td>- Constant threat of terrorism affected transport more than any other sector.</td>
</tr>
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<td></td>
<td>- Economic globalization affected trade and increased demand for international transport services to and from countries of developing economies.</td>
</tr>
<tr>
<td>The way the European Union is managed changes</td>
<td>Basic Domestic market legislation is, to a considerable extent, in place</td>
</tr>
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<td></td>
<td>- Effective implementation of legislation</td>
</tr>
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<td></td>
<td>- Proposing exchange of the best solutions;</td>
</tr>
<tr>
<td></td>
<td>- Regulations must match innovation.</td>
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<td></td>
<td>- European agencies in four areas of transport policy, constituting the second level of European administration responsible for making specialized technical contribution, were established.</td>
</tr>
</tbody>
</table>


Also in 2006, the European Parliament and the Council obliged the Commission to develop a universal, clear and comprehensive model of assessing external costs of transport, such as pollution and congestion, to constitute a base for calculating charges for the use of infrastructure. The work of the Commission in
this area resulted in the Greening Transport Package, published in July 2008\textsuperscript{12}, which stresses the need of employing a wide range of tools, from economic instruments regulations to investments in infrastructure and new technologies, to attain the objective of sustainable mobility. “Making prices realistic” is of utmost significance in this respect. Economic instruments, smart prices in particular, can be an incentive for transport users to optimize mobility behaviours or to choose more environment-friendly forms of transport, to use less crowded elements of infrastructure or to travel at different times of the day\textsuperscript{13}.

The new strategy is, first of all, to make the fares reflect, to a greater extent, the real cost for the society, and make the damages to natural environment and traffic “bottle necks” gradually decrease, and efficiency of transport and the entire economy rise at the same time.

19.3. Consequences of unsustainable development of transport based on assessment of TERM indicators

European Environment Agency (EEA) has been monitoring transport sector for sustainable development since 2000. It makes use of a package of 40 selected indicators. The package is constantly detailed and expanded\textsuperscript{14}. In its report of 2006, Transport and Environment: on the way to a new common transport policy, EEA presents 27 indicators, based on which it assesses the progress towards sustainable development of the transport sector\textsuperscript{15}. Unfortunately, the conclusions are not optimistic. It was impossible to calculate six out of the 27 indicators due to lack of data for EU members states, six other ones showed neutrality, 15 indicators have deteriorated. None of the measures indicated positive trends. It means that the situation concerning implementation of sustainable development policy in transport is threatened.

The most important challenges to transport development indicated in the report include still the problem of separating economic growth rate from demand for transport. For a few years now decoupling has been the key objective


\textsuperscript{14} Indicators information is available at EEA website http://www.eea.eu.int.

of EU transport policy. But it has not been attained yet. The demand for transport in the European Union has systematically been growing at the same rate as the economy, or faster. The growth rate was almost 20% in the case of passenger transport and ca 30% for cargo transport.

The demand for cargo transport has been growing considerably since 1992, which results in greater environmental impact of transport. However, if we take a closer look at the data concerning transport and GDP in individual EU member states, it turns out that EU-15 indicated a much higher growth rate in terms of demand for transport than 12 New Member States (NMS). The explanation of such a situation is that in “the old” EU countries introduction of common market caused certain changes in location and organization of production, which resulted in growing demand for transport, the growth rate being bigger than that of economic growth. And in the majority of “new” EU countries the processes of economic restructuring and transformation, changes in structure of production from heavy industry towards branches producing high value products resulted in a situation in which the relations of growth rate in transport and that of economic growth were not as strong as in EU-15. Unfortunately, economists say that this is a temporary trend and that it is likely that the new member states will in the future follow the “old” member states in this respect. Figure 56 presents mutual relations between transport and the GDP in EU-25.

If we analyze the data presented in Fig. 57 we notice that the demand for cargo transport exceeded economic growth in the last decade. It means that the

![Fig. 57. Comparison of growth rate of demand for transport and GDP in EU-25](image)

activities aimed at separating demand for transport from economic growth are grossly ineffective. It is thus necessary to intensify efforts in this respect.

Stabilization till 2010 of the modal split in transport at 1998 level is another key objective of sustainable development in transport policy of the European Union. The data (see Fig. 58) show a constant tendency for road transport to take over the cargo previously carried by other modes of transport. Road transport has dominated the market of cargo movement. It is almost 46% in UE-25 market. Development of transport in the 1990s was dominated by road and air transport, whereas the other forms of transport, such as railway, inland water transport or maritime transport, experienced stagnation or even a decline.

The differences in transport intensity of individual member states should also be noted. The differences in the structure of economy and production, as well as the differences of consumption models lead to differences in the volume of cargo transport per GDP unit. The indicator of GDP transport intensity in individual countries varies considerably. Two new EU member states, Bulgaria and Romania have the highest transport intensity indicator. In 2004, the ratio for these countries was estimated at the level of 1 250 tkm/1000 Euro of GDP in 1995 prices. The ratio is only slightly lower in 10 member states that joined the Community in 2004. It is important that it is almost four times higher in UE-15, where it is 225 tkm/1 000 euro of GDP.

Fig. 58. Modal split of cargo in EU-25
Unfavourable tendencies are also observed in the development and modernization of transport infrastructure. In the last decade, the network of motorways in the old member states increased by over 12,000 km, and in the new ones by ca 1,000 km. The investment in EU Trans-European Transport Network concentrated mainly on enhancing international connections between networks of high speed trains, as well as those between road networks, but the road programme developed much faster than the railway one, as a result of which the total length of motorways grew quickly, whereas the extent of conventional railway infrastructure and inland water transport slowly but gradually decreased. Such a state of affairs does not favour activities designed to change the modal split of EU transport towards more environmentally friendly modes: the rail and the inland waterway.

The TERM report also emphasises the problem of transport pricing patterns. Generally, they do not support the objectives of EU transport policy. What has been noticed, however, is a slight progress in the restructuring of transport charges, aimed at proper inclusion of external costs, which can contribute to a reduction in the overall demand for transport and transport infrastructure, as well as optimize the modal split. For example, price structures favour private cars, but not public transport. The total cost of car use, including both the purchase and the running costs, has remained at the same level, whereas the costs of other modes of transport have increased. This means reduced mobility of the persons that cannot use a car.

The EEA indicates that European transport policy should focus on the uncontrolled growth of demand for transport and the resulting environmental consequences. Transport is responsible for 24% of GHGs in EU countries (excluding international aviation and maritime transport). The share of road transport in transport emissions is 93%. However, it is the emissions from international aviation that grew the fastest in the period of 1990–2006 – by almost 90%. According to the TERM report published for the period of 1990-2006, GHGs increased by 26%, that is 180 million tons (excluding international aviation and maritime transport), which exceeds national annual emissions in 2006 for Belgium – 132 million tons or Romania – 157 million tons. During the same period, the total volume of cargo transport measured in tkm for the member states increased by 35%, that is 650 million tkm. Railway transport and inland water transport showed a decline in market share. The average increase in 32 EEA countries was 25%. It is also worth emphasising that environmental activities during the period of 1990–2006 resulted in a decrease or stabilization of emissions in most sectors of the economy (energy, industry, agriculture, waste management), whereas they significantly grew in transport.

It is also worth noting that energy consumption in EU member states keeps growing. In 2004 the increase was 1.1% over the previous year, and in the period of 1990 - 2006 the average increase in EU was 12.6%. Transport was considered to be the sector in which the increase was the highest (28.6%). Transport is also the biggest consumer of final energy in economy. It is also stressed that despite the achievements in reducing energy consumption of means of transport, demand growth offset the achieved effects. Table 40 presents energy consumption in EU-27 during the period of 1990-2006.

Table 40. Final energy consumption in EU member states in 1990-2006 period (MTOE)

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<td>1 014.4</td>
<td>1 026.8</td>
<td>1 086.8</td>
<td>1 100.5</td>
<td>1 129.4</td>
<td>1 142.0</td>
<td>1 142.7</td>
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<td>38.0</td>
<td>37.9</td>
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<td>14.7</td>
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</tr>
<tr>
<td>Sweden</td>
<td>30.5</td>
<td>33.7</td>
<td>34.6</td>
<td>33.7</td>
<td>34.1</td>
<td>34.0</td>
<td>33.2</td>
</tr>
<tr>
<td>Great Britain</td>
<td>137.4</td>
<td>142.4</td>
<td>151.2</td>
<td>148.5</td>
<td>150.6</td>
<td>153.0</td>
<td>150.4</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>16.1</td>
<td>11.4</td>
<td>8.6</td>
<td>8.7</td>
<td>9.4</td>
<td>9.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Romania</td>
<td>36.1</td>
<td>26.3</td>
<td>22.2</td>
<td>23.0</td>
<td>24.2</td>
<td>26.1</td>
<td>24.7</td>
</tr>
</tbody>
</table>

Source: Data of European Environment Agency http://dataservice.eea.europa.eu/atlas/viewdata
The biggest growth in energy consumption is observed in the following countries: Portugal – 66%, Spain – 72%, Ireland – 79% or Slovenia – 47%. On the other hand, other transition economies show a decline in energy consumption. These countries include the Baltic States, with an average decrease in energy consumption of 50%. Also Hungary decreased its final energy consumption by 6% respectively, while Poland noted 2% increase.

There is growing concern about what is happening because the pollution caused by transport directly affects our health. Almost 25% of EU population live within less than 500 metres from roads with the annual traffic of over 3 million vehicles, the result being loss of almost four million years of life due to high pollution levels.

19.4. Challenges of future transport sector development

Experiences since 1992, evaluation of the degree to which the objectives of transport policy of 2001 have been attained, as well as analyses and forecasts developed indicate that the measures taken so far are not sufficient to provide for further attainment of the fundamental objectives of EU policy, in particular to control the environmental impact and other adverse effects of transportation while providing for mobility as the most significant objective of transport policy.

It seems necessary that mutually complementary activities be taken at all levels of administration, at EU, national, regional and local levels, as well as action on the part of the citizens themselves and the industry. The European policy on sustainable mobility must thus be based on a wider set of tools enabling switching to more environment friendly means of transport where desirable, in long distance transport in particular, in urban areas and in congested corridors. At the same time, each means of transport must be optimized, more environment friendly, safe and efficient in terms of energy consumption. And finally, intermodality, that is effective use of various means of transport independently and in combination with others, can lead to optimum and sustainable use of transport resources.

Based on ASSESS project report forecasts, which constitute a basis for progress report on the attainment of transport policy objectives of 2001, we can conclude that transport will continue to develop along the observed trends. Table 41 presents expected growth rates in individual transport modes.

Figure 58 presents present-day relations between transport, society and economy. On the one hand, there are the benefits of transport development to economy and society, but on the other, there are transport-related costs.
Table 41. The most likely growth scenario of transport operations in EU-25 between 2000-2020

<table>
<thead>
<tr>
<th>Category</th>
<th>Growth %</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>52%</td>
</tr>
<tr>
<td>Cargo transport total</td>
<td>50%</td>
</tr>
<tr>
<td>Passenger transport total</td>
<td>35%</td>
</tr>
<tr>
<td>Road freight</td>
<td>55%</td>
</tr>
<tr>
<td>Railway freight</td>
<td>13%</td>
</tr>
<tr>
<td>Short-see shipping</td>
<td>59%</td>
</tr>
<tr>
<td>Inland navigation</td>
<td>28%</td>
</tr>
<tr>
<td>Private car use</td>
<td>36%</td>
</tr>
<tr>
<td>Railway passenger transport</td>
<td>19%</td>
</tr>
<tr>
<td>Air transport</td>
<td>108%</td>
</tr>
</tbody>
</table>


The main challenge for the transport policy decision makers is to manage the sector in such a way as to maximize the benefits at minimum costs. There is a lot to do in the area of optimization of demand for both passenger and cargo...
transport. Further efforts to decouple the demand for transport and GDP growth are highly desirable. Activities for more sustainable modal split in transport constitute yet another challenge. The joint efforts of transport and logistics people can help solve many problems. There are also hopes in modern, more environment friendly technologies and engineering solutions, both in terms of vehicles, infrastructure facilities and support systems.

EU strategic documents, reports and forecasts analyzing transport development trends and transport-environment interactions indicate that the challenges faced by today’s transport policy can be grouped into 7 main objectives, the attainment of which is to provide for improvement of sustainable mobility:

1. Reduction of conventional pollution from transport to a level that is not an environmental hazard and does not cause the environment to deteriorate.
2. Reduction of transport related emissions of GHGs.
3. Enhanced transport safety and security.
4. Improvement of acoustic climate by reduction of transport related noise.
5. Congestion abatement.
6. Elimination of bottle necks and gaps in infrastructure in individual member states.
7. Improvement of citizen mobility and bridging the differences in accessibility of transport infrastructure in member states, infrastructure upgrading.

Table 42 presents seven of the above measures towards sustainability of future transport development. The areas that can contribute to the attainment of the objective set are also specified.

The review of the objectives and activity areas indicates that European transport system faces significant challenges in the years to come. Finding the money for necessary investments in transport infrastructure and protection against more cargo being taken over by road transport will be a big challenge for EU member states and for the Union as a whole. The forecasts to 2020 say that road cargo transport will increase by over 55% in the European Union, and in the 12 new member states it is expected to double during the same period. The growth will result in road traffic congestion, degradation of natural environment, accidents and danger of losing the competitiveness of European industry, which must consist in profitable and reliable transport systems to manage its supply chains. Moreover, road cargo transport is totally dependent on fossil fuels, which makes transport system sensitive to global changes of supply. Fossil fuels mostly contribute to CO₂ emissions. This is why transport that uses energy more efficiently is in the interest of EU, both for better results in environmental protection and more thriving transport management.

<table>
<thead>
<tr>
<th>Area of activity</th>
<th>Specific activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reduction of emissions</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Vehicle | – application of new technological solutions “clean technologies”,
– stricter vehicle emission standards, works on stricter EURO5 and EURO6 standards; |
| Fuel | – promoting and fostering the use of bio-fuels;
– developing mechanisms of fostering the use of alternative fuels,
– optimization of engine fuel consumption; |
| Modal split optimization | Promoting environment friendly modes
– promoting multimodal transport,
– fostering reorganization of railway transport;
– promoting cabotage. |
| Organization and optimization of traffic management | – Work on intelligent transport systems, such as navigation systems, systems of reduced access charges and interactive driver support systems, which can contribute to improved safety and fuel economies; |
| **Reduction of greenhouse gases emission** | |
| Increased efficiency and rational use of energy in transport | – activities to reduce demand for transport;
– fostering research on and use of alternative fuels;
– improved efficiency of energy use in all modes of transport;
– change of modal split;
– promoting integration of logistics and transport policies |
| **Improved safety and security** | |
| Vehicle | – high level of passive and active safety of vehicles and increased compatibility of vehicles in terms of safety requirements
– vehicle technical solutions reducing hazards to bicycle users and pedestrians |
| Traffic management | – improved quality of infrastructure, road infrastructure in particular;
– activities to change mobility behaviours
– new solutions in traffic management in terms of infrastructure, road lights
– improved systems of emergency response, optimization of cooperation between emergency services |
| **Improved acoustic climate** | |
| | – noise reduction as a result of modern solutions in vehicle construction
– noise reduction as a result of new solutions in engineering structures
– noise reduction owing to acoustic screens
– monitoring the condition of infrastructure |
| **Abatement of congestion** | |
| | – introduction of fair pricing in transport,
– optimization of demand for transport services;
– modernization and development of necessary infrastructure; |
In the circumstances, intermodality should be promoted to a greater extent, because it makes a better use of the existing infrastructure and the services by combining short range transport by sea, rail and inland waterway into logistics chains. It was emphasised in the interim review of the White Paper of 2001 that logistics plays an important role in providing for sustainable mobility. It also contributes to the attainment of other objectives, such as clean environment, security of energy supplies, etc. To solve the problems, it is necessary to optimize European transport by applying advanced logistic solutions. Logistics can increase efficiency of individual transport modes, as well as of intermodality. The result should be fewer transport vehicles or vessels and increased volume of goods carried. Then environmental impact will decrease, respectively.

It is also necessary to modernize railway and inland navigation. Air cargo transport should be better integrated with the system. Positive changes in short-sea shipping should be accelerated. It is necessary to develop long range maritime transport and its linkage with land transport. Further works on cargo transport should result in introducing logistics perspective to transport policy. Real complementarity of transport and advanced logistic solutions enable planning, control and implementation of supply chains within one mode of transport as well as multimodal chains, and their effective management.

Observation and cargo tracking in all modes is a prerequisite for the existence of efficient transport. The following will very positively affect development in this respect: introduction of GALILEO global satellite navigation, Long-range Identification and Tracking – LRIT system, River Information System – RIS and Automatic Identification System – AIS. In railway transport telematics applications for cargo transport (TAF) and European Railway Traffic Management System (ERTMS) should enhance traffic management.

Quality of infrastructure is of utmost significance to future development of transport. Planning of infrastructure under Trans-European Transport Network (TEN-T) and structural funds improve the wide infrastructure network that Europe needs to operate in the areas with no internal borders and to meet the challenges of globalization. Building new infrastructure is not an objective as
such. The use of the existing infrastructure can be enhanced by introducing more efficient and sustainable solutions and management. These include fleet management, railway and inland navigation infrastructure management, closer cooperation between business partners and infrastructure managers, full use of load capacity, avoiding empty runs, or combining various means of transport, observing European competition regulations.

EU programme documents, research projects and analyses do not question the significance of transport to economy. The three modes of land transport – the road, the rail and the inland waterway – are of fundamental significance to the problem of employment, welfare and global exports of Europe. Technological progress in transport will have – apart from stimulating innovation and knowledge – a positive impact on European economy and social integration. But each mode of transport poses serious challenges to natural environment, societies and scientific research – in particular in view of the inevitable growth of demand for transport.

Attaining the objectives specified in modern transport policy requires coordinated approach of all the stakeholders involved in research and transport. The new technological platforms for each type of transport make the process easier:

– ERRAC – European Rail Research Advisory Council European – has been leading and guiding European and national plans of research on rail since December 2002;
– ERTRAC – European Road Transport Research Advisory Council presented its action plan in January 2005;
– WATERBORNE technological platform was launched in October 2004.

Only integration of activities at all levels, from the Community level through national, regional and local levels, and including all the stakeholders and entities of transport market can bring about the expected effects in the form of reducing the environmental impact of transport and optimization of demand for transport services.

19.5. Bibliography

2. EEA - http://www.eea.eu.int


13. **Transport & energy in figures in 2009, EC, Brussels 2009,**


20.1. Introduction

International logistics nowadays is regarded as the epicentre of business transformation in the rapidly globalising world economy. This results from the fact that the aim of logistics in the 21st century is the integration of supply sources, production and turnover of goods between companies in all the continents, and the minimization of costs of such operations, ahead of the processes of economic globalisation. The rapid development of logistics is often generated by subsequent waves of globalisation, which consequently has a significant impact on international competitiveness of companies.

The aim of the present discussion is to identify major trends in the development of international logistics in a wide context of the role and significance of international business.

20.2. Major reasons for the development of international logistics

The study to identify major reasons for the development of international logistics should start with the definition of logistics itself. So, international logistics is the management of the international supply chain, understood as the integra-
tion of logistic activities of companies, links of the supply chain, particularly the operational, financial and marketing functions of logistics management, and the control of the physical flow of goods, financial resources and information across and above national borders².

It must be added that in specialist literature and business practice the term of ‘global logistics’ appears. Therefore, global logistics is a complex of logistic operations all over the world carried out between companies in various countries and continents. The nature of relations between logistic tasks and globalisation processes of the world economy results from this definition. At present, globalisation processes are thought to have started at the turn of the 19th and 20th centuries, when – as a result of the onset of free trade – the flow of goods became more liberated and the share of exports in the world income doubled³. As a result, intensified international business activities caused more numerous business interrelations between particular countries, which was regarded as an indication of globalisation.

According to A. Gwiazda or A. Jarczewska - Romaniuk⁴, at least two globalisation waves occurred in the economic space (see Table 43). Moreover, globalisation processes were not limited to integrating the economy, creating global markets or developing global production networks, but they also referred to political and social spheres. Therefore, it was in such an economic space – where a rapid growth of international activities was generated – that the role of interna-

<table>
<thead>
<tr>
<th>Waves of economic globalisation</th>
<th>Waves of logistics globalisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensified international activities of companies were defined as the first wave of globalisation, characterised by a high level of economic integration of the world's main powers.</td>
<td>The first wave of logistics globalisation was its rapid development when a growing number of supply chains were created between companies closely cooperating with each other, from manufacturer to the place of consumption.</td>
</tr>
<tr>
<td>SECOND WAVE, 1990s.</td>
<td>SECOND WAVE, late 1980s.</td>
</tr>
<tr>
<td>The second wave of globalisation is the processes of creating truly global interrelations between economies of particular countries, covering all the countries in the world.</td>
<td>The second wave of logistics globalisation occurred simultaneously with IT revolution and brought about the creation of the world communication infrastructure using satellite communications network.</td>
</tr>
</tbody>
</table>

Source: Own study.

² E. Gołembska, Podstawowe problemy logistyki globalnej, międzynarodowej, eurologistyki, WN WSK Łódź, 2007, p. 72.
⁴ A. Gwiazda, Globalizacja i regionalizacja gospodarki światowej, UMK Toruń 1998, pp. 31-33; A. Garczewska Romaniuk, Relacje polityki i ekonomia w procesie globalizacji, Globalizacja a stosunki międzynarodowe, BRANTA, Bydgoszcz 2004, p. 36.
tional logistics strengthened, and logistics itself developed through subsequent waves of logistic globalisation. However, these waves were spread in time differently, and occurred a little later, as the first one started in the mid-twentieth century, and the second one in the late 1980s.

Therefore, a question arises: How to define the most significant reasons for the development of international logistics, determining the directions of this development? On the basis of empirical studies conducted in 2000-2004, with regard to theoretical and practical international experiences, it must be accepted that at present there are five reasons for the growing significance of logistics in globalising world economy. They are:

– functional and institutional diversification of forms of business internationalisation;
– growing importance of foreign direct investment (FDI);
– rapid development of the global network of trade in goods and services and modern forms of outsourcing, supported by information technologies;
– rapid growth in the number of transnational corporations;
– development of urban logistics within the network of international cities.

The nature of the relation between the diversification of forms of business internationalisation and development of logistics (apart from the obvious need for adapting to growing international competition) comes down to the impact of internationalisation strategies on the effectiveness of logistic tasks. Therefore, the role of cost and delivery elements for the internationalisation of a company is significant. Cost elements result from the necessity to cut down on labour costs, while the delivery elements – from promptness and frequency of deliveries.

The importance of FDI for logistics, on the other hand, consists not only in capital relocation, but first of all, in creating new logistic technologies in all the links of the international supply chain. Rapid development of the international trade and service network, the development of outsourcing in particular, depends on the implementation of state-of-the-art information technologies and modern transport services. The 3PL/4PL (third party logistics and fourth party logistics respectively) methods are of great significance here. Recently, a shift from 3PL to 4PL meant a significant expansion of logistics services (see: Fig. 60).

The 4PL method is a service combining the extreme links of the whole supply chain, from effecting the physical movement of goods to financial services. In transport, however, creating transport fleet becomes more and more important, and according to J. Sutherland, the development of such fleet in the USA

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resulted in a reduction of 20% in transport costs, 50% in stock levels, and 33% in cargo handling time.

The development of the world trade network is closely related to the establishment of transnational corporations. It is said that multinational corporations are an effect of FDI, and they are set up by means of takeovers, mergers, or grassroots investment. The specific nature of these corporations lies not only in the effects of their activities related to FDI, but also – or perhaps first of all – in international flows of goods. The flows take place within technological structures created by international logistics.

At present, the number of transnational corporations is growing: in 1997 there were 53,560, now their number amounts to over 60,000. The share of corporations in global GDP amounts to ca. 30%, and they are responsible for 80% of international transfer of technologies and 70% of FDI deposits. It must be added that 80% of corporations are based in the USA, Canada, EU countries, Japan and Singapore, and the value of sales of goods and services produced by their subsidiaries is nearly 50% higher than the value of the world exports. Significant economic potential of transnational corporations, generated by 200 largest companies in the world, amounts to 18 trillion dollars of the total annual income, with assets of 65 trillion dollars and 63 million jobs.\footnote{E. Golemska, \textit{Podstawowe problemy}, \textit{op. cit.}, p. 57.}

However, a rapid growth of information technologies necessary for the implementation of logistic processes in transnational corporations causes a risk of asymmetric threats.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig60.png}
\caption{Shift from 3PL to 4PL}
\source{Own study.}
\end{figure}
Paradoxically, we can say that the use of these technologies may turn against the creators of such corporations. This results from the fact that global IT and telecommunications networks can be used by terrorist groups, and as a means to generate illegal income. It should be explained that the asymmetric conflict occurs when one of the parties, e.g. a small country or privately-owned entity, has a capacity advantage, and the other party tries to level it down. Asymmetric threats include such aspects as hostile use of IT leading to infowar or cyberwar, transnational crime or terrorism. Asymmetric threats coming from privately-owned entities fit well in the logic of globalisation processes, as one of the characteristic features of these processes is an increase in importance and influence of non-governmental players in international relations. Therefore, these threats are at the same time the result, manifestation and element of globalisation, determining both the environment in which they exist and technical/organisational aspects of corporate functioning and the scale of their impact on the international situation.

The last of the above-mentioned reasons for the development of logistics is the phenomenon (discussed later) of the role and significance of urban logistics in the network of international cities. Today we know that international cities are important modal points of the global logistics network, and their participation in this network is determined not only by transport management, telecommunications network or public services and waste management, but also by the fulfilment of international functions stimulating international trade.

20.3. Factors stimulating the development of international logistics in Polish businesses

The reasons for the development of international logistics in relation to the operations of Polish businesses as links of the international supply chain must be considered in the context of empirical studies of both individual companies and regions.

Therefore, the basic question here is: Which of the numerous factors stimulating the growth of significance of logistic processes in Polish companies should be now regarded as the most important?

The answer to this question includes at least three such factors, namely:

– systematically growing level of internationalisation of Polish companies;
– better use of outsourcing;

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8 M. Madej, Globalizacja zagrożeń asymetrycznych. (in:) Globalizacja a stosunki międzynarodowe, BRANTA, Bydgoszcz 2003, p. 224.
– higher influence of the functioning of Euroregions on Eurologistics.

As has already been mentioned, empirical studies were carried out on how Polish companies, big, medium-sized and small, are prepared for modern logistic processes, both in Europe and in the world\(^{10}\). The survey was carried out in 145 businesses located in all 31 powiats of Wielkopolskie Province (in big and medium-sized ones between 2000 and 2004, and in small business sector in 2005); its aim was to assess the level of internationalisation, with regard to the use of modern methods of logistics management. It should be added here that the basic forms of internationalisation include: exports, licence transfer, franchising, joint venture, foreign subsidiaries, production plant, daughter company. The results of the survey show that as many as 62\% of companies implement international logistics processes in one of the most important forms of internationalisation, i.e. in the production plant (see Fig. 61).

![Fig. 61. Logistics of Polish companies in various forms of internationalisation (%)](image)

**Source:** Own study.

In other forms of internationalisation, i.e. in licence transfer and franchising, there were no formal references to their integration with logistic processes. What is positive is their structure, not to mention the volume of capital outlays for the purchase of modern information technologies, in spite of the fact that the state-of-the-art methods of logistics management supported by IT are being already applied. And so, the companies under survey are going to allocate 45\% of

\(^{10}\) The results of the research carried out within inter-university grants were published in: E. Golemb ska, D. Kempny, J. Witkowski, *op. cit.*, and *Logistyka w internacjonalizacji przedsiębiorstw UE*, *op. cit.*
their financial resources (by 2008) for purchasing and implementing these technologies. As for fixed assets, 42% of them will be allocated for construction or modernisation of warehousing facilities, and 38% for transport means. This kind of structure of planned investment justifies the statement that companies are making and will make better and better use of outsourcing.

In 2005, empirical studies were carried out in the SMEs sector\textsuperscript{11}, because the role and significance of this sector is growing year by year. It must be added here that already in 2002 the share of this sector in GDP was 48.6%, and it offered 68.1% of the total number of jobs.

It is also worth mentioning that in the period of 2002-2005, 47% of capital outlays for the construction and modernisation of fixed assets was used in the provinces of Mazowieckie, Śląskie and Wielkopolskie. Therefore, it was decided that 100 companies based in Wielkopolskie using – now or in the past – EU resources should be studied in order to find out how these resources influenced the development of their financial base, necessary to implement logistics processes. It turned out that the EU resources were allocated for:

- warehousing space development, purchase of means of transport, and implementation of quality management systems – 60% of the resources granted;
- modernisation of production processes – 21%;
- purchase of computer hardware and software – 19%.

With their flexibility and innovativeness, small and medium-sized companies constitute important, often complementary to big forms, links of international logistics chains, and with the EU financial support, they can efficiently compete with enterprises operating in international and European markets.

As it was mentioned before, outsourcing becomes increasingly important in business services. Outsourcing is regarded as a remedy for cutting down the company’s operational costs. The average global value of outsourcing services amounts to 1 billion dollars a year, and is still growing.

The Polish logistics services market is developing quickly, as in the period of 2001-2003 logistics companies transported 46% more goods than in 1999. Stock handling also increased – by 85.1% as compared with 1999, with storage space increased by 38%. It must be stressed that in the 2000s, logistics companies doubled their income from operations in Poland, while their turnover with Western Europe increased by 75%, and with Eastern Europe by 53\%\textsuperscript{12}.

More common use of outsourcing in logistic processes is considered to be one of the most important factors stimulating the development of logistics, as it makes it possible to lower logistics costs and keep timely deliveries.

\textsuperscript{11} E. Gołemb ska, \textit{Podstawy logistyki}, op. cit., pp. 140-142.
A condition necessary both for further business internationalisation and use of outsourcing is the use of telematics systems, the role of which is to measure such values as distance and time, thus making transport processes, cargo safety and transport costs effective.

The main technological media used by telematics systems include the following satellite communications and navigation networks:

- networks of the International Maritime Satellite organization, INMARSAT
- IRIDIUM
- GLONASS (Russian Global Navigation Satellite System)
- Global Navigation Satellite System GALILEO, GNSS-2
- NAVSTAR GPS.

The INMARSAT system enables the transfer of sound and image, and any computer data together with signal scrambling, which makes the system secure. As far as the IRIDIUM network is concerned, access terminals are installed in transport vehicles, and there is a possibility of using mobile phones compatible with GSM mobile communications networks. The GLONASS system is being modernised at the moment, and in response to this system the EU introduced the GALILEO network. GALILEO is an international and civilian system; it is supposed to guarantee better operational continuity, as well as better quality and precision of data transfer. The GALILEO system, put into operation in 2008, can be used in air, sea, road and railway transport. It enables the control of all the stages of flights, as well as identification of all the means of transport.

The advanced GPS satellite navigation technology is composed of three segments: space, control and users’ segments. From the logistics point of view, it is important that the GPS receiver gives information about a vehicle’s geographical position, its route, speed and possible time of reaching destination. A method increasing the accuracy of GPS measurements is DGPS, i.e. Differential GPS, as it gives more possibilities of controlling the movement of vehicles: along main transport routes, correction bases are placed, and they send signals correcting errors by radio.

Generally speaking, telematics systems supporting fleet management significantly lower logistics costs, transport costs included, because they enable a detailed record of routes and speed, as well as the amount of fuel used and vehicles’ loading capacity.

Finally, the third factor stimulating the development of logistics is the impact of Euroregions on Eurologistics (See Fig. 62). First we should ask what Eurologistics is. So, Eurologistics is a specific variant of international logistics, within which logistic processes are carried out within European countries.

The fact that in the 1970s Euroregions were established was fundamentally important for logistics, because one of the essential conditions for effective Eurologistic processes was the development of transport infrastructure, in a wide context of spatial development.
At present, there are 15 Euroregions in Poland, inhabited by almost 40% of the country’s total population. It must be noted that decisions to allocate the largest amount of financial resources for Euroregional transport infrastructure (45%)\(^{13}\) are meant to create opportunities for sustainable development in these Euroregions in order to enhance Eurologistics activities.

Combining the functioning of Euroregions’ with Eurologistic operations of companies – partners in the European supply chain – requires cooperation and coordination at the local level in the first place, then at the regional level and finally, joint arrangements at the national level.

Economically effective correlation between the growing importance of Euroregions and Eurologistics efficiency result in stronger competitiveness of the EU countries as compared with non-EU countries, particularly in the context of globalisation and internationalisation of world economy.

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\(^{13}\) These resources were allocated as follows: transport 45%, support for companies 17%, tourism and cultural heritage 11%, environmental protection and ecology 10%, development of rural areas 7%, vocational training 10%.
20.4. Urban logistics in the environment of internationalisation and globalisation

A latest phenomenon is the significant impact of economic internationalisation and globalisation on the growth of importance of international cities with their urban logistics. The question is: What are the reasons for this phenomenon? In fact, there are at least three reasons for generating urban logistics in the 21st century:

1. Introduction of the term ‘economic base of the city’, in the context of shift from hierarchical to network systems of cities;
2. Development of internationalisation processes of cities;
3. Greater significance of internationalisation and globalisation of cities.

Therefore, the modification of the theory of the city economic base as an economic phenomenon generally comes down to:

– opening of the city’s economy to international relations;
– diffusion of innovation by treating the city as an open system;
– interrelations between cities functioning in network systems.

In this new reality, the concept of an entrepreneurial city was created, which comes down to a practical look at the reality of city functioning. A city is regarded as entrepreneurial when its groups of interest of both public and private sectors together carry out a common vision of its development and create organisational structures to achieve this goal. Urban logistics is one of the most important structures, because an entrepreneurial city is regarded as an indirect or direct result of economic globalisation. In this context, urban logistics must be seen as an important link of international logistics, especially as a binding element of the logistics network. According to D. Harvey, globalisation in late capitalism caused a shift from resource allocation management to a new kind of entrepreneurship, private sector activation in particular.

Most frequent measure of internationalisation of a city is its existing transport system, particularly its accessibility, as well as availability of education, services for businesses, quality of city environment and qualified labour force.

J. Komorowski in his studies on internationalisation of Polish cities uses the following groups of features:
1) the city’s economic and demographic potential;
2) international accessibility of the city space
3) international production relations of the city;

4) international financial relations of the city;
5) services related to international relations;
6) the city’s intellectual potential;
7) employment in services related to international connections.

As a result, according to S. Conti and G. Spriano\textsuperscript{17}, there are three factors that make a city entrepreneurial:

– ability to make strategic decisions in the area of controlling international production and distribution systems, and financial markets;
– ability to become global in terms of creating high quality services, transport and logistic services included;
– ability of authorities and economic institutions to integrate cities within international city systems.

In recent years, cities have become more global and international. It must be stressed that internationalisation consisting in establishing businesses and adaptation to the rules of international economy also means that these rules spread to all layouts and spatial systems of the city, thus causing a shift from hierarchical to network city system. Moreover, as new management conditions are more and more accessible, internationalisation refers not only to metropolitan cities but to smaller cities as well, the latter capable of taking over international functions.

What is also worth mentioning is the significance of globalisation in city logistics management. Cities are important environment for economic, political and cultural globalisation, although they are subject to alterations and transformations, depending on the current need for changes\textsuperscript{18}. Therefore, we can say that globalisation takes place not only in big cities: thanks to cooperation between cities of various sizes, it reaches a network of cities, particularly those where economic infrastructure, transport infrastructure included, develops together with urban logistics.

In this context, a question arises: What is urban logistics?

Urban logistics is the management of the movement of goods, financial resources and information within the city logistics system, with regard to environmental protection and improvement of quality of life.

In any case, then, urban logistics must be considered in terms of systems, i.e. as a set of basic subsystems. Fig. 63 shows the scope and structure of urban logistics.

External and internal conditions are particularly important among numerous tasks to be carried out in order to improve the city’s functioning.

As for external conditions, it is necessary to see the city in the context of European transport systems. In 2004, the CONNECT project was implemented

\textsuperscript{17} S. Conti, G. Spriano, Structure Urbane, Innovazione tecnologica e reti urbane internazionali, Seminario internazionale della Fondazione, G. Agnelli, Torino 1989, 4, pp. 28-31.

in 8 Central and East European countries, Poland included. Within the project, intelligent transport systems ITC were launched; their task is to solve transport problems on roads and motorways within international transport corridors.

In this sense, cities function in networks, and performing international functions of urban centres, they pay particular attention to the following logistics problems:

1) improvement of the accessibility and capacity of the city transportation systems;
2) development of telematics, being an intelligent transport management system;
3) development of ecologistics and waste management.

At first, the accessibility of transport points and nodes is examined by means of the traffic stream distribution\textsuperscript{19}: the city is divided into areas and, considering the number of inhabitants, the origin and destination urban transport volumes are determined. The gravity model can be used here, as it enables the quantification of the following correlation:

\begin{equation}
F = \frac{aQz}{t^b}
\end{equation}

\textbf{How does gravity of areas diminish as the distance grows?}

\textsuperscript{19} It should be pointed out that the following results of the survey can be used to reorganise transport systems in a large urban area:

- about 50% of car trips are shorter than 5 km,
- in big cities, travelling by bicycle (3-4 km) is quicker than by car in rush hour,
- along the main transport routes, travelling by tram is faster than by car.
Where:
\( F = \text{number of trips between two areas} \)
\( Q = \text{transport originating in an area} \)
\( Z = \text{transport destination for another area} \)
\( T = \text{travelling time between the two areas} \)
\( a, b = \text{constants established upon practical experience} \)

As for the city transport layout, particular attention is paid to such urban logistics tasks as:
- increase in the number of integration nodes\(^{20}\) of transport subsystems;
- development of night and weekend public transport;
- development of public transport to retail centres.

The latest solution used in the 21st-century urban logistics is telecommunications/IT systems. The term ‘telematics’ was created by combining two notions: ‘telecommunications’ and ‘informatics’. Telematics is intelligent transport control systems.

The aim of using telematics in urban logistics is to improve quality of life and the effectiveness of investment in fixed assets of the transport system, and to reduce the harmful impact of transport means, not to forget the inhabitants’ safety. As far as transport of goods is concerned, telematics means the use of the GSM, mobile phone network and, in particular, the GPS satellite navigation system.

Here are some of the state-of-the-art solutions used in big city logistics:
1) The EU project called CAPE (Coordinated Action for Pan-European Transport and Environment Telematics Implementation Support) is being implemented; its goal is the support and implementation of telematics technologies in Central and Eastern Europe, Poland included.
2) The German project ISOLDE implemented in Nuremberg; it consisted in dividing the city into 5 zones, each one with a logistics mini-centre. The mini-centres are nodes rendering logistics services, and their comprehensive nature enables best possible use of vehicle capacity in public transport.
3) At the moment, a public transport project in the city of Poznań waiting to be implemented is the automated track transport system **FUJIBANA**.

The idea of the FUJIBANA system is that main transport lines run as elevated structures (See: Fig. 63).

In this case, the most important challenge for urban logisticians is to choose the optimum route for the rail. Major selection criteria for such a route are:
- the strengthening of urban axes within the public transport network;
- utilisation of public land and the space above;
- making public buildings and city centre more accessible.

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\(^{20}\) Integration nodes should be understood as the volume of transhipment relations.
At present, the term ‘ecologistics’ is complementary to ‘urban logistics’, being a sub-branch of both ecology\(^{21}\) and logistics, waste management included. In English-speaking countries, ecologistics is commonly associated with recycling, incineration, composting or waste disposal. In Germany, ecologistics, *Entsorgungs Logistik*, means, first of all, methods of waste disposal.

In view of the above, the development of logistics in international cities becomes part of international logistics in globalising economy, thus constituting a common open system of relations determining the rationalisation of world business standards.

20.5. Bibliography


\(^{21}\) The term ‘ecology’ derives from the Greek words ‘oikos’ – ‘house’ or ‘life’ and ‘logos’ – ‘science’. Therefore, ‘ecology’ means the science of environment. The term was first used in 1863 by Ernst Haeckel, a German zoologist, who claimed that “ecology is the comprehensive science of the relationship of the organism to the environment”.

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11. Harvey D., From Managerialism to Entrepreneurialism, the Transformation in Urban Governance in Late Capitalism, Geografiska Annaler, 1989, 71B(1).
Chapter 21
BUILDING NEW LOGISTICS CENTRES IN EUROPE
(Ireneusz Fechner)

21.1. Introduction

Despite a few decades of presence in logistics networks, logistics centres still have not taken the high position that they deserve there, and the concepts of establishing them keep changing. And so does their description - the result being lack of uniform nomenclature in the literature of the subject. It is a common practice to use the notion of “logistics centre” quite freely and to abuse it. Using this term as a synonym to a central warehouse of a company in which the main stock is kept can be an example here.

A logistics centre is a spatial object of specified functionality, having its specific infrastructure and organization, in which logistics services connected with receiving, storage and distribution of goods are provided, together with accompanying services, by a business entity that is independent from either the consignor or the consignee.

Even this definition does not fully account for the nature of a logistics centre, which can cover various forms of nodal logistic infrastructure, including modern warehousing facilities built by developers, which are sets of modern warehouses designed for various users. Most of them are serviced by road transport, in accordance with user preferences, and investments in these structures are of commercial nature, as the public sector gets involved in joint investments only when, by doing so, it can increase the share of other modes of transport, the rail in particular, in the carriage of goods.

In the sense of Western European logistics, in particular in the states in which logistics centres are built in a systematic way, the term is reserved for those logistics network hubs that are places of concentration of warehousing su-

prastructure and logistics services, in which it is possible to service intermodal transport. This means there must be container terminals there providing transhipment of cargo between at least two modes of transport.

It is logistics centres meeting these conditions that are the subject of this article.

21.2. European concepts of logistics centres

Based on the analysis of the existing logistics centres, the following concepts of developing them can be distinguished:

a) direct – consisting in the construction of logistics centre as an element prior to the ultimate shape of the area set for business, which in this form concentrates production, trade and service companies that require logistics services of the centre; in this concept, the existence of the logistics centre attracts other investment;

b) development – consisting in construction of logistics centre as an investment closing the process of forming an area previously set for business, the origin of which is the creation of one or more industrial zones with preferences for manufacturing activities;

c) redevelopment – consisting in transforming post-industrial areas into logistics centres by disposing of the previously conducted business operations, dismantling the existing infrastructure and adapting the land recovered in this way to the development of logistics services.

The concepts mentioned above were applied to the construction of logistics centres in West European countries, whose logistics network consists of over eighty intermodal logistics centres. By comparison, logistics network in Central and East European countries consists of just over ten such hubs, and the backlog in relation to Western Europe is ca 20 years. There is a clear asymmetry in the number of intermodal logistics centres between the two parts of the continent, which is accounted for by different models of economic development and lesser welfare of the states that changed their economic system less than 20 years ago and introduced market economy. Public funds allocated by those countries for construction of logistics centres are inadequate to the need of levelling the existing disproportions, resulting from the past political and economic divisions and lack of a uniform policy of developing regional logistics networks.

The disproportions can also be seen in the countries of Western Europe, as also in this part of Europe no common programme of building logistics centres was ever implemented. Most of logistics centres were built in Germany, Spain, France, Denmark and Italy. The case of Nordic countries is interesting, as despite
favourable conditions, the programmes of building logistics centres are not far more advanced than in Poland, Lithuania, Czech Republic or Hungary.

21.3. Development of logistics centres in Europe

The process of developing the concept of logistics centre goes back to the end of World War II, when standard mass production of the industry working to meet the war needs switched to production for the needs of the market, which after years of limitations became the consumer's market that required efficient distribution systems. The concept of logistics centres was born under the influence of the following factors:
- lack of modern warehousing space in the outskirts of large urban areas;
- the rise of intermodality as sea containers (ISO) had to be transported by rail from seaports to hinterland consignees;
- the growing public opposition to HGV traffic through city centres.

The first logistics centres began to appear at the turn of the 1960s and 1970s in France, Spain and Italy (see Fig. 65).

![Fig. 65. Development of logistics centres in Europe](source: Own study)

In the 1980s, more factors appeared providing additional impulse to logistics centres construction in Europe:
- no space available for the extension of storage space in ports, with the growing demand for such space and warehouse services, which made it necessary to build warehouse facilities outside ports;
- significant increase in cargo volumes, mainly taken over by road transport;
- initiatives of national railway carriers designed to prop the declining market share of the rail by promoting intermodal transport.

The first logistics centres actually achieved operational status in the mid 1980s, because the planning phase – that is the period from the beginning of the initiative to construction of the first structures – takes about ten years (see Fig. 66).

The greatest variety of implementation models can be found in Germany, which equipped its national logistics network with the largest number of intermodal logistics centres – over thirty. And the most impressive in terms of floor space and turnover expressed in intermodal and palette cargo units were built in Italy. With only just a few exceptions, West-European logistics centres were built to the initiative of the public sector, under public-private partnership, which took various legal forms as well as the structure and proportions of investment capital.

Fig. 66. Stages of putting a logistics centre in place in Bologna
Source: Own study based on information of Interporto Bologna S.p.A.
Currently the process of building logistics centres in Western Europe is much slower than 10 years ago. Italy is about to complete the long-term programme of co-financing logistics centre development commenced in the early 1990s. It had been designed for ten most developed objects of the kind, which, as a result of growing demand for warehousing space, required additional investment funding. The activity of the public sector and budget funds are targeted at complementing logistics network with transhipment terminals and creating permanent, intermodal railway connections between existing container terminals (the so called block trains), as well as at increasing the transport of palette packed goods by rail, using traditional ways of handling on loading ramps in duly prepared warehouses. It is to extend the programmes of supporting the increase in intermodal transport and cargo carriage by rail in general, and raise their efficiency.

It is only now that the countries of Central and Eastern Europe are building their own networks of intermodal logistics centres, and two ways of doing it can be observed: logistics centres are being built according to the direct concept – e.g. Lithuania and Poland or the development concept – e.g. Hungary and the Czech Republic.

**Direct concept** consists in building a logistics centre in a location chosen on the basis of estimated absorption of logistics services and forecasts of its future growth in the business environment of the location so selected, with the assumption that the presence of the logistics centre will stimulate further growth in the demand for such services.

**Development concept** consists in creating conditions for intensive growth of industrial output by creating various types of incentives for launching production plants in the specified location, with the assumption that the type of production will create a demand for logistics services, providing the conditions for the construction of a logistics centre.

The first concept works well in regions of established industrial traditions. The other one is effective in regions or sub-regions that, for various reasons, are planned to be stimulated economically.

In the Baltic Sea region, the situation concerning the functioning of logistics centres is varied. Denmark has a developed network of logistics centres. It is also true about Germany, which nevertheless still develops its network of logistics centres (examples: Rostock, Lübeck, two from the three centres planned around Berlin and a similar facility in Frankfurt an der Oder). Finland creates its network of logistics centres based on sea ports in Kemi, Turku, Kotka and Oulu. Lithuania, Latvia, Estonia and Poland have developed location plans for logistics centres, which are at an early stage of implementation, and in the case of Poland do not have the status of an official government document. Similarly in Russia,

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3 The total subsidy of the Italian government is EUR 362 million. The money is transferred in annual tranches, and the financial assistance will continue till 2007.
which plans to cover the whole country with a network of intermodal logistics centres. The programme assumes building 10 logistics centres of national importance, 22 of regional significance and 23 of lesser importance. The programme also envisages the construction of a considerable number of independent container terminals (the assumption being that in the Moscow urban area alone there will be thirty such terminals).

Table 44 presents the existing logistics centres around the Baltic Sea. It must be emphasised that the locations indicated do not exhaust opportunities for regional cooperation based on advanced logistics services, as in each of the countries involved there are seaports with a large capacity for the handling of intermodal cargo in the form of container terminals, ro-ro terminals and warehouse suprastructure. So the Baltic sea ports should be seen as logistics hubs complementing the European network of logistics centres.

Table 44. Existing logistics centres in the Baltic Sea region

<table>
<thead>
<tr>
<th>Country</th>
<th>Logistics Centre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>Oy Bothia Logistics Centre Ltd (BLC) Kemi</td>
</tr>
<tr>
<td></td>
<td>Logisforum Oulu</td>
</tr>
<tr>
<td></td>
<td>Turku Logistics Centre/Pilot Turku Turku and Raiso (centre for road transport)</td>
</tr>
<tr>
<td></td>
<td>Logistics Turku Region Turku</td>
</tr>
<tr>
<td></td>
<td>Aviapolis Vantaa</td>
</tr>
<tr>
<td></td>
<td>Straightway Southeast Finland Kotka</td>
</tr>
<tr>
<td>Germany</td>
<td>Logistics Centre Lübeck Lübeck</td>
</tr>
<tr>
<td></td>
<td>Logistics Centre Rostock Rostock</td>
</tr>
<tr>
<td>Sweden</td>
<td>Arlandastad Logistics Network (ALN)</td>
</tr>
<tr>
<td></td>
<td>Onyx Logistics Centre Nyköping area</td>
</tr>
<tr>
<td>Denmark</td>
<td>Nordic Transport Centre (NTC) Aalborg</td>
</tr>
<tr>
<td></td>
<td>Taulov Transport Center (TTC) Taulov</td>
</tr>
<tr>
<td></td>
<td>Hoeje Taastrup Transport Center (HTT) Copenhagen region</td>
</tr>
<tr>
<td></td>
<td>Herning Ikast Transport Center (HITC) Central Jutland</td>
</tr>
<tr>
<td></td>
<td>Skandinavisk Transport Center (STC) Copenhagen region</td>
</tr>
<tr>
<td></td>
<td>Transport Center Slagelse (TCS) Central Zealand</td>
</tr>
</tbody>
</table>


Sea ports in the Atlantic coast (e.g. Rotterdam, Antwerp) or the Mediterranean coast (e.g. Barcelona) should be perceived in the same way. It must be emphasised that sea ports are logistics hubs of key significance to creating intermo...
dal logistics networks, as maritime transport is the main supplier of containerized cargo for inland container terminals. The new container terminals currently being built in Polish Baltic ports (Szczecin, Gdynia, Gdańsk) are an indication of anticipated increase in the stream of container transport in the national logistics network. From this point of view, the important thing is the capacity of inland container terminals, whose current annual handling capacity is ca 600 thousand TEU. This may prove insufficient after the new terminals in the seaports have been built, and their handling capacity has grown by ca 1 million TEU. The capacity and efficiency of linear infrastructure, the technical condition of which is still unsatisfactory, is of great significance for intermodal transport. The example of the port of Antwerp, which due to the growth of maritime container transport, has problems with transporting the containers inland, should be a warning against the selective treatment of the problems related to the development of logistics infrastructure.

European Association of Logistics Centres Europlatforms has about 70 members, i.e. ca 2/3 of European logistics centres. Logistics centres located in the Baltic Sea region are under-represented there, and of all the countries of Central
and Eastern Europe, it is only a logistics centre in Ukraine that is a member of the association (see Fig. 67). Logistics centres in Denmark and most of German centres are members. The remaining Baltic countries do not have their representation there.

21.4. Bibliography

Chapter 22
LOGISTICS COSTS IN MODERN ECONOMY
(Henryk Woźniak)

22.1. Introduction

The problem of logistics costs and various aspects of qualitative changes in logistics that affect the costs are raised in the document Opinion of the European Economic and Social Committee on the European logistics policy published by the European Commission in Brussels on 15th February 2007. According to the document, comparison of logistics expenditure (including transport) with the volume of Gross Domestic Product between Europe (EU-15) and North America indicates that the share of the costs in GDP of European countries grew from 12.2% in 1998 to 13.3% in 2002. During the same period logistics expenditure in North America decreased from 11% to 9.9%. The document also confirms that logistics costs in economy have not been determined to a satisfactory extent, and significant logistics decisions are actually made on the basis of incomplete, and thus imperfect information. It requires that models be developed for the calculation of the actually incurred costs. Logistics costs should be a significant indicator of company productivity.

22.2. Logistics in the process of change in world economy

The world’s economy is undergoing significant changes. The last phase of globalization began in the 1990s, when the fast growing Asian economies started

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to open for market economy. It led to significant de-location of industrial production of developed countries-exporters, and consequently, of logistics services. In Europe, significant structural changes have also taken place in industrial production and in the markets of logistics services, caused by EU enlargement and the relatively fast development of new member countries. Here we also have a clear trend towards de-location of production to countries of low labour costs. Industrial production will be growing mainly in the emerging markets of China, India, Brazil and Russia, at a slower pace in countries of Eastern Europe, including Poland. Not only do the volumes of transported goods grow but so do the distances covered. Control of global supply chains becomes time consuming and costly, whereas decision centres could be moved to Asia. Since competition between economic regions of the world is growing, efficiency of transport infrastructure becomes a more and more important factor of competitive capacity. Additionally, production and consumption growth in countries of Eastern Europe forces modernization of transport infrastructure and its integration with European Union transport system.

In the case of industrial production and logistics services, customer orientation is the element deciding about the structure of supply chains, which differ not only because of various properties of products but also, or perhaps mainly, because of the needs and expectations of the customers. System integration refers not only to technological aspects but also to organizational ones, and is based on knowledge. Developing supply network structure is, to a great extent, based on inventiveness, not only in relation to flow of products but also processes and procedures. From logistics point of view, management of supply chains in contemporary market conditions and new models of running business constitute, according to the conclusion of the document quoted here, the most important areas of development. Thus, it should be assumed that the character of these changes, their intensity and scope of application will affect the level of logistics costs in individual economies and in the selected sectors of individual countries.

22.3. Research on logistics costs

Research on logistics costs in economy has been carried out relatively regularly for years. It has, however, one basic fault - various methods of calculating or estimating costs are applied, which results in significant differences in presented results. For example, the research results presented by M. Christopher

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2 Ibidem, p. 5.
3 Cf.: M. Christopher, Logistyka i zarządzanie łańcuchami dostaw. Polskie Centrum Doradcztwa Logistycznego 2000, p. 73.
H.Ch. Pfohl\textsuperscript{4}, obtained by various institutions in the early 1990s, and referring to the share of logistics costs in the sales income of selected countries of Europe and the USA – differ considerably. It was quite clear in the case of transport costs, where extreme values of the share for selected countries were as follows: for Germany 2.10–5.81%, for Great Britain 1.10–2.65%, for Spain 1.44–4.08%, and for Italy 0.70–3.46%. It is similar for the costs of warehousing and stock keeping, where the differences reach the level of 100%. This can be understood in view of the fact that most of the data from companies was obtained by means of a questionnaire. The problem becomes more serious, however, when significant differences appear in estimations of the share of logistics costs in Gross Domestic Product. In “Wikipedia” (in German) under the entry “logistics” we can read: “the share of logistics costs in the total costs is significant. It refers in particular, to transport and storage costs, stock keeping included. Logistics costs depend on the sector, e.g. high logistics costs occur in consumer goods industry. Logistics costs also depend on the level of economic development of countries. And e.g., the share of logistics costs in Gross Domestic Product of less developed countries is up to 20%, in industrialized countries – less than 5%.”\textsuperscript{5} Also other publications say that the share of logistics costs in industry of highly industrialized countries is 3-5% of total costs.\textsuperscript{6} The comparison of logistics costs and Gross Domestic Product as of the 1990s presented by H. Ch. Pfohl\textsuperscript{7} makes it doubtful whether such regularity exists. And so, the share of logistics costs in the GDP of Greece is 3.1%, of Portugal – 4.4%, of Germany 7.2%, of Luxembourg 10.3%, of USA – 10.6%, and of Finland 13.8%.

Especially in the case of Finland it is a surprisingly high ratio, confirmed by 2006 data. In Finland annual logistics costs in industry, trade and construction are EUR 26.4 billion, which is 13.0% of sales revenue in these sectors.\textsuperscript{8} It is a surprisingly high level in international dimension. Transport costs constitute one third of that value. This is caused by great intensity of cargo transport to Russia, which in recent years grew at an average annual rate of 20 to 30%. Most of the goods are carried by road. In terms of weight, transit transport via Finland to the East doubled within the last four years. Relative logistics costs of Finnish companies grew by 1% in the last five years, however.

A very interesting attempt at precise identification of logistics costs was made last year in Germany, where three independent estimation methods were


\textsuperscript{5} Cf.; entry “Logistik” [in:] Wikipedia.

\textsuperscript{6} \textit{Logistikdienstleister und Spedition}. [In:] Fraunhofer Institut Integrierte Schaltungen. Arbeitsgruppe fuer Technologien der Logistik-Dienstleistungswirtschaft ATL. 30.04.2007.

\textsuperscript{7} Cf.; H.Ch. Pfohl, \textit{Systemy…}, op. cit., p. 53.

\textsuperscript{8} Kraftige Zunahme beim Güterverkehr. Quer durch Finnland nach Osten. [in:] Finnfacts 2006.

\textsuperscript{9} Ibidem.
used and where the full range of costs, including costs of supply chains management and costs of transhipment were taken into consideration\textsuperscript{10}.

The obtained results say that in 2004 logistics costs were EUR 170 billion\textsuperscript{11}, which was about 7.3% of the GDP, and in 2006 – already EUR 180 billion\textsuperscript{12}. From the amount of EUR 170 billion, 79 billion is allocated to broadly understood TL sector and for in-house logistics in industry, trade and other sectors – slightly over EUR 90 billion.\textsuperscript{13} As for the turnover, logistics sector came third, together with the engineering industry, after vehicle manufacture (EUR 285 billion) and after business activities connected with health care (EUR 250 billion).

### Table 45. Structure of logistics costs

<table>
<thead>
<tr>
<th>Costs of logistics activities</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs of cargo transport</td>
<td>44%</td>
</tr>
<tr>
<td>Costs of cargo handling and storage</td>
<td>26%</td>
</tr>
<tr>
<td>Costs of order processing and costs of warehouse orders</td>
<td>5%</td>
</tr>
<tr>
<td>Costs of stock keeping</td>
<td>20%</td>
</tr>
<tr>
<td>Planning and administrative costs</td>
<td>5%</td>
</tr>
</tbody>
</table>

Source: own study.

The large share of employment in direct market of logistics services (2.5 million people), in the market of logistics suppliers (EUR 70 billion and 0.5 million employees) and employment induced by logistics sector in other sectors (ca 1.6 million people)\textsuperscript{14} should be noted.

Development trends in logistics services market are undergoing very significant changes. Annual average growth of turnover in the sector in the period of 2001-2004 was 2.1%, with very dynamic development of the market in international relations and simultaneous drop of turnover in domestic markets. Logistics outsourcing grew over the same period from 44.65% to 46.1%. The share of contract logistics is growing very fast. Its share in company logistics is ca 30%. The character of the changes affects not only the level of logistics costs but mainly their structure.

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\textsuperscript{10} Neuvermessung der Logistik; Aktuelle Ergebnisse aus der Studie, Die “Top 100 der Logistik” 2006. Fraunhofer Institut Integrierte Schaltungen. Arbeitsgruppe fuer ATL, p. 2.

\textsuperscript{11} This value is thought to be inflated by some authors. E.g. P. Klaus is of an opinion that the wrong estimates result from calculating some logistics costs in supply chains twice. He gives the example of automobile sector, where the manufacturer usually covers “upstream” logistics costs of supply as well as “downstream” logistics costs of distribution. In many sectors, however, the supplier covers the costs of customer supplies, which in this case are shown as costs of distribution. According to Klaus, the adjustments mean that logistics costs should be reduced to EUR 150 billion annually, plus/minus 5% (cf.; Interview: Die wahren Kosten der Logistik. [In:] Verkehr und Umwelt vom 13.04.2004)

\textsuperscript{12} Logistikaufwand wächst auf 180 Mrd. EUR. [In:] DVZ.de, News of 27.04.2007.

\textsuperscript{13} Ibidem, p. 2.

\textsuperscript{14} Ibidem, p. 4.
The dominant share of German economy in total value of logistics services provided in Europe, ca 23-25%\textsuperscript{15}, is worth emphasising. The total value of these services, depending on the number of the countries taken into consideration, is between EUR 600 million to EUR 730 million, the latter value referring to EU-15 plus Switzerland and Norway\textsuperscript{16}.

Development and modification of future logistics systems will increasingly determine competitiveness of companies and regions in the globalizing economy. The share of logistics costs in total costs is often treated as a measure and an indicator of success of logistics in a company and success of the company. It happens despite the fact that the costs are underestimated even by 50% and treated as a “ballast impossible to optimize”, and because there is no understanding that they can become “a leverage of profits”\textsuperscript{17}. The practice indicates that optimization of logistics processes does not consist only in aiming at reducing costs but rather in modification of logistics processes and structures, thanks to which logistics, generating “income of its own”, becomes a financial leverage of the company.\textsuperscript{18} The potential for reducing logistics costs in some sectors is estimated at 10 to 20%\textsuperscript{19}.

A review of available materials indicates that tendencies in changes of the level of logistics costs (or their share in total costs, GDP or sales revenue) in modern economy do not show a uniform pattern. To say that they will be decreasing may be just as true as to say they will keep increasing or that they will remain stable. It depends mainly on the point of reference - the country, economic sectors, group of companies or individual companies. It is very important to adopt a specified, concrete time perspective, since in a certain period of time the costs can grow, and in another - they can decrease or remain relatively stable. There are many factors that decide about it.

22.4. New trends in modern logistics

In must be emphasised that in practice we have to do with a continuous process under which logistics adjusts to the changing requirements of market environment, from local through to global dimension, which has led to the emergence


\textsuperscript{16} Cf.: Neuvermessung der Logistik...op. cit. p. 2.

\textsuperscript{17} Cf.; N.Lebelt und G.Smekal; Signifikante Kostensenkung. [in:] MM Logistik, 15 April 2005, Ausgabe 3.

\textsuperscript{18} Ibidem.

\textsuperscript{19} Ibidem.
of intralogistics (see Fig. 68). These parallel adjustment processes are most often described as trends in development of logistics, which, as a result, affect the level and structure of logistics costs.

At present, eight significant trends can be distinguished in the general economic, political and social environment. They will transform logistics into a dynamic area of activity with significant range of changes in a few years to come. The trends are presented in Table 46.

In the 1990s corporate logistics shifted from function-oriented to process-oriented organization, at the core of which was the shaping and optimization of process chains and value creation chains. Apart from the main corporate processes, including supplies, production and distribution, the areas of development and secondary recovery were integrated with the processes of coordinating material flows. This initiated process chain management and global networks creation. At the same time, the structure of cargo and average volume of one order changed. Production plants concentrated, to a greater and greater extent, on core competences, gradually reducing the depth of processing. There was also an increase in external supplies and cooperation with system suppliers, supplying not only parts but also complete subassemblies.²⁰

Table 46. Logistics development trends

<table>
<thead>
<tr>
<th>4 megatrends, describing demand side logistics:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Globalization of production and transport management – Relocation of production, growing transport distances, new communication and integration needs, growing intensity of competition</td>
</tr>
<tr>
<td>2. Moving to post-industrial society – End of industrial production growth, individualization and expansion of customer service economics</td>
</tr>
<tr>
<td>3. Acceleration of “on demand” business in the world – Immediate reaction to customer wishes, shortening of technological and product life cycles, competition based on time, structural effects in logistics</td>
</tr>
<tr>
<td>4. Growing sensitivity of natural environment – Recycling, significant lengthening of supply chains, vision of economy based on flow, growing aversion to road transport</td>
</tr>
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<tr>
<th>4 megatrends, describing supply side logistics:</th>
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<tbody>
<tr>
<td>1. Discovering positive effects of optimized organization of structure and processes – Comprehensive management of supply chains, according to “pull” rules, making use of JIT and CRP, individualization of supply chains</td>
</tr>
<tr>
<td>2. Deregulation and privatization of existing public services and transport – New providers, new packages of services offered, new competition</td>
</tr>
<tr>
<td>3. Concentration on key competences and thinking in terms of value to shareholders – Concentration on reduction of complexity and the use of outsourcing</td>
</tr>
<tr>
<td>4. Concentration and diversification of structure in the sectors – “Polarization” and “hierarchization”; growth of the biggest market entities and the very small ones, establishing new relations between entities, multi-tier cascades of subcontractors</td>
</tr>
</tbody>
</table>

Source: own study.

Integration of the European market impels many companies to change their orientation in creating product and market strategies. A sort of compulsion appears to expand the existing sales markets and to choose complementary locations for organizing new production and distribution sites. The processes of concentration in trade require the creation of wide distribution networks. Transport distances and supply times become longer. Picking-and-packing centres become important points of distribution and supply systems. Globalization of markets and the growing division of labour in industrial production cause some of domestic production activity to be transferred, from the most developed countries in particular, to countries of low labour costs (LCCs – Low Cost Countries), of low costs of raw materials and less restrictive environmental regulations. Globalization of markets refers to an equal extent not only to Asian or Latin American countries, but also to our part of Europe. By installing some of the production processes in new places, foreign companies establish new cooperation relations with regional partners. This trend leads to an increase in the spatial dimension of distribution networks. Transparency of supply markets in terms of prices and differences in levels of broadly understood productivity improves in the process of creating information networks covering various economic regions in the world. The global strategy of supply (Global Sourcing), re-
sulting in the creation of new sales markets is becoming more and more significant. Close distance to new customers and markets is becoming a priority in creating new production sites abroad. Polish, Hungarian and Czech markets will be playing an important role in the process. And the binding strategy is for the growth abroad to ensure production and employment at home at the same time.

As mentioned before, a trend to reduce the depth of processing is observed in almost all production sectors, which means that the primary production tasks are shifted to new “additional” suppliers. Due to the growth of the scope of contract outsourcing in manufacturing we have to do with:

– increase of transport distances,
– greater value of goods,
– increase of mutual relations between manufacturers and their global suppliers,
– increase of complexity and scope of supply processes,
– creation of network production structures that require new quality in cooperation and effective planning as well as new logistics networks controls,
– growing share of outsourcing in corporate logistics.

The available information indicates that the volume of sourcing from Low Cost Countries (LCCs) will double in the next three to five years, which will make supply chains of many companies change significantly in terms of geography, strategy and operations (see Fig. 68). The character of the changes mentioned will certainly also cause changes of the level and structure of logistics costs.

According to A. T. Kearney company, known for various types of analyses in the area of logistics, due to the growing globalization of economy and the resulting complexity of logistics processes, logistics costs – after many years of relatively stable level – should grow in the period of 2004-2008 by ca 8%. Whereas in the past logistics was treated as a core area from which costs reduction was expected, nowadays many entrepreneurs envisage their increase (see Fig. 69). The big, growing share of purchases outside Europe and high reliability of supplies expected by customers stimulate their complexity. The shortening time of flow, the growing number of stock keeping units (SKU) as well as customer demand for more and more complex level of service are an increasing challenge for logistics. Such character of

21 Ibidem.
Using supply chain to boost revenue, increase market share, develop competitive advantages

Old school
- Treating supply chain as a cost centre
- Concentration on in-house control and reduction of costs
- Recognizing in-house efficiency as extraordinary cases
- “Lean resources as a goal in itself”

New school
- Using opportunities to create new types of value creation
- Investment in very special resources
- Developing a clear business model
- Using new resources to enhance customer relations

Fig. 69. Changes in strategic construction of supply chains

<table>
<thead>
<tr>
<th>% of companies that expect decrease of logistics costs in the next 5 years</th>
<th>% of companies that expect increase of logistics costs in the next 5 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>Transport</td>
<td>Transport packaging</td>
</tr>
<tr>
<td>66</td>
<td>54</td>
</tr>
<tr>
<td>13</td>
<td>52</td>
</tr>
<tr>
<td>Warehousing</td>
<td>Stocks</td>
</tr>
<tr>
<td>46</td>
<td>51</td>
</tr>
<tr>
<td>19</td>
<td>Administration</td>
</tr>
</tbody>
</table>

Fig. 70. The polled experts expect a general increase in logistics costs in the future
changes refers mainly to these sectors of industry in which the share of logistics costs in the volume of market turnover is high. In the case of the engineering industry it is 7.5%, in consumer goods production and in the media – 6.3%, whereas it is relatively small in pharmaceutical industry – 2.5\%26.

The strategies implemented by companies are to prevent the growing complexity and increase of logistics costs. Segmentation of supply chains by differentiating them depending on customer requirements, defining service levels and acceptable cost level are certainly significant activities in this respect. Such differentiation of logistics is currently practiced by ca 50% of European companies. Thanks to individualization of supply chains they can, on average, reduce logistics costs to 15%, and flow times even by 22%27.

Further, not fully used potential of savings is connected with optimization of cooperation activities between suppliers and customers through effective use of information technologies. Thanks to this, every fourth company improved timeliness of supplies from 91.5% to 95% in recent years, and the share of error-free supplies (that is completeness) – from 97 to 98.5%.

Optimization of the entire value creation chain and making the partners fully participate in the process of enhancing “end to end” competences is a key issue. In connection with the growing scope of outsourcing, companies expect that suppliers will be improving and changing the scope of their competences and quality standards. Only the companies that in the environment of diversified offers of customer service give the highest priority to customer preferences will be able to implement the necessary diversification of supply chains. Flexibility and integration with customers and suppliers are an effective solution in optimization of supply chains. It leads, however, to a qualitatively new situation, when growing customer requirements in many cases of organizing such chains will increase the share of the processes that create new value, which in the long run will cause an increase in logistics costs (see Fig. 71 and Fig. 72).

The previously presented production relocation to the countries of our region (Poland, Czech Republic, Slovakia, Hungary) also cause significant changes in logistics costs. Some authors are of the opinion that they can even double in the case of auto parts and subassemblies production28. The problem of quality and productivity caused by insufficient qualifications of the workforce appears in particular at the initial stage of production. Further problems are caused by very strong links with the parent company, when all the production orders are coordinated and reviewed by the head office. To provide for the safety of supplies, the parent company maintains bigger buffer stock, which, together with higher transport costs and longer flow times, “eat up” the benefits of low labour

26 Ibidem.
27 Ibidem.
It seems that the trend of decreasing share of logistics costs may have ended

<table>
<thead>
<tr>
<th>Services Creating Added Value</th>
<th>1998</th>
<th>2003</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td>1.4%</td>
<td>1.8%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Stock</td>
<td>1.0%</td>
<td>0.8%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Warehousing</td>
<td>1.0%</td>
<td>0.8%</td>
<td>0.8%</td>
</tr>
<tr>
<td>Transport</td>
<td>1.6%</td>
<td>1.5%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Transport packaging</td>
<td>2.8%</td>
<td>2.6%</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

Fig. 71. The nature of changes in the structure of logistics costs (% of sales)
Source; H-Ch. Pfohl; CEE-Expansion..., op. cit., p. 13.

Fig. 72. Increase in logistics costs and complexity of processes is caused by additional services that create added value
Source; H-Ch. Pföhl; CEE-Expansion...op. cit. p. 14.
costs. Because of the “bypassing” of the new location by the head office, there is no direct contact between requests of customers and control of production in its new location. To confirm these opinions one may give two examples from the practice of manufacturers-suppliers in the automotive industry:

Example 1: Interior Supplier. Sales revenue – EUR 100 million. Relocation to Czech Republic

<table>
<thead>
<tr>
<th>Increase in productivity within first 3 months</th>
<th>up to 30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional checks in Germany</td>
<td>ca EUR 100 000/year</td>
</tr>
<tr>
<td>Unplanned transport costs</td>
<td>ca EUR 80 000/year</td>
</tr>
<tr>
<td>Increased flow time</td>
<td>up to 100%</td>
</tr>
<tr>
<td>Additional costs of packing and re-packing</td>
<td>ca EUR 100 000/year</td>
</tr>
</tbody>
</table>

Example 2: Company 2. Sales revenue – EUR 400 million. Relocation to Poland

<table>
<thead>
<tr>
<th>Unplanned transport costs</th>
<th>ca EUR 80 000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased flow time</td>
<td>ca 60%</td>
</tr>
<tr>
<td>Increased level of stock in parent company</td>
<td>ca EUR 700 000</td>
</tr>
<tr>
<td>Additional costs of packaging</td>
<td>ca EUR 80 000</td>
</tr>
</tbody>
</table>

Although the examples indicate increase of logistics costs, they do not eliminate the general advantages of relocation to countries of low labour costs. It may be assumed that in the process of learning and market adaptation, the level of the unplanned, additional logistics costs will be decreasing.

Some instruments of transport policy of the state can also have an impact on the level of logistics costs, of which an interesting example is the introduction by some countries of a system of charges for the use of road infrastructure, which directly increases logistics costs in the part related to transport subsystem. And so, for example, on 1st January, 2004 Austria introduced a toll of between 13 and 27.3 cents for using Austrian motorways and express roads by trucks of total allowable weight exceeding 3.5 tonnes, and in six sections of motorways – of up to 1.73 per kilometre. The toll significantly increased logistics costs in trade, in which previously the costs reached or even exceeded the level of 20% of total costs. Studies conducted by Austrian Trade Association indicate that distribution processes of over 50% of big trade organizations are carried out through 1 to 3 distribution levels for fast moving consumer goods. The estimates say that the resultant increase of logistics costs in trade in various groups of companies was from 5 to 20% (average increase by 7.5% of total logistics costs) – see Fig. 73.

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29 Ibidem.
30 Handelslogistik 2004: Kundenzufriedenheit sichern, Kosten reduzieren. [In:] Informationen für Handel und Commerce. 10 Jahrgang, 7-8 2004, p. 2.
31 Ibidem, p. 2.
The increase in logistics costs due to toll imposition was almost 3% of the value of the goods. In the financial dimension, in 2004, it meant that the economy paid ca EUR 720 million for using the roads. In connection with the above it is interesting to say that until toll system was introduced, logistics costs were of relatively stable character, and in many cases they even decreased as a result of modification of supply chains by greater scope of cooperation of exchange process participants.

22.5. Bibliography


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Fig. 73. Development of logistics costs by industry (industrial averages)
Source; H-Ch. Pfohl; CEE-Expansion…, op. cit., p. 16.


Chapter 23
RISK IN INNOVATIVE PROCESSES
IN TRANSPORT AND LOGISTICS
(Przemyslaw Borkowski)

23.1. Nature of innovative risk

Operations of transport and logistics companies are accompanied by many risks, the most significant of which is innovative risk as a factor that may diminish the company’s competitiveness. If a company fails to introduce proper innovations in transport production or to change the character of services in time, it exposes itself to the risk of being outdistanced by its rivals, who react to market demands quicker and better. On the other hand, risk may be related to hazards of innovations themselves. So, on the one hand, a company takes a risk when it does not update its offer in time, thus losing to its potential rivals: in this context the innovative risk becomes a competitive risk. On the other hand, the introduction of innovations brings about a number of threats resulting from lack of experience, possible implementation errors, or improper technical and organisational solutions. When a company does not introduce innovations, the competitive risk arises, and as such it is evaluated within the company. From the point of view of the company introducing innovations, the risk occurring then is the most relevant; this kind of risk is called ‘the’ innovative risk.

The innovative risk must be differentiated according to the nature of the companies involved; the forms it takes in transport, forwarding and logistics companies are different from those in enterprises dealing in infrastructural investments.

The innovative risk within transport and logistic activities can be equated with the technological risk as defined by Schumpeter’s theory. According to

this theory, a natural course of development of a given market with no innovations is a shift from many competing entities to their limited number or even to a monopoly. This results from a general need for cutting down costs. At a certain stage, the only way to reduce costs is to combine business entities in order to achieve economies of scale. The survey shows that there is strong competition within the sector, particularly in road and air transport. What has caused this situation is innovations: the monopoly collapses when new inventions appear, breaking the monopolist’s petrified offer (the monopolist, as the only transport service provider, has no incentive to introduce improvements), and as the inventions are improved, competitiveness grows stronger. In the competitive transport sector, the dominating type of competitiveness is most important; if competition concerns quality and prices, the tendency to introduce innovations is stronger. Then the innovative risk regarded as equivalent to the technological risk translates, on the one hand, into the hazard of stronger competition that will be more effective because of the introduction of new solutions, and on the other – into the hazard of the company’s own technological underdevelopment.

There are four kinds of errors enterprises make, becoming vulnerable to the innovative risk in its technological form. Firstly, they are mistakes in development strategies which make technological development impossible. Secondly, there is lack of vision, which means the inability to adapt new discoveries to innovative business operations. Thirdly, we can say a company lacks vision when it does not see possible relations between the existing technology and innovations, and the impact they can have on the market, population, culture, customers’ habits. A significant number of transport devices and appliances were invented by individuals, i.e. innovators who took the risk of innovation on their own, and in the beginning were often rejected by the transport market. For example, when it produced its first automobiles, the Daimler company was considered flippant, and its product a fad; great success of the aeroplane started in the workshops of French and German aviation pioneers and in a bicycle workshop owned by the Wright brothers in the USA. The fourth mistake is lack of resilience necessary for the implementation of one’s own good project. Usually, the introduction of an innovative idea encounters many obstacles, particularly when it goes off the beaten track. Determination is a precondition for outrunning the competitors.

However, it would be over-simplifying to reduce the innovative risk solely to its technological dimension, although it is usually a critical element in all innovations. Apart from technologies, other elements include refinement of procedures and changes in management systems. All these elements of innovative risk can be defined through factors that generate them.

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23.2. Factors of innovative risk level in transport and logistics

The sector is characterised by specific features determining the nature and sources of innovative risk. The intangible character of transport services, the necessity to respond flexibly to demand fluctuations and finally the dependence on infrastructure provided by third parties – they all combine to determine the sources of innovation risk. Factors determining the level of risk in innovations introduced by enterprises of this sector are mainly:

– project size;
– pro-innovative attitude of the enterprise or lack of experience;
– technology;
– organisation;
– specific conditions of the project.

The scale of the project is relevant considering its time perspective. Short-term projects (particularly those up to twelve months – thus financed with short-term capital) are marked by lower risk than long-term ones. The volume of financial involvement is considerably important as well. What is also important is the number of people involved in the project: innovations that engage a small number of employees in the process of their implementation are considered low-risk operations. It must be remembered that what is most relevant is a combination of all the above factors. The best method of risk assessment while innovation is introduced in a transport company is to use a number of risk maps illustrating the following factors: the degree of risk in the time scale, the degree of risk in the frequency scale, the number of people involved and the capital expenditure.

The highest innovative risk will occur in projects with large capital expenditure (because losses may be high) and those involving a large number of people (because errors may be made at more implementation stages). On the other hand, a significant element disturbing this simple analytical system is the staff competences. If many people with limited competences are involved in the implementation of innovation, risk-carrying activities are only those which affect the success of the project as a whole, as well as those which cannot be rectified at further stages of implementation.

Another frequent problem – particularly in the case of innovative projects within transport infrastructure – is the very number of the stakeholders. Some of them often have contradictory opinions on the role and function of the innovation, which results in the fact that they are not fully committed to the project (for lack of time or because of the nature of the project, where the party commissioning the project, e.g. local government, delegates to the project officials already engaged in other activities).

Another element increasing the risk is the division of the project into many constituent parts, which are very difficult to control. This also leads to blurred responsibility, where responsibility for the risk is not individually assigned.
On the other hand, the company’s previous innovation-oriented policy is a very advantageous factor in the introduction of innovations. Experience is important because it helps avoid many procedural mistakes during the implementation of innovations. Technological innovations (e.g. a new light signalling system, traffic management system, a new type of engine, etc.) can be first tested on a prototype. Organisational innovations (changes in timetables, different coordination of a transport process, etc.) can also be tested on a specific section of the transport network. Moreover, the latter type of innovation should follow a market research.

Another factor that will lower the risk is a pilot study of the project. It is important for end users to participate in the ex-ante innovation assessment, as it is their acceptance or rejection that will determine the actual innovative risk in the future. Very often, risk can be mitigated if existing standards are observed in the part of the project that keeps to its routine functions. Many projects include only one innovative element, while its other components only duplicate the existing solutions. It must be remembered, however, that the crucial aspect of innovation is the change of the previous state, therefore standardisation and certification will be applied as risk-limiting tools to a small extent only.

Another important risk factor is lack of commonly accepted norms and legal regulations in the area of innovation. Sometimes appropriate regulations are established after the innovation has been introduced (which often happens in transport – for example, traffic regulations were created after the car had been constructed, and air traffic regulations were worked out after the aeroplane had been constructed). On the one hand, this is an advantage for early innovators, because they decisively influence future regulations, but on the other – in a long-time perspective – it may be a factor limiting the profitability of the undertaking due to stricter transport safety standard of service regulations.

Technical risk sources appear when technological innovations are introduced in transport. New types of vehicles must usually undergo a test run in order to eliminate errors in the design. It must be noted that this process should take place in plants where they are produced, and transport companies should receive a ready-to-use product. However, in spite of the producer’s advanced methods of quality control, faults do emerge quite often in the operation. An ever greater problem is design errors in infrastructural facilities, as their repairs or alterations cause higher costs or even transport disasters. A possible technical source of innovative risk is the change in technical parameters of infrastructure caused by its upgrading, which at company level may cause the necessity to replace the vehicles used so far.

In the organisational context, the staff’s poor qualifications are the most significant risk factors. Users of vehicles might not be qualified enough to handle them – this problem is often solved through training offered together with the product. Similarly, support service staff must acquire new skills when innovative means of transport are introduced. However, the biggest potential hazard is
caused by innovations introduced into the transport organisation process, algo-

rithm of transport customer services or changes in forwarding. In this area, lack

of competence may remain unnoticed for quite a long time. Staff are reluctant to

admit they are nor skilled enough – and while technical skills are easy to verify,

organisational skills, prevailing in contacts with customers and management,

are often difficult to assess. Another problem may be caused by the use of

wrong shipping documents, insufficient knowledge of constantly changing

regulations and inability to respond to IT innovations.

Uncommon features of innovations become a specific source of risk. This

category includes all the unique elements of innovation which determine the

level of the company’s risk. And because they are of unique nature, they can

chardly be anticipated. They are an inherent part of the innovation process – in

fact, innovations, by definition, must generate unique and unprecedented haz-

ards. Efficient operation, flexibility in dealing with unexpected threats and

highly-skilled staff will provide protection in this respect.

23.3. Innovative risk management – identification of risk

The aim of risk management in innovative processes is to identify areas of un-

certainty that can appear as a result of innovations, and to protect the organiz-

ation from possible negative effects of innovations. It must be remembered that

innovation risk management in the sector is a process rather than a single ope-

ration. It consists of several stages, typical of the methodology of risk manage-

dent: identification, assessment and survey, protective measures and control of

results; but in the analysis and assessment of innovative risk, the specific nature

of the transport sector must be taken into account, i.e. the intangible character of

services, the dynamics of demand and its fragmentation, the complexity of

transport processes, or the time factor, so crucial in logistics.

A common mistake is to perceive risk management in innovation processes

as strict keeping to the plan, as a process the aim of which is to eliminate any de-

viations from the original plan, whereas the innovation process is determined

by a multitude of options, a possibility of departures and alterations – the nature

of innovation makes its “planning” problematic. At most, it is possible to deter-

mine general aims of innovation, and not particular details of every aspect –

technical, organisational or financial – of its implementation. In this context, the

process of risk management in innovation processes must be oriented at elimi-

nating any occurrences that could diminish the positive impact of innovation

rather than at eliminating any deviations from the original plan. Therefore, from

the practical point of view, it is best to use the quantitative measures of risk as
a basis, particularly the evaluation of potential threats to additional cash flow generated by the values created by innovations. On the other hand, quantitative methods assume “the quantifiability” of risk factors considered ex ante, which in transport innovations – because transport is a service – is problematic. Therefore, qualitative methods should be included in the process of risk assessment, especially techniques that are relatively easy to introduce in companies, i.e.:

- brainstorming;
- questionnaires;
- expert’s opinions – expert methods.

All the above analytical tools have one positive feature: they can be applied universally in the transport sector where companies vary a lot. It is impossible to create a single model process of risk management in transport, forwarding or logistics, because this sector is highly diversified: there are geographically different markets, different modes, different vehicles, various organisational structures of companies and various management strategies. The above techniques should rather be used in a flexible way, adjusting their general principles to the specificity of a given company.

The brainstorming technique consists in sharing opinions by a group of appropriately selected people. The team should usually include people who play a key role in the implementation of a given innovation task. It is advisable for brainstorming to be performed according to a specific pattern and led by a moderator with a good knowledge of the scope and features of the planned innovation. A typical procedure is like this: the moderator outlines the problem, and then particular team members devote some time to formulate their individual opinions; a person best aware of the situation writes down a draft list of risk factors on the board, and the other members add their own suggestions. Then the whole team look through the list, grouping similar risk factors where appropriate. Typically, the list is limited to about 9-12 key risk factors which can have some subgroups. Brainstorming is particularly useful while carrying out risk analyses of new projects or in unusual situations, because they conduce to innovative thinking and breaking schematic patterns. The “list of threats” technique, often regarded as an alternative one, is not particularly effective in assessing innovation risk – it is recommended in routine situations as more effective and quicker, but burdened with conventional thinking. The questionnaire technique is worth considering: each of the key people is given a form with a list of questions. However, there is a risk here that the types of questions could suggest answers. Moreover, the number of people filling in the forms may be insufficient, and filling in the form can be time-consuming. Table 47 shows a model risk questionnaire.

In order to identify the widest possible scope of risk factors, questionnaire-makers often base their forms on particular stages of implementation of a concrete innovative task, i.e. the WBS (Work Breakdown Structure). The problem is that in fact a well-designed WBS may be provided only by a manager responsi-
ble for the implementation of a given innovative project. There are two impediments here: firstly, he/she must be involved in the procedure of risk factor identification (i.e. devote time), at the same time being one of the people to whom questions are addressed, so he/she is responsible for both input data and its future evaluation. A method frequently used by companies is analysing similar innovation processes carried out by their competitors; however, innovation by definition always includes new and unique elements, so comparative assessment of risk factors could be highly erroneous. A good method is to rely on experts’ opinions, as far as a company is able to recognise the value of their recommendations. In order to reduce the effects of a wrong choice of expert, companies often make use of services of specialised advisory institutions. A drawback of this method is a high cost of hiring a professional advisor, and it can also be difficult to identify the proper expert, as there are a lot of consultants operating within the sector.

23.4. Innovative risk assessment and mitigation

The innovative risk is one of the least measurable risks. On the one hand, it is difficult to determine a priori the impact of abortive innovations on possible decrease in the company’s value, and on the other – there is no benchmark with which to compare it. Because of this, and because of the difficulty in estimating the cash flows the innovation can generate in future, it should be recommended that risk be evaluated by qualitative rather than quantitative methods. The following methods can be useful:

– list of risks;
– risk mapping;
– risk matrix.

The first method is particularly useful in TL companies; the second one is most commonly applied to assess transport infrastructural investment risk, but can be also used to describe hazards in transport companies; the third one is practical for both, innovative investment in infrastructure and a transport company’s own investment.

Table 47. Risk questionnaire

<table>
<thead>
<tr>
<th>No</th>
<th>Risk factor according to respondent</th>
<th>Risk description</th>
<th>Corresponding WBS element</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>XXXX</td>
<td>XXXXXXX</td>
<td>XXXXXXXXXX</td>
</tr>
<tr>
<td>2</td>
<td>XXXX</td>
<td>XXXXXXX</td>
<td>XXXXXXXXXX</td>
</tr>
<tr>
<td>...</td>
<td>......</td>
<td>........</td>
<td>........</td>
</tr>
</tbody>
</table>

Source: Own study.
The ‘list of risks’ method consists in the identification and prioritization of factors which can be a source of innovative risk. In practice, this means making a list of all the aspects of an innovative undertaking, grouping them according to the scope of problems, analysing the risk load of each of the listed elements, and describing any expected negative effects it may cause (See Table 48).

Table 48. A possible format of a list of risk factors in implementing innovation

<table>
<thead>
<tr>
<th>Element</th>
<th>Consequences</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Critical/major/medium/minor</td>
<td>Description of potential effects should a given risk component occur</td>
</tr>
</tbody>
</table>

Source: Own study.

In practice, during the implementation of innovations in companies, these lists can be very complex and include many unit areas – depending on the service range. A good key for making the list is the use of identified risk sources divided according to the above-discussed areas in which they arise.

The second of the techniques, the risk map, is the idea of risk lists extended by an element of time of exposure to risk. While risk lists enable identification of the strength of risk factors, the risk map makes it possible to estimate their frequency and duration. An additional value of the risk map for the innovative process is a clear graphic form of presenting results, which enhances quick decisions neutralising factors generating risk during the implementation of innovations. The risk map is supposed to help the risk manager to recognise the whole scope of risk generating factors to which the entire company is exposed during innovation processes. Its aim is to prevent making decisions based on fragmentary information that does not show the full impact of innovation on the company.

In a transport company, there are some areas influenced by potential innovations that are particularly important, and should be included in the risk map. They are: type of cargo, type of vehicles and their potential replacement, transport procedures, transport routes, maximum axle load, worktime and working conditions (depending on the mode: drivers, pilots, navigators, etc.), impact on technical requirements, scope and type of shipping documents. The implementation of innovations may cause changes in each of these elements, and the risk map is meant to illustrate the strength of these changes in the context of adaptation time (i.e. how long particular areas are exposed to risk) or their frequency in the course of a given service. In forwarding, an additional aspect of innovations is their impact on other services the forwarder can offer: influence on terms of insurance, payment dates, possibility of using selected business forms, change of a means of transport or cargo handling operation. As far as logistics is concerned, there are some more aspects of impact to be considered: on warehousing operations, storage conditions, speed of cargo delivery, possibilities of imple-
mentation of adopted logistics concepts, effectiveness of IT systems supporting logistics.

Innovations may refer to each of the typical activity areas of the TL sector (See Table 49). Therefore, these areas are subject to innovative risk assessment by being analysed individually with regard to risk generating factors, and then placed on the risk map.

Table 49. Typical innovation areas in investment risk assessment in the TL sector

<table>
<thead>
<tr>
<th>Logistics</th>
<th>Transport</th>
<th>Transport and forwarding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer service</td>
<td>Loading</td>
<td>Forwarding consultancy</td>
</tr>
<tr>
<td>Demand forecasting</td>
<td>Unloading</td>
<td>Organization of shipping process</td>
</tr>
<tr>
<td>Flow of information</td>
<td>Carriage</td>
<td>Insurance</td>
</tr>
<tr>
<td>Stock management</td>
<td>Transhipment</td>
<td>Trade and shipping documents</td>
</tr>
<tr>
<td>Order execution</td>
<td>Organisation of transport processes</td>
<td>Customs clearance</td>
</tr>
<tr>
<td>Supplies</td>
<td>Transport management</td>
<td>Financial settlement</td>
</tr>
<tr>
<td>Site selection</td>
<td>Shipping documents</td>
<td>Feeder service</td>
</tr>
<tr>
<td>Packing</td>
<td>Vehicles</td>
<td>Elements of transport, if the forwarder is also a carrier</td>
</tr>
<tr>
<td>Handling of returns</td>
<td>Drivers’ working conditions</td>
<td></td>
</tr>
<tr>
<td>Waste management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deliveries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logistics management</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Own study.

Not only does the risk map vividly, graphically, inform about risk factors of a given innovation, but it attributes a value (relevance) and probability of occurrence to each of them as well (See Fig. 74).

The risk map may also refer to another level of innovative risk assessment – the comparison of innovation implementation expenses and staff engagement, measured either in terms of the number of employees involved or in terms of the number of man-hours spent. (See: Fig. 75).

Each risk map lets us distinguish four quarters. Risk factors in the upper right-hand quarter denote the most significant innovative risk components, which if materialized, may cause serious effects. When creating a specific innovative risk map for a company, we must consider what we want to achieve. The aim of the process may be to demonstrate what risk size is acceptable to the company, to create a catalogue of factors having negative impact on proposed innovation, or critical factors – which may undermine the very sense of the innovation. The assessment of the impact of risk factor on its level – i.e. deciding about the location of individual elements on the risk map – is a key element of
the success of this risk description method. Ranking is relatively simple where these factors can be demonstrated as certain values. The problem arises when there is no such possibility, because the factor is immeasurable or difficult to evaluate. In such a situation, we must rely on transport experts’ opinions who will prepare risk ranking based on their long experience.

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Generally, in most innovation processes in transport or logistics companies, the support of external experts is problematic because of high costs, the intent to keep the innovation secret before it is launched on the market, and the difficulty and effort (financial and intellectual) needed to prepare a description of the company’s standing that an external expert would need. Therefore, most often in-house experts are asked to do it. Such a team of experts would play a role similar to that played by risk committees in big companies; it should be composed of, at least, a person responsible for launching innovation, a representative of the board, a representative of the financial department, the manager supervising the implementation of innovation. If the innovation is of technological nature, it is necessary for the team to have an expert in the technology in question.

For reasons mentioned above, it is often very difficult to conduct precise estimation of factors generating innovative risk in transport and logistics. In this situation it is advisable to give certain value intervals depending on the scenario: best-case, normal or worst-case. This means, however, that the risk map is no longer an optimum tool, because every risk map will show only one path of developments. Therefore, a transport sector (in the wide sense of the word) company can make use of one more technique that would enable comparisons between different variants of innovation implementation, i.e. the risk matrix which enables more flexible evaluation of scenarios. The first step in the procedure of building up the risk matrix is similar to the procedure applied in risk lists. The company should define certain intervals, e.g. minimum, little, medium, great or disastrous impact of a given factor on the risk of the innovative process.

It is necessary to define the duration of risk factor in order to use this method. Therefore, a time horizon matrix is created (See Table 50).

Table 50. Time horizon of risk factors

<table>
<thead>
<tr>
<th>Frequency of occurrence</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>Occurs very often, once a week or more often</td>
</tr>
<tr>
<td>High</td>
<td>Occurs often, once a month on average</td>
</tr>
<tr>
<td>Medium</td>
<td>Occurs occasionally, once a year</td>
</tr>
<tr>
<td>Low</td>
<td>Might occur but rarely, usually once in a few years (every 3 years, every 5 years)</td>
</tr>
<tr>
<td>Very low</td>
<td>Unlikely, usually once in 10 years or more</td>
</tr>
</tbody>
</table>


It must be stressed that what is at issue here is not the estimation of the time needed to implement innovation, but the estimation of the duration of the transport process, forwarding or logistics operations, or the time of cargo storage in a warehouse and circumstances which (if the innovation fails or has unforeseen effects) can bring about unfavourable occurrences. Therefore, time of both operations is relevant, i.e. duration of the innovation implementation and duration of its effects overlapping duration of the company’s typical operations. Depending on the implementation time, a specific value interval in the time horizon matrix should be adopted. Transport infrastructure innovations are usually characterised by a long time of implementation, which means that risk factors may occur in a long period of time. In transport operations this period is shorter, in forwarding it depends on the duration of the forwarding process, while in logistics (which is usually based on the shortest possible operation time) it is short.

Other risk factors that should be taken into consideration are those of recurring nature, i.e. occurring, for example, at the beginning of innovation implementation process and in certain circumstances in the course of implementation.

On the basis of input data defined in this way, the company weighs them up, thus illustrating the impact and duration of risk factors. In this way it obtains the framework risk matrix. Creating a specific final risk matrix for a specific innovative investment depends on the assumptions of acceptable risks and results of subsequent stages of innovative project implementation and the expected time of their completion. The objective of this process is both to demonstrate what level of risk is acceptable during the implementation of the innovation and make a catalogue of occurrences of critical significance for the innovation to be introduced successfully. As is the case of the risk list method, this also requires the identification of which risk factors are critical, and their analytical presentation. Specific items from the earlier established risk list are used, and then entered into particular cells of the risk matrix built by a juxtaposition of probability and severity of impacts of particular risk factors. Particular cells of the table designed in this way correspond to various degrees of hazard (See Table 51).

Table 51. Risk matrix

<table>
<thead>
<tr>
<th>Effects/Probability</th>
<th>Very high</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Very low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Major</td>
<td>D</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>M</td>
</tr>
<tr>
<td>Moderate</td>
<td>D</td>
<td>S</td>
<td>S</td>
<td>M</td>
<td>N</td>
</tr>
<tr>
<td>Minor</td>
<td>S</td>
<td>S</td>
<td>M</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

D – high level of risk, S – moderate level of risk, M – low level of risk, N – negligible risk from the investor’s point of view.

Source: Own study.
Next, it is possible to read the factors that have a strong negative impact on the innovation and occur in a short time perspective, thus requiring immediate action (See Table 52).

<table>
<thead>
<tr>
<th>Risk factor level</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Immediate</td>
</tr>
<tr>
<td>Moderate</td>
<td>Action to mitigate risk should be taken as soon as possible</td>
</tr>
<tr>
<td>Low</td>
<td>Long-term strategy for reducing risk must be planned</td>
</tr>
<tr>
<td>Minor</td>
<td>Acceptable risk</td>
</tr>
</tbody>
</table>


Finally, in order to define risk protection procedures as recommendations for entities implementing innovation, a risk keeping/transfer diagram must be used (See Table 53).

<table>
<thead>
<tr>
<th>Probability Effects and value in monetary units</th>
<th>Unlikely</th>
<th>Rare</th>
<th>Possible</th>
<th>Likely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible (value 0-1000)</td>
<td>Z</td>
<td>Z</td>
<td>Z</td>
<td>Z</td>
<td>Z</td>
</tr>
<tr>
<td>Small (value 1001-10000)</td>
<td>Z</td>
<td>Z</td>
<td>CU</td>
<td>CU</td>
<td>CU</td>
</tr>
<tr>
<td>Moderate (10001-50000)</td>
<td>Z</td>
<td>CU</td>
<td>U/Z</td>
<td>U/Z</td>
<td>U/Z</td>
</tr>
<tr>
<td>Large (50001-500000)</td>
<td>U/Z</td>
<td>U/Z</td>
<td>U/Z</td>
<td>U/Z</td>
<td>U/Z</td>
</tr>
<tr>
<td>Catastrophic (more than 500000)</td>
<td>U/Z</td>
<td>U/Z</td>
<td>W</td>
<td>W</td>
<td>W</td>
</tr>
</tbody>
</table>

Z – keep risk, CU – insure risk partially, U/Z – insure or manage with the use of financial tools, W – give up action.


Risk factors with effects of negligible value or unlikely to occur should be left unprotected. As a potential loss grows, insurance packages should be applied, and then active risk management with the use of market financial instruments must be adopted. Similarly, with growing probability of risk occurrence protective measures grow as well. When the analysis shows factors with catastrophic impact on the company and high probability of their occurrence, it is a sign for giving up the implementation of innovation. The values proposed in the Table were established in an arbitrary manner, and correspond to the situation of an average transport company – depending on company size, its readiness to take risk and its resources, these thresholds may be individualized, depending on a company’s needs.
Partial formalization in the process of innovative risk assessment is necessary for maintaining reasonable time scope and accumulating resources (human and material) for risk assessment so that the cost of risk assessment would not be higher than potential losses the innovation might bring. However, the innovative risk is a type of risk where unconventional thinking is needed, i.e. dealing with threats as they arise. As Albert Einstein said: “We can’t solve problems by using the same kind of thinking we used when we created them”. It is not enough to identify risk to prevent its impact. Creative thinking is necessary when expected effects of risk are being estimated, because only such attitude will enable appropriate protective measures to be taken. It must also be remembered that innovation in a TL company has a measurable positive effect, and risks emerging during its implementation are not the essence of innovation but just its “side effects” which can rarely ruin the effect of innovation completely. However, innovative risk analysis is important as early identification and assessment of risk make it possible to modify strategies for innovation implementation thus increasing its effectiveness.

23.5. Bibliography

Chapter 24

INNOVATIVE FINANCING
OF TRANSPORT INFRASTRUCTURE
(Elżbieta Adamowicz)

24.1. Introduction

Innovation, inevitably connected with all areas of social and economic life, is a challenge of modern civilization. Adapting to innovative challenges also refers to transport sector. Modern transport must meet the needs of efficient communication and spatial integration of distant markets, while observing the principles of sustainable development. In this context, shaping modern techniques of physical movement and servicing of people and goods, developing innovative solutions based on information and satellite technologies, implementing new concepts of managing transport and logistics processes as well as integration of various forms of transport become more and more significant. In recent years also qualitative parameters of transport activity, such as reduced energy intensity, decreased environmental impact, better use of means of transport, enhancement of traffic and transport safety, increased traffic flow and traffic optimization in time (on a daily basis in particular)\(^1\) are becoming increasingly important. Implementing innovations in this area requires application of innovative solutions not only in terms of means of transport and traffic organization but also in terms of infrastructure, which, however, is hindered by the existing financial barrier. It refers in particular to the financing of infrastructure, which is capital-intensive both to build and to maintain. Investments in means of transport are also capital-intensive, although this is a problem of transport companies, which can receive various forms of external financial support. Significant differences

between those types of investments can refer to, *inter alia*, typical sources of finance, to implementation time, entities responsible for undertaking the investments, and finally, ways of assessing profitability. The special character of such investments determines sources of finance, and this is why they should be considered separately. Looking for innovative forms of funding transport infrastructure is the subject of this chapter. Intensity of research in this respect increases along with the increasing deficit in public finance and the growing difficulties in public finance management.

**24.2. Factors affecting the search of innovative forms of funding transport infrastructure**

A detailed analysis of direct and indirect effects generated by infrastructural investments helps to determine whether financing from various sources is justified. Undoubtedly, a significant share of effects received by the society make public funding a must, whether from the state budget, or from local government budgets. Legitimacy of involving public funds in financing transport development also results from considerable fiscal revenues from transport, in the form of charges paid both by individual car users and by transport companies. Transport expenditure constitutes a significant part of household consumption, which in EU-27 countries in 2006 reached the level of 13.6%. In 2006, the households in EU-27 countries spent a total of 893 billion euro\(^2\) on transport. The budget revenue generated in this way, from fuel fiscal charges in particular, constitutes a significant source of finance generated by transport. The funds from such fiscal charges are not always allocated to support the sector that has generated them. Very often road transport income finances objectives set by individual states. An analysis of the situation in most countries indicates difficulties in acquiring funds for infrastructure maintenance and development. The problem is of special significance in the countries in which the existing needs considerably exceed the available traditional sources of finance. The backlog of many years in financing transport infrastructure can still be observed, in particular in the new EU Member States.

The deepening deficit of public finance affects the transport sector in particular. The existing difficulties in public finance management influence the infrastructure managed by public authorities, which consequently affects development of transport infrastructure. Actually, all European states have a problem

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with weakness of public finance and that is why, despite the use of traditional forms of financing, new solutions are being sought. It refers both to international level, as well as national and regional levels. Since the traditional sources of finance do not meet the existing needs, looking for and implementing new and thus innovative solutions supporting the development of infrastructure is of special significance.

The main difficulties in looking for effective solutions of financing infrastructure also include user resistance against attempts of charging them with the costs of using the access to transportation network. Specific features of infrastructure, capital-intensity, high risk and long period of infrastructural investment projects hinder looking for new sources of finance. Those features significantly limit, and in some case exclude, participation of a private investor, who expects return of invested capital in the shortest possible time. Creating various forms of incentives (e.g. revenue bonds) and eliminating barriers hindering involvement of private capital in financing infrastructure is a challenge of today.

Despite limited funds, irrational use of available sources of finance in the process of implementing investment projects is not infrequent. The problem can be seen, inter alia, at the stage of project selection, which not always results from assessment of existing needs and consistently implemented infrastructure development strategy and transport policy, but may be an effect of the pressure of various interest groups. Many shortcomings can also be observed at project implementation stage, which increases the costs and lengthens construction period. The observed shortcomings in using the funds constitute a significant premise for seeking solutions that will increase the effectiveness of the projects that are implemented.

24.3. The nature and directions of innovative financing of transport infrastructure

The notion of innovativeness is most frequently identified with introducing into economic practice of a new or significantly enhanced solution in relation to a product (merchandise or service), process, marketing or organization. In this context, innovations in the financing of infrastructure can consist both in developing totally new solutions on a global scale and in improving the existing solutions in traditional systems of financing. It is often the case that what is innovative financing solutions for the transport sector may have been used before in

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other sectors of the economy. Such type of innovation is called imitating innovation, and consists in replicating original changes applied in other entities or in other markets. This is why a solution already present in the market but applied for the first time in other entities can be treated as innovative.

Innovativeness can appear at various levels, both of the entity itself (creating or implementing innovation), and of a given market, sector, region, country or the world. It must be emphasised that innovation does not have to be new for the market, but it has to be new for the entity implementing it. Involvement of public-private partnership in financing infrastructure development can be an example of this type of innovation. In countries in which public-private partnership has been successfully used for years this form of financing can be considered to be traditional (Australia, Great Britain). And in many countries this form of financing is treated as innovative financing. The differences in involvement of private capital in infrastructure depending on maturity level of the market is presented in Fig. 76.

Fig. 76. Variations in infrastructure of market maturity across global markets


Trying to place innovative financing of infrastructure within a certain type pattern of innovation, one can apply the most frequently used criterion of the subject, under which the following can be distinguished:

– product innovations;
– process innovations;
– organizational innovations.

In the case of innovative financing one can also apply a criterion of implementation scale, which assumes three levels at which innovation is new:

– new for the entity (new in micro scale);
– new for the market;
– new in global scale.

Because of the specific character of transport infrastructure projects, one can also distinguish between local, regional, national and international scale.

Innovative financing of transport is broadly defined as a combination of specially created methods that complement traditional financing (most often - public). In this context, the following are considered to be the basic objectives of innovative financing:

– greater number of infrastructural projects in transport;
– maximization of the fundraising capacity of entities responsible for infrastructure development;
– more efficient use of existing funds;
– faster project implementation;
– making implementation possible of projects that could not be financed in traditional conditions.

Looking for new and more efficient system solutions in financing transport infrastructure is multi-directional. The research carried out for many years now emphasises mainly charging the users of transport infrastructure with its costs. Additionally, the main areas in which innovative solutions are sought include the following:

– enhanced use of the existing public funds – e.g. by improved management of infrastructural projects;
– increased powers of local authorities in imposing charges, management and financing of transport infrastructure;
– increased involvement of private capital.

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7 Ibidem.

Comparative analysis of innovative solutions applied in EU Member States indicates the leading position of Great Britain. Numerous examples of involvement of private capital in financing transport infrastructure, as well as considerable decentralization of investment decisions are worth mentioning here in particular.

Innovations in transport financing can be analyzed both in terms of raising funds and spending them, in the aspect of availability of new financial products, new methods and techniques of raising funds, new rules of funds allocation, new ways of infrastructure management (shifting the responsibility for infrastructure development from public authorities to other entities), new ways of investment project management.

International research focuses both on looking for new instruments and sources of finance and new ways of managing investments and infrastructure. In Europe the problems of innovative solutions in the financing of infrastructure were dealt with under the project FUNDING (implemented under 6th Framework Programme). The project focused on creating scenarios of financing big transport infrastructural projects. The proposal to establish European Infrastructure Fund at the EU level, is an innovative solution.

Increasing the role of private capital, inter alia, through contracts, partial or total privatization of infrastructure as well as through involvement of pension and insurance funds constitutes a significant direction of innovative solutions.

24.4. Innovative forms of financing transport infrastructure in the USA

Looking for a model of financing transport infrastructure one can refer to the system functioning in the United States, considered to be the precursor in innovative forms of financing of transport infrastructure. In the US, the selection of financing instruments for an infrastructural project depends on the degree of its profitability. Financial instruments used to implement infrastructural projects according to their profitability are presented in Fig. 77.

The system of financing road investments currently functioning in the United States is based on a model of federal projects, which are implemented based on cost refund rule. All the projects applying for various forms of support from public funds must get the approval of FHWA – Federal Highway Admi-

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9 Ibidem, p. 74.
10 FUNDING. http://www.econ.kuleuven.be/funding/
nistration. As the diagram presented in Fig. 77 indicates, traditional non profit projects are the prevailing form in the American market, which can also be supported by state bonds issued under a special programme, GARVEE - Grant Anticipation Revenue Vehicles. Federal funds are used to repay debts by servicing the bonds issued by the state. Innovative techniques of project management are also used for that purpose. They increase the flexibility of funds use and thus enable faster implementation of projects, which in turn increase their effectiveness. Innovative management of federal funds consists in cash flows shifting, enabling state authorities to implement the necessary projects faster. When there is a shortage of federal funds for the implementation of an infrastructural project in any given period, state authorities can use the opportunity of accelerated construction process, which consists in refund of the costs incurred in implementation of investments, after the approval by Federal Road Administration and on completion of the project. The project is implemented with the use of own funds of state authorities, and part of the costs incurred (pro rata to the set share of federal funds) is refunded on completion of the project. Innovative are also the changes in cash flows, which enable state authorities to recover their own funds allocated to finance projects, in accordance with the time schedule,
on presenting periodical payment invoices. And this is how state authorities receive funds to continue their projects.

Another group of projects includes undertakings that can partially be implemented from expected income, but require public support, e.g. in the form of easier available loans. These projects can also make use of special programmes offering state loans and the specially established TIFIA (Transportation Infrastructure Finance and Innovation Act) instrument. TIFIA instrument supports mainly projects of the highest significance to the country or the state, the implementation of which would not be possible otherwise, due to their scope, costs, complexity and high risk. Financing by private capital only is envisaged for a relatively small number of profitable projects in the American market.

Table 54. Revenue from highway users in the United States in 2004, according to distribution tier and origins

<table>
<thead>
<tr>
<th></th>
<th>Federal budget</th>
<th>State budget</th>
<th>Local budget</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel taxes</td>
<td>31%</td>
<td>32%</td>
<td>1%</td>
<td>64%</td>
</tr>
<tr>
<td>Road tolls</td>
<td>-</td>
<td>6%</td>
<td>2%</td>
<td>8%</td>
</tr>
<tr>
<td>Other user taxes and charges</td>
<td>3%</td>
<td>24%</td>
<td>1%</td>
<td>28%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>34%</td>
<td>62%</td>
<td>4%</td>
<td>100%</td>
</tr>
</tbody>
</table>


The innovations in the United States refer not only to new sources of finance, e.g. in the case of special forms of bonds (GARVEE) and new forms of crediting, but also to organizational solutions (state infrastructure banks, TIFIA) and process ones (innovative management of federal fund). Innovations in terms of generating new income, both on taxes, and charges that can be used for infrastructure maintenance and development are of special significance. Highway user income structure is presented in Table 54. Fuel taxes play a major role in generating transport income (in Florida they are responsible for 55% of budget transport revenue). The United States are also a precursor in terms of innovative charges for the use of transport infrastructure. Congestion charges depending on rush hours and charges for the use of less congested dedicated lanes can be an example here. Innovative solutions also include charges connected with the distance covered (the so called mileage charging) and charges

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dependent on the number of people travelling in a car. Pilot projects aiming at introducing charges supporting reduction of congestion are an element of SAFETEA-LU (Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users)\(^{16}\) programme, established in 2005. The programme, developed to provide for financial stability of infrastructure investments, focuses on facing the challenges of the 21st century, such as enhanced safety, congestion reduction, improved efficiency in transport of cargo, more intermodal connections and better environmental protection.

### 24.5. Innovative forms of financing transport in Poland

The forms and methods of financing infrastructure used in Poland so far do not ensure the meeting of fundamental needs in the field of Polish transport infrastructure enhancement. The weakness of the Polish system of financing infrastructure consists not only in the condition of public finance and low efficiency of public funds management, but also in lack of innovative financial solutions limited to the legal framework of public-private partnership. From the point of view of the existing needs in Polish transport, special emphasis should be put on intensification of available sources of finance. Apart from sources of capital available for many years now, new opportunities in this respect appear in the Polish market. The evaluation of the first years of Polish membership in EU indicates a significant role of EU funds in developing new quality of transport infrastructure, as the funds used so far have resulted in both quantitative and qualitative changes, in road infrastructure in particular. Despite considerable involvement of public funds, concentration of EU financial assistance on infrastructure investments is not enough to improve the position of Poland in transportation market. That is why looking for new solutions in financing transport infrastructure is so important.

Polish practice shows that development of financial market leads to evolution in financing transport undertakings. Current availability of funding opportunities for both infrastructure and means of transport is much higher than at the beginning of Poland’s transition. The introduction of new forms and techniques of financing is undoubtedly an innovation in the Polish market. Since Poland is not a pioneer of implementing innovations in financing transport, the use of ideas and solutions applied elsewhere should be considered innovative. According to the guidelines for the Operational Programme – Innovative Economy for the period of 2007-2013 – innovation is implementation (for the first

time) of a new solution that has not been used in Poland for longer than 3 years. In this context, the use of EU funds and the establishment of the National Road Fund was innovative at the time. New forms of financing companies and infrastructure are currently being implemented. The research carried out by the author for many years now indicates an existing information barrier concerning availability of funding in the Polish market. In the area of infrastructural development, the problem in particular refers to local authorities (municipalities and districts - powiats). It certainly hinders implementation of many undertakings, because very often entities involved do not have the information on new financial solutions, innovative in the Polish market.

Funds offered by Swiss-Polish Cooperation Programme are undoubtedly a novelty in the Polish market. Under the programme, Switzerland has granted to Poland non-refundable financial assistance of 489 million CHF for a five-year commitment period and a ten-year period of spending, which started on 14th June 2007. Environment and Infrastructure with the total allocation of 127.5 million CHF is one of the four assistance areas. The programme also provides financial assistance in the area of improving management, safety, efficiency and reliability of local/regional transportation systems. Projects eligible for support under that objective are the ones of a minimum value of 3 million CHF (projects with investment elements - 10 million CHF) to be implemented in the following areas:

- development of documentation (feasibility studies) for big investment transport projects;
- small and well targeted projects on railway infrastructure and rolling stock;
- modernization of monitoring and control systems;
- passenger and ticketing services.

Financial products innovative in the Polish market and assistance programmes concerning development of infrastructure projects are also offered by international financial institutions. The analysis of the support to transport investments indicates the dominant role of the European Investment Bank. The JASPER initiative, under the auspices of EIB, supporting big infrastructure projects can be an example here.

Financing infrastructure within public-private partnership can still be considered innovative in Poland. This form, used in many countries, has not been significantly present in Poland so far. The concession system of building motorways has not contributed to reaching the expected results. The legislators responsible for not adopting relevant legislation and political and social barriers

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19 Ibidem.
are usually blamed for such a state of affairs\textsuperscript{20}. The public-private partnership law has many errors, is not clear enough and as such is not very popular. The legislation due to be adopted lets us be optimistic in this respect. Sejm, the lower house of parliament, has just completed proceedings on the government project public-private partnership. One must mention, however, that resistance in this respect occurs both on the part of public entities (fearing corruption charges), and on the part of private entities.

The examples given above do not present the full range of new sources of finance available in Poland to the entities responsible for the implementation of infrastructural undertakings (local and national agencies). The existing financial solutions are not sufficient to meet the current needs, and that is why looking for new rules, techniques and forms of financing is still a problem waiting to be solved.

\textbf{24.6. Bibliography}

10. \textit{Narodowy Program FORESIGHT “Polska 2020”}.

SUMMARY AND CONCLUSIONS
(Jan Burnewicz)

Innovations in transport and logistics are dynamic, short-lived and obsolescent, but they create the biggest chances for the future of the sector. The analysis conducted in individual chapters of this monograph was subordinated to the need for defining a prospect – clear and as reliable as possible – of sustainable and new-quality development of the sector in the nearest 15-20 years. Careful observation of innovation processes in the world shows that the second decade of the 21st century may become a period of a concentrated technological breakthrough in transport.

A starting point for the assessment of changes in the TL sector is their clear-cut and indisputable classification from the point of view of their innovative character. What is practically significant is the distinction between simple changes, breakthrough technologies and revolutionary concepts. The latter are often of purely theoretical character, and are unfeasible in given economic and social conditions. Chapter I of this monograph organises the notions related to this topic; its author, Sylwia Pangsy-Kania, presents a theoretical framework of innovation processes in modern economy. The innovations should be viewed broadly to include: • functional innovations (concepts of meeting new, previously undisclosed social needs, creating new functions of products and services), • object related (ideas for new objects to be substituted for those currently in use, as better fitted to the task), • process related innovations (introducing new, more efficient production methods, thus making manufacturing cheaper, while improving working and environmental conditions), • structural/organizational innovations (improving the organisation of work and production and occupational safety).

Innovations are usually thought to be progressive, but we must not fail to notice cases of creating harmful innovations (new weapons, substances and drugs, fast foods, etc.). Such negative innovations appear in transport as well, and they are usually created in order to disable or neutralize certain bans or regulations (radar detectors, CB radio, noxious fuel additives) or to make leisure
activities more attractive (quads, mini-hovercraft). However, only progressive innovations (facilitating processes, cutting down energy consumption, improving safety, etc.) are introduced into national and regional transport systems.

Innovation is a social phenomenon that entails creating pro-innovative culture, entrepreneurial activities, social acceptance and recognizing the innovation as a key element of economic development. Innovations created in closed scientific circles are not very significant. Innovations affecting large groups of population can be created only with close cooperation between science and industry, enterprises introducing new technologies, public and local government institutions and consumer organisations.

The motives for creating innovations are both the creative capabilities of scientific research centres and industry as well as pressure from consumers for a greater higher of products and services, and elimination of faults in things and processes commonly used. Considering these two motives, we can identify the following models of innovation processes: • technology push innovation model, • market pull innovation model, • interactive (coupling) model, • integrated (network) model, • simultaneous (system integration) model. Observations show that in the present-day world there is an evolutionary shift from technology push or market pull to integrated and system models. This is manifested by new organisational forms of innovation processes, i.e. technology platforms.

In the modern world, innovative intensity is not distributed evenly, neither in spatial nor in sectoral scales. There are regions or conurbations being traditional cradles or driving forces of innovation: the famous Silicon Valley, the European autocluster BelCAR (Stuttgart Region, East Anglia, Upper Austria, Lombardy, Catalonia), Kansai Science City, Japan (situated halfway between Tokyo and Osaka), Tsukuba Science City, Japan, and others. There are also a number of ambitious initiatives to build from scratch some innovation centres in selected regions (RIS - Regional Innovation Strategy), whose importance, against the existing well-known innovation-cultivating regions, cannot be over-

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2 Transport innovations in Europe are created by such technology platforms as ERRAC, ERTRAC, WATERBORNE and ACARE.
6 Tsukuba Science City – http://www.tsukuba.ac.jp/english/about/tsukuba.html.
estimated. In 2008, European countries – innovation leaders were: Denmark, Finland, Germany, Sweden, Switzerland and Great Britain.

In industry, there are production sectors regarded as innovative and creating grounds for the development of other sectors. These are now sectors specialising in nanotechnology, biotechnology, information technologies, ecology technologies, power-production technologies, quantum engineering, spintronics (mesoscopic electronics) and other emerging technologies (high-tech industry). Traditional production sectors create ever higher demand for innovative segments specialising in creating new generation sub-assemblies, instruments and recycling systems.

Innovative prospects of the TL sector must be perceived and programmed on the basis of previous long-standing experience (both success stories and failures) in the development of the technical and organisational civilisation of the sector, created by discoveries, inventions and innovations. There are fundamental differences between these notions. A discovery is a positive breakthrough in the existing knowledge, and a manifestation of scientific progress. It is an observation, described and reliably proved in the course of experimentation, of a natural phenomenon that has not been noticed before. It is usually of theoretical (conceptual) character. An invention is a new technological solution that does not exist in nature, e.g. the wheel, car, radio or computer. Ground-breaking organisational changes, e.g. the calendar, legal code, assembly line, are also inventions. Long-term cycles of industrial development result from inventions. An innovation is the most universal change in human skills and knowledge, consisting in a constant sequence of improvements based on previous discoveries and inventions. However, not every novelty is an innovation – it is not if it does not improve significantly the functionality of a product (e.g. changes in design, colour scheme or range of products). The term “innovation” is excessively used in marketing and advertising campaigns, and by authors of computer programs and politicians dealing with innovations.

Innovations important for the TL sector are very often created outside it, in sectors providing it with factors of production (mainly in industry). The implementation of innovations, however, depends on absorbing capacity of the transport and logistics sphere (in the wide sense of the term), driven by both current and long-term reasons and various motives for making decisions. The logic of and reasons for the implementation of innovations in the sector are presented in Chapter II by Robert Tomanek, who outlines the scientific environment of the modern transport sector, including such fields as transport economics, technical sciences, natural sciences and social sciences. Transport research is increasingly

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interdisciplinary, although individual research reports are usually classified as separate in the achievements of particular branches and fields of science. The research is no longer an exclusive domain of specialised research centres. Innovative solutions are stimulated by the world of science as well as the automotive industry, infrastructure managing organizations, transport companies, logistics providers, consumer organisations and users of means of transport. Mature concepts and breakthrough transport technologies result from repeated and modified ideas and selected material means in the form of multi-partite consultations and brainstorming between the above-mentioned groups of entities. Innovations that meet efficiency, effectiveness and social convenience requirements can be created only when complementary technical, economic, natural and social verifications are carried out in the whole process of theoretical analyses and engineering work.

In the European Union, scientific research and innovations constitute one of 32 areas of its common policy. The issues of transport and aeronautics are regarded as priorities in all the framework programmes. Projects implemented by international and interdisciplinary teams bring concrete effects in the form of new solutions and structures in some of the most important groups of issues of the TL sector, such as: new type of propulsion, new transport information systems (telematics), electronic toll collecting systems, new systems improving the safety of carriage and traffic, new means of reducing environmental impact of transport. Owing to the fact that this research is conducted on the EU level, its results and practical use are quickly disseminated in all the member states.

A number of groups of entities take part in creating innovation processes in transport and logistics: research centres, the automotive industry, carriers and logistics providers, transport users, central and local governments, and non-governmental organisations. The success of innovative undertakings depends on cooperation between these groups of entities and on the existence of the government’s pragmatic pro-innovative policy. The issues from this perspective are presented in Chapter III by Piotr Niedzielski. A strategic (superior) objective of pro-innovative policy in transport is creating a sustainable transport system that would facilitate efficient and rapid socio-economic development of the country, with due regard to present realities of social, economic and political life. The transport system with all its elements must contribute to higher competitiveness and productivity. The implementation of this policy requires constant adequate funding of scientific research and innovations (at least 2% of GDP, including at least 0.2% of GDP for transport research), creation of pro-innovative attitudes (fighting technological conservatism), and removal of bureaucratic, procedural and fiscal barriers.

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Further chapters of this monograph outline a wide panorama of trends and innovation processes in contemporary transport and logistics. Firstly, Chapter IV presents a complete picture of present-day innovations in the entire transport sector, then Chapter V – a palette of innovation processes in logistics. The following chapters deal with characteristics and analyses of selected detailed changes in contemporary transport that are of innovative nature.

**Chapter IV by Jan Burnewicz** is a detailed and complex analysis of trends in present-day international transport. The starting point is the identification of deficiencies of the existing systems, in particular transport modes creating a “drawn effect” of innovation processes. The need to create and implement new concepts and new means results from the low efficiency of many technical elements and processes in transport, which can be seen through its inadequate efficiency and capacity, its unreliability, waste of time and resources and inflated operating costs. Another reason for seeking new solutions in transport is a necessity of improving its relations with the environment by making it more accessible in terms of space and time, by improving the quality of services and reducing its environmental impact.

The prospect of transport development is determined by the awareness that the resources of oil feasible for extraction will run out in 40-50 years. Innovations must be oriented at the development of alternative fuels and alternative types of propulsion. Quality of life stops rising when the percentage of private cars has reached a high level (more than 400 cars per 1,000 inhabitants), calling for innovations as an alternative to traditional car use resulting in constant traffic jams. The problem of land cargo transport systems is the technical separation of rail and road transport caused by the fact that in the 19th century the concepts of mechanical vehicles with iron wheels and rubber-tyres went separate ways. Innovations are needed to integrate the two modes of transport in a better way than the multimodal transport systems known so far.

The history of the development of transport technology shows that the following types of inventions and innovations were a failure: (1) inventions not founded on a specific need, (2) inventions based on risky concepts (airships, passenger vacuum tube trains, supersonic aeroplanes, jet trains, gravity control propulsion vehicles), (3) inventions taking the form of gigantic structures (gigantic vehicles, superships, superplanes), (4) inventions with significant innate defects that are difficult to eliminate by upgrading (pneumatic railway, hovercraft, lighter aboard ships, mobile passenger lounge systems, automated container handling terminals, monorail, gyrobuses, and the like). The risk of creating and promoting miscarried transport innovations involves such factors as: • limited applicability (little demand, small market), • high capital-intensiveness of research and implementation of utility projects, • irremediable defects (heavy environmental impact, high failure incidence, high energy consumption), • quick obsolescence of underlying ideas (a large number of possible substitutes), • low competitiveness as compared with existing traditional technologies. Present sys-
tem and modal deficiencies of contemporary transport make it advisable to carry out research and innovations both in the area of vehicles and their propulsion, and in linear and nodal infrastructure they must use.

The most important thing for future development of transport systems will be the implementation of the most promising breakthrough innovations on which many research and industrial centres in the world are working.

The innovation prospect for road transport consists of breakthrough solutions in the areas of: (a) new generation vehicles, (b) new generation road infrastructure. The main motive for innovations is replacing currently used fleet with vehicles that are environment-friendly, more functional, safer and occupying less space. A rich spectrum of innovations observed in the area of motor vehicles and their equipment is mainly oriented at new types of propulsion and alternative fuels. Most significant examples of specific solutions include: • vehicles entirely propelled by electricity (All-Electric Vehicle, Battery Electric Vehicle (BEV)), • Fuel Cell Vehicle (FCV), • Hybrid Electric Vehicle (HEV), • Compressed-Air Vehicle, • Road Automatic Guided Vehicle (AGV), • Full Transparent Front Vehicle, • Road Trains – developed in Australia, the USA and western Canada.

In recent years, a great opportunity has emerged of making a technological breakthrough in motor transport, based on a mature concept and successful prototypes of electric vehicles. The ambition of inventors and designers is to preserve their feature as an individual means of transport that does not depend on power supply infrastructure (as is the case with trolleybuses). If the electric vehicle is to retain all the functional values of the combustion vehicle and become a symbol of Zero-Emission Vehicle (ZEV), it must: (1) be equipped with new generation, electronically controlled, high-power batteries, fixed or replaceable, much lighter than the traditional ones, performing well in both hot and cold climates, (2) ensure a satisfactory range after a single charging of the batteries, requiring no frequent disruptions of the journey (80-200 km in cities, at least 300 km in rural areas), (3) be equipped with reasonably priced batteries, with running costs equal to or lower than the cost of fuel and high-temperature lubricants used in traditional vehicles, (4) have a well-developed power network at its disposal throughout the country, for quick recharging or replacement of the new generation high-power batteries. The first requirement – efficient powerful new generation batteries – has largely been met, since 2008. For the past few years, producers have been able to install the following new generation batteries in their electric vehicles: • sodium batteries (resistant to low temperatures), • lithium-titanium batteries, • lithium-phosphate batteries, • lithium-ion (SCIB ), lithium-polymer batteries.

The need to substitute the battery electric vehicle (BEV) for the traditional combustion vehicle is the greatest in large cities and urban areas. In these populous places there is not enough room any more for the traffic or the parking or garaging of presently bought and used typical-size cars. At the beginning of 2009, there were over 100 electric model and prototype cars of various makes
ready to be launched on the market in the nearest years to come. It has become a matter of honour for major automakers to create their own model of electric vehicle adapted to city traffic or long-distance traffic or as a highway vehicle (so far, most often as a sports car). A group of several dozen companies from various industries make the electric car their flagship product.

Of all the city BEVs already launched and marketed, the following models have attracted the greatest interest so far: • the Norwegian electric car TH!NK city, with a range of 170-180 km, prepared for mass production for the Nordic and American markets • Indian electric cars made by REVA Company, • small city cars made by the British NICE Company, • Italian electric microcars made by Micro-Vett Ydea Company, • American Tango T600 – a narrow (99 cm), extremely fast and efficient in traffic jams electric car by Commuter Cars Corporations, • the Canadian electric car by ZENN Company, • big electric city cars made by Dynasty Electric Car Corporation, • small, electric two-seater Kurrent made by American Electric, • small electric city car Maya Mobility by the Canadian Electrovaya Company, • small Chinese electric city car Flybo XFD-6000ZK, • electric minicar Toyota FT-EV. The day when vehicles of this category will be in common use is very close, because of their high technical and operational values, sufficient range and reasonable prices. After 2020, many countries will introduce traffic regulations banning the use of vehicles other than electric, hydrogen and compressed-air ones.

The perspective of electric long-distance cars being in common use is a little more remote. Battery-powered cars must have a range, after one quick charging, long enough to be suitable for long-distance travel. Therefore, they must be equipped with a larger block of state-of-the-art batteries, which makes them heavier and more expensive. In early 2009, the following long-distance BEVs were among the most mature ones in operational and commercial terms: • intensely promoted sports Tesla Roadster made by American Tesla Motors (Google), with a range of 390 km, • Toyota eBox, with a range of 240 km, available on the Californian market • very expensive luxury sports Lightning GT of the British Lightning Car Company, to be marketed in 2010, with a range of 400 km, • the Californian ZAP-X Crossover EV, with a range of 350 km, • Chrysler Dodge ZEO, with a range of 400 km, • highly advanced technologically Koenigsegg NLV Quant, equipped with flow batteries made by NLV Solar AG Company, which guarantee a range of 500 km. Apart from cars, prototypes of long-distance battery buses and trucks are being made. A leader in propagating electric vehicles is the Swedish government, which plans to eliminate all the combustion-engine vehicles after 2030. Even now, the Swedish government supports electric cars financially, giving bonuses for buying them twice as high as those given at the purchase of biofuel cars.

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11 Every car in Sweden electric by 2030. The Environmental Transport Association (ETA) – http://www.eta.co.uk/Every-car-in-Sweden-electric-by-2030/node/11951
Hydrogen propulsion is becoming another ground-breaking technology in road transport. Hydrogen is generally regarded as the cleanest and most environment-friendly fuel, because what is liberated in its combustion process, whether it takes place in air or in oxygen, is water only. Fuel Cell Vehicles (FCVs) are a technological innovation designed to reduce exhaust emissions to the atmosphere. There are several methods of using hydrogen as a fuel. It may be burnt in a traditional internal combustion engine or used in fuel cells to generate energy for the engine. A fuel cell generates electricity through the process of fuel oxidation, the fuel to be constantly supplied from outside. Most fuel cells producing electricity use hydrogen on the anode and oxygen on the cathode (other fuels are also used, e.g. potassium hydroxide, phosphoric acid, methane and methanol). The most sensitive element of the proton exchange membrane fuel cell (PEFMC) is a polymeric membrane which must be protected from low temperatures during longer parking or garaging periods because of its high saturation with water.

An optimistic prospect for hydrogen-powered vehicles results from the fact that automotive industry all over the world has been testing their successful prototypes. The advantages of fuel cells as propulsion for vehicles are: • high efficiency (65% as compared with 35% for the combustion engine), • no vibrations and noise in energy-production process, • generation of energy that directly powers electric engines, • no fuel burning when a vehicle is not moving, • constant torque, and many others. The main problem in marketing FCVs is their high price.

Between 1994-2009, some 105 model hydrogen and hydrogen/combustion vehicles were built and tested in the world. At the beginning of 2009, the product range of technologically mature hydrogen-powered vehicles included:
• Honda FCX Clarity with a range of 430 km, after a single refuelling with compressed hydrogen – it is the first car in the world powered by hydrogen solely,
• BMW 7-series Hydrogen with a dual propulsion engine: hydrogen- and petroleum-powered,
• Toyota FCHV equipped with high-pressure (70 Mpa) hydrogen tanks, which gives the vehicle a range of ca. 830 km, • petroleum/hydrogen-powered hybrid Mazda RX-8 Hydrogen RE with a Wankel engine, equipped with an additional 110-litre compressed-hydrogen tank, which enables a 100-km drive solely in a hydrogen fuel mode, • hydrogen/electric Nissan X-Trail FCV with a range of 500 km in the hydrogen mode, • Suzuki Hydrogen Fuel-Cell SX4-FCV with a range of 250 km, • the DaimlerChrysler Mercedes-Benz B-Class F-Cell Tourer with a range of 410 km, • the Fiat Panda Hydrogen with a range of 200 km. Particular attention is drawn to more common use of hydrogen-powered buses in big cities because of the need to decrease the level of smog and noise. At the beginning of 2009, there were 44 proj-

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12 Sweden favours electric cars over ethanol. The Local Europe AB – http://www.thelocal.se/12054/20080528.
ects carried out in the world, aimed at the implementation of hydrogen- or methanol-powered city bus technology. Technologically successful hydrogen- or methanol-powered model buses include: • **Daimler Mercedes-Benz Citaro fuel cell bus**, • gas/hydrogen **Flyer Invero LF Bus (F40LF)**, • hydrogen-powered **Toyota FCHV-BUS**, • hydrogen-powered **MAN Lion’s City (H2ICE)**, • hydrogen-powered **Irisbus Iveco (Fiat) City Class hydrogen**.

Another promising innovation, although revived, is the concept of the development of the Air-Powered Car technology. This technology will be less competitive as compared to electric and hydrogen-powered vehicles because of the laborious process of compressing and accumulating compressed air for distribution, yet it has a high environmental value in cities with compressed air distribution infrastructure.

There is an urgent need for innovations in **rail transport** to improve its corporate image and strengthen its position on the market. High-speed rail is no longer a novelty, it is a technology known in Japan for 40 years and in Europe (French TGV) since 1981. Its development is becoming an element of classical innovation process in different countries. However, there are numerous new concepts and innovative technologies discussed in publications and the Internet, and some of them deserve particular attention: • passenger double-deck high-speed trains, • the tram-train, • train scheduling optimizers, • telematics rail cargo transport control systems, • advanced bimodal and underground urban cargo transport systems, • energy-efficient rail vehicle propulsion systems (hybrid trains).

Major rolling stock producers in the world regard it as a priority to seek innovative solutions, presenting prototypes of new generation trains adapted to long-distance, regional or urban traffics. However, there are serious barriers to innovation in rail transport, such as the monopoly-based model of the sector, political nature of decisions on structural and technical changes, insufficient rail companies' own funds for investment, insufficient skills of personnel, national orientation of rail companies, etc.

**Air transport** is an example of a transport sector producing the “drawn effect” in innovation processes throughout its history. There has always been something to improve in the design of aeroplanes, engines, navigation systems, traffic control systems, safety control or airport functioning. The sector still pushes for further innovations, as the existing air systems are far from perfect.

The most intensive technological progress takes place in air forces, where a number of negative inventions (used to kill enemies) have been made. The benefits to civil aviation derived from the achievements of military technology are a by-product, so to speak; at present, innovation processes in civil aviation include: (1) concepts of new generation aeroplanes, (2) new generation navigation systems in traditional aeroplanes, (3) IT- and satellite-based air traffic control systems, (4) new generation airports and airfields. Of all the air transport innovations described in numerous publications and the Internet, the following
can be regarded as the most important: • concepts and prototypes of variable-geometry VTOL aircraft (Rotorcraft, Tiltrotor), made by such producers as Textron, Erica and others, • new generation cargo airships, • designs of eco-friendly planes, with low CO₂ and noise emissions; an example here is the concept of hydrogen-powered Cryoplane, • new generation planes called a “flying wing” (with no traditional fuselage), • very big airliners (such as e.g. Airbus 380, the prototype of the 1,000-seat Boeing 797 Blended Wing, experimental Boeing and NASA X-48B) meant to reduce the number of take-offs and landings, thus reducing congestion at airports, • new generation airports (including Smart Automated Airports, Highway in the Sky, Offshore Air Stations), • merging huge airports with cities and transforming them into logistics centres (Aéropolis), • self-service passenger terminals, • technologies of automated safe air traffic control systems (ATS).

The originality of air transport innovations does not simply translate into their common application in passenger traffic. For example, it is difficult to outline the development prospects for concepts like solar-powered planes (e.g. HP-SIA Solar Impulse by a Swiss designer, Bertrand Piccard). The following factors are decisive for an innovation to become a commercial and operating success: • technical reliability of planes, • applicability for mass passenger traffic, • possibility of getting aviation industry interested in new concept planes, • possibility for new generation planes to use traditional airport infrastructure without its costly modernisation, • guarantee that operating costs of new generation planes are permanently lower than those of currently used models.

Research centres, shipbuilding industry and central governments demonstrate a high level of activity in creating innovations that change the character of modern maritime transport and seaports. In practice, however, in spite of intensive research and implementation work, innovation processes in this sector are can hardly be deemed spectacular. Of the new solutions described in numerous publications, the following seem most significant: • designing and constructing high-speed craft (HSC) with a speed of 35-45 kts and super high-speed container ships (HTH) with a speed of over 50 kts, • implementing advanced security systems (Automatic Identification Systems – AIS, Ship Security Alert Systems and Long-Range Tracking – SSAS, US Container Security Initiative - CSI), • concepts of environment-friendly compressed natural gas-powered vessels (e.g. concept vessel E/S Orcelle), • automated container handling in seaports (Automated Container Handling Technology), • concepts of automated logistics systems in seaports (including virtual deep-sea terminals) and new generation containers (foldable containers).

The perspective of using alternative propulsions (hydrogen, electricity) for sea-going vessels – limiting energy consumption, CO₂ emissions and noise from engine rooms, and improving passengers’ comfort – is becoming more and more promising. The innovation process enabling the construction of totally unsinkable vessels still remains an important goal.
Nature significantly limits human inventiveness in creating innovations in inlet water transport. Although energy inventions used in this transport mode may be the same as those used in road transport (hydrogen, electric drive), but radical change of waterways and inland craft parameters is extremely difficult: neither the speed nor the size of vessels can be increased for reasons of environmental protection of the shore zone. However, in spite of these limitations, innovation processes do occur in this transport mode as well. The following innovations are worth attention: • concept of new generation inland ships (including energy-saving “clean” container ships, like the ro/ro catamaran or articulated container vessel with pivot system, ships designed to navigate shallow inland waterways, e.g. INBAT\(^{13}\)), • solutions promoting a shift from road to inland water cargo transport, • modern river information systems and technologies (River Information Services – RIS), • new technologies allowing winter navigation of inland waterways (important in northern countries). For environmental reasons, it is necessary to maintain a balance between transport and other functions of inland waterways, and this results in little pressure for innovations and ground-breaking technologies in this transport mode.

**Urban transport** is characterised by exceptionally high concentration of traffic over a small area, so the fact that insatiable demand for innovations has been lasting for years is a natural thing. However, there is great contrast between the need for urban innovations and the capabilities of research and industrial organizations to create concepts and means of relieving the effects of congestion, chaotic traffic, air pollution, noise and accidents. The situation continues despite the existence of many institutions, centres and initiatives targeted at creating innovations and sustainable city transport systems, addressing both passenger transport and urban freight.

Creating effective innovations for the improvement of urban transport systems takes time and patience. In spite of failures or dubious effects of the implementation of new concepts and means, some large urban areas are experiencing more order and harmony in the way their systems of carrying large numbers of passengers are organized. The following trends in new urban transport organisation and technologies may prove advantageous in future: • a radical shift from individual to public transport through reorganisation and new urban planning of city districts, • environmentally clean city vehicles (electric, hybrid, gas-, hydrogen-, compressed-air-powered), • automated city vehicles systems of the PRT (Personal Rapid Transit) type, i.e., special independent vehicles moving on their own course, grade-separated from traditional streets, • creating low emission zones (LEZ) by restricting access to internal combustion vehicles, • urban

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\(^{13}\) See: INBAT - Innovative barge trains for effective transport on inland shallow waters. The project coordianted by DST, Duisburg, within the EU 5th Framework Programme – [http://www.vbd.uni-duisburg.de/inbat/index.htm](http://www.vbd.uni-duisburg.de/inbat/index.htm).
lift-sharing, also called car-pooling, car-sharing or ride-sharing, • Call-a-Bus services, also called Demand Responsive Transport (DRT), and others.

All the activities related to the construction and maintenance of **transport infrastructure** form a very important area of transport innovations. The effectiveness and efficiency of these activities can be improved by: (a) innovations in designing and integrating infrastructure with its environment, (b) innovations in the use of materials, (c) concepts of extra fittings and furnishings, (d) systems improving traffic flow and safety, (e) intermodal solutions.

A good transport infrastructure system is created when at the very beginning of its thorough redevelopment and modernisation, there is an integrated plan that includes both future needs for the capacity of routes and junctions, and the interests and feelings of people living close to the infrastructure network, but using it only occasionally. The current knowledge about construction and materials engineering makes it possible to build roads, railway tracks, runways at airports and sea terminals from materials with specific features (nanomaterials) that improve utility value and durability of infrastructure facilities. Another symptom of advancement and innovativeness is equipping traditional linear and nodal infrastructure with smart traffic control systems, security control systems, and electronic tolling systems.

In long-term road infrastructure development, the following trends of innovative changes are of the greatest significance: • use of materials alternative to traditional aggregate (i.e. alternative and recycling materials in road construction), • new materials supplementing traditional asphalt, concrete or asphaltic concrete (geotextiles, geosynthetics, composites, polymers and others), • skid-resistant road surfaces, • solar energy collectors for heating and de-icing road surfaces in winter, • new noise-absorbing road surfaces in residential areas, • satellite navigation and traffic control systems, • road parking places management systems, • construction of underground infrastructure for freight carriage.

There are two kinds of infrastructure innovations in the rail transport sector: (1) those improving the traditional railway track and its elements (switches and rail joints), (2) those introducing unconventional railway solutions (magnetic levitation, SkyTrain, etc.). The following innovative materials and subassemblies are very important for rail traffic quality and safety: • noise-absorbing sleepers and fixing, • pre-formed surfaces that eliminate road vehicle bumps at rail/tram crossings, • innovative materials for the construction of rail noise screens.

New construction materials in air transport infrastructure are most useful in the construction, upgrading and recycling of runway. The properties sought in these materials are greater durability (crack resistance), better visibility for pilots (concrete or asphalt mixed with granulated glass), proper surface texture, hydroplaning prevention in heavy rain.

Seeking innovative solutions for water ports infrastructure is of specific character, because innovative materials are inspired by the challenges of protecting the infrastructures against the destructive impact of the waves, preventing
siltation of port basins and canals (caused by sea currents). Innovations in the area of materials used in this transport mode are much more difficult than in land transport, as recycling opportunities are limited (materials used in hydro-engineering must not be toxic, must have a long life cycle and be friendly to the marine environment).

The development of intermodal transport infrastructure to date has concentrated on constructing big, efficient and fast-operating terminals at the meeting point of two transport mode sub-systems. Currently existing solutions have little to do with genuine intermodality, understood as the ability of a given means of transport to run smoothly in various modes (road, rail, water). Certain innovations are created to meet the requirements of this kind of intermodality, e.g. the DMV (dual-mode vehicle) concept, i.e. road-rail vehicles that can run independently on either track or road, without terminals.

Another step in outlining the innovation prospects of the sector was the analysis of the palette of the world’s emerging concepts and new logistic solutions, presented by Aleksandra Koźłak in Chapter V. Innovation in logistics services may refer to the service as a product and to the process of providing it, to enterprise organisation and management or to relations with the environment. Changes in logistics are mainly related to macroeconomic changes, the growing customer requirements, and implementation of state-of-the-art technologies. Thanks to information technologies and new business models, a “new economy” could be established and developed, which made it necessary to implement new solutions in logistics as well.

The main motive for innovations in logistics is a necessity to make companies more modern and competitive through greater effectiveness and customer satisfaction. Logistics companies must focus on establishing cooperation and creating networks in order to improve the effects of their services in the movement of cargo and its control, information flow technologies and other advanced processes. There are two kinds of logistics innovation processes: • innovative concepts and solutions in organisation, • technological innovations.

Organisational innovations are modern forms of outsourcing in logistics services and new business models, from simple supply chains to complex logistics networks defined as 5PL. These organisations are almost entirely virtual because, without possessing typical assets, they focus on acquiring the skills necessary to manage and coordinate activities of other contractors through dedicated information solutions; they also match demand with supply through electronic markets of logistics services. The key to success in this area is information technologies and integration of computer systems. The category of new business models has been called 'Virtual Network Consorcia' (VNC).

According to the scope of logistic activities, technological innovations can be divided into four categories: • data identification and capture technologies, • information technologies, • warehousing technologies, • transport technologies.
A large group of technologies, given a common name of Automatic Identification Systems (AIS), are applied in supply chains. The AIS is a set of means and technical devices for automatic data capture, processing and transmission. They enable data input to the information system database without using a keyboard. The AIS applied most frequently is bar codes, but the Radio Frequency Identification system (RFID), which seems very promising, is used more and more often.

The development of modern information technologies is related to the integration of various IT systems and the use of current data interchange standards. These modern technologies applied in logistics include Electronic Data Interchange (EDI), the Internet, Value-added Networks (VAN), Logistics Information Systems, Points of Sale (POS), Electronic Ordering Systems (EOS), Internet telephony VOIP, and enterprise information portals. A very important aspect of using information technologies is the development of integrated systems supporting the management of various activity areas, for which enterprises increasingly often use information systems. Logistics providers use information technologies for the supply chain management (SCM), or just some of the modules, like warehouse management systems (WMS) or transport managements systems (TMS).

Warehousing technology innovations are induced by the nature of modern economy, where it is most important to ensure continuity of cargo flow and maintaining flexibility in meeting consumers' demands. Automatic information about stock or its location in a warehouse is not only just work rationalisation but is becoming a necessary precondition for an enterprise to be competitive in the market. Automatic systems take over many cargo relocation and storage processes. Warehousing technologies commonly used in the logistics sector include, among others, automatic storing, searching and sorting systems, computer-aided order preparation systems, or cooling systems. An innovative technology, more and more commonly used in warehouse management systems, are voice systems. They are a breakthrough in the communication between the computer system which manages the warehouse and the human being. Voice systems are able to ensure a quick and effective way of finding and shipping goods stored in the warehouse. They are a technology which is complementary to popular solutions used in warehouses such as, for example, RFID.

Transport technological innovations applied in logistics include, among others, real-time information systems and the Geographic Information System (GIS), Global Positioning System (GPS), data recording devices, e.g. tachograph. These technologies are used for vehicle and parcel tracking, route analysis and planning, storage management, and also vehicle use planning. In the coming years, Intelligent Transport Systems (ITS) will be applied more commonly; they are created by the implementation of interoperable telematics solutions based on wireless communications and vehicle electronics.
Innovation processes in transport infrastructure include both new building materials used for constructing and maintaining infrastructure facilities and new building technologies, and new generation infrastructure facilities. Chapter VI of this monograph by Krystyna Wojewódzka-Król presents trends in designing and construction of big new generation infrastructure facilities.

A large number of new generation infrastructure facilities meet some of the key present-day challenges: • they reduce congestion, • they are environment-friendly (they improve safety, fit in the landscape and are sustainable), • they are built with state-of-the-art solutions, very often in extreme conditions, under traffic, • they often have additional architectural values.

One of the greatest challenges is to build huge fixed links – bridges and tunnels – to replace ferry crossings where previously there was no such need or technical capacity. The innovativeness of these facilities consists in technical boldness and originality of construction. This category bridges have unusual parameters, e.g. the Akashi Kaikyo Bridge spanning the islands of Honshu and Awaji, Japan (the longest suspension bridge in the world), or the Millau Viaduct over the valley of the River Tarn, France (the highest structure of the type in the world). A planned road-railway bridge across the Strait of Messina is of similar character: its technical parameters significantly exceed those of typical bridges.

Bridge building innovations consist not only in spectacular sizes and original construction, but also in better integration into natural environment. In order to achieve these goals, various means of active protection are applied (appropriate site selection, road routeing which will bypass most sensitive areas on the one hand, and ensure smooth traffic flow or limited intrusion on the environment on the other, etc.). Concepts of innovative solutions in this field were proposed in the EU research project “COST 341. Habitat Fragmentation due to Transportation Infrastructure”, carried out in 1996-2003. An example to the opposite was an attempt to build a ring road in Augustów, Poland, in the protected area “Natura 2000” (the River Rospuda Valley).

The innovations and concepts of new generation tunnels are less numerous and less spectacular than huge bridges and viaducts, although the construction of long undersea or mountain tunnels is a great challenge, both technical and financial. There are over 50 tunnels more than 10 km long, of which the most prominent are two undersea ones: • the railway tunnel Seikan 53.85 km long (between the islands of Honshu and Hokkaido, Japan), running almost 240 m below the sea surface, • the rail Eurotunnel 50.45 km long spanning Calais, France, and Folkestone, Great Britain. In 2012, they will both be superseded by the longest road tunnel in the world (under construction at the moment) – the St. Gothard tunnel (57 km) connecting Erstfeld, Switzerland, and Bodio, Italy. Innovations and interesting concepts also consist in advanced traffic safety and fire protection systems installed in big tunnels.

Every human activity has an impact on the environment, and building infrastructure, because of its character, has a permanent impact, often causing irreversible changes in the environment. Therefore, it is important to minimize the negative impact of infrastructure development, and create – as far as possible – modal split transport and environment-friendly technologies. The degradational impact of infrastructure on the environment is mitigated by various means of active protection (noise screens, crossings for people and animals, etc.) and passive protection (appropriate site selection, road routeing which will bypass most sensitive areas on the one hand, and ensure smooth traffic flow or limited intrusion on the environment on the other, etc.) An example of minimizing adverse effects is constructing flyovers which have a lesser impact on the environment than conventional roads.

For decades, point infrastructure (stations, terminals) has been a testing ground for architects and engineers to experiment with innovative shapes of buildings it is made of. Modern trends here are manifested by giving buildings unique shapes to make them generally identifiable and expanding their strictly transport functions with other functions (commercial, exhibition, artistic).

A trend particularly fruitful and important in long-time perspective is the development of satellite-aided traffic control technologies. These issues are outlined in Chapter VII by Monika Bąk. The European Commission perceives the development of satellite navigation systems as a necessary tool facilitating the implementation of transport policy as well as agricultural, energy and environmental policies, and also including civil defence, emergency response or search and rescue operations. Satellite navigation in transport is unquestionably effective because it enables automatic identification of vehicles in motion, controlling their routes, providing drivers with relevant information or alerting them to potential dangers. Apart from these essential functions, there are other possibilities of using satellite navigation, depending on the specific nature of individual transport modes.

The issue of satellite navigation was included in the programme document shaping the trends in the EU transport policy, i.e. the 2001 White Paper. It was included in two packages of instruments for this policy: • Package 6 on the development of trans-European networks, where the project of the European satellite navigation system Galileo was entered on the list of TEN network, • Package 12 on managing the globalisation of transport where the development of Europe’s own system Galileo is considered one of the partial objectives in gaining satellite navigation independence. However, the use of satellite navigation system is possible, or rather necessary, to achieve many other objectives of the EU transport policy, e.g. improving road safety or adopting rules of effective charging in transport. Moreover, since the 2001 White Paper was published, there has been rapid technological progress in transport, and environmental challenges are now treated more and more seriously, which allows us to say that
the common, wide-range use of satellite navigation in transport will be greater than anticipated by the latest EU transport policy programme document.

Satellite navigation in transport is used not only in passenger or freight transport, where the GPS is being introduced on a large scale. Thanks to satellite navigation, also other transport modes can develop in the way that enhances safety, optimizes energy consumption, reduces congestion, etc. This is why it is impossible to overestimate the values of satellite systems in carrying out transport policy which on the level of both EU and most European countries aims at sustainable development, change in modal split and reduction of external costs. Therefore, the activities of the public sector must be intensified, and the private sector must be stimulated to take action to improve the existing American GPS or to build a new European system Galileo.

If the EU is not able to accomplish its plans for creating the Galileo, the first in history satellite navigation system controlled by civilian institutions, the natural expansion of the existing and developing dynamically systems – American GPS and Russian GLONAS – will take place. We must not forget the Chinese expansion in this market either – the BEIDOU navigation system, which in its first stage covers the area of China and the neighbouring countries, but it is likely to cover the whole globe in the future. After 20 years in operation, the GPS is considerably worn down, and the oldest satellites need to be replaced (this will be happening from 2010 on).

In spite of the fact that Polish entities are not members of the consortium developing the Galileo and the only sign of Poland's share is the installation of one of the many measuring/observation stations of the EGNOS system in Warsaw, efforts must be taken to engage Polish research institutes in scientific research projects, financed by the European Commission and targeted at the development of satellite navigation innovative solutions. What is also relevant is to inform transport users and the public about the possibilities and the increasing perspectives of practical application of satellite navigation in the transport sector.

A related area of transport innovations with optimistic prospects for future development is telematics; its usefulness in road transport is discussed by Janusz Łacny and Wojciech Zalewski in Chapter VIII. Telematics systems are useful both for making right decisions in managing a road transport enterprise and improving transport safety and security.

Complex navigation and positioning systems, operating both on-line and off-line, make it possible to use human and technical resources of an enterprise more effectively. They are used to control fuel consumption, points of refuelling, cargo security, axle load, work of tachograph, to monitor vehicle's status (whether in motion or stationary, if its engine is on or off); they can retrace the itinerary on the basis of digital information gathered in SQL databases or even stop the vehicle in case of emergency. They even enable audio-monitoring of the driver's cabin and cargo space.
The most useful function of road cargo transport telematics is programming routes for vehicles according to criteria important for the carrier: optimized structure and level of costs, reduced travel time, avoiding toll motorways, etc. The use of IT or ICT solutions may be decisive in determining the productivity of cargo carriage in international cargo transport. They enable the calculation of a real revenue per every kilometre covered by a vehicle in every completed transport cycle.

Halina Brdulak in Chapter IX examines another important line of special type innovations, i.e. equipping contemporary advanced logistics with information technologies adapted to its functions and needs. If we study present customer expectations in terms of time and reliability of logistics services, we can presume that they can be fulfilled only by integrating more information technologies into traditional services, which leads to changes in business model. In e-business-oriented companies, there is a constant increase in the number of IT-operated activities, from electronic orders, on-line payments, cargo tracking and deviations in the execution of orders, to delivery confirmation and tracking of returns, responding to complaints or generating reports.

At present, logistics enterprises take the advantage of IT development, but at the same time they have to make every effort to meet the challenges resulting from such trends as: • integration of IT systems not only within the enterprise and its particular departments, but also throughout the entire supply chain/network, • ensuring high security level for information flowing between particular links of supply chain/within supply network (certificate ISO 27001), • identification of dedicated solutions for individual sectors, e.g. pharmaceutical, automotive, FMCG, or electronic industries.

The following systems are particularly significant among integrated IT systems in logistics networks: • Electronic Data Interchange systems, as a kind of “integration bus” between various systems, • systems for accepting and recording orders on the customer side, • systems enabling placing transport orders to logistics provider, and preparing shipping documents, • mobile systems for drivers, as a kind of terminal of integrated systems supporting logistics provider's internal organisational processes, • systems for planning and optimization of pickup and delivery on the logistics provider's side, • integrated management systems supporting logistics provider's internal organisational processes, • WMS (Warehouse Management System) class systems if an offer includes warehousing services, • reporting systems, including tracking systems and performance indicators control (KPI) in a chain.

Integration technology has become a new product available on the market. It is offered under a variety of names, such as “integration bus”, Services-Oriented Architecture (SOA) or EDI platform. It can have the form of a specified software package to be chosen by customers depending on technology employed, it can consist in establishing information interchange standards
(EDIFACT, XML), encoding channels (e.g. HTTPS, SFTP) all the way to the help desk for solution users, and 24/7 assistance.

The development of IT brings about a number of threats to logistic operations safety, fraught with consequences particularly in case of system failures. This requires, apart from traditional solutions, applications of innovative methods of minimizing risk, such as doubled data processing centres and double WAN lines.

A full perspective of possible transport operations can be defined most precisely by analysing the demand for new solutions in individual transport forms and modes. There is a high diversity as far as sectoral innovative needs are concerned; this also refers to possibilities of creating innovations dedicated to passenger transport and cargo transport, long-distance and local transport, and transport in mass and dispersed supply chains.

An area of the greatest demand for innovations is urban transport, with its numerous symptoms of transport system inefficiency and their burden to natural and social environment. These weaknesses of the systems can be surmounted by technological innovations, new organisational concepts and new mobility patterns of the population.

Trends in the development of modern urban transport organisation systems in Europe are presented in Chapter X by Olgierd Wyszomirski. The most important aspect of these trends is a shift from monopolist transport services provided by a single carrier established by public authorities to a system of competitive services rendered in accordance with standards established by a public urban transport provider (a special unit is set up to carry out regulatory and organisational tasks only). Solutions applied in individual countries are marked by significant differences. For example, in Great Britain the market is accessible to all carriers who meet specified technical requirements, while in France the market is accessible for a specified period of time to a single carrier only, awarded the contract upon a tender for transport services for the whole city. Another difference between these countries is the number of transport service regulations established by public authorities (more numerous in France). Urban transport in the capitals of these countries is based on different principles. Other European countries have adopted systems close either to the British or the French model, except Germany, where a traditional system is still in operation, i.e. an association of municipalities employs common carriers and subsidize urban transport services.

Urban transport innovation trends are inspired and accelerated by a common idea of transport sustainable development. In the last 25 years, the urban transport balance was upset by offensive development of private motor transport, particularly by prevailing irrationality of car use in cities (cars too big, carrying less than 2 people on average, excessive number of cars for short trips, traffic concentration for a few hours during the day, etc.). This is caused by the process of suburbanization manifested by extensive spatial growth of cities, with
a growing number of inhabitants living in suburban areas rather than in city centres. The issues of city transport sustainable development are discussed in Chapter XI by Marcin Wo³ek. A new trend here is an integrated approach to urban population mobility management, which is applied more and more frequently. This approach consists in perceiving urban transport issues in a perspective wider than before, including: • transport infrastructure development, • traffic management in urban areas, • public transport development, • public transport financing, • spatial planning. The integrated approach management in Central and East European cities takes place in different (more difficult) conditions than in West European cities, where it concentrates on “soft measures” (non-investment ones), such as the introduction of various charges for transport infrastructure users or creating transport plans. Investment activities are mainly targeted at making the existing infrastructure more efficient.

In order to create a set of most promising innovative solutions in the field of urban mobility (in a wide context), research was carried out within the NICHES (New and Innovative Concepts for Helping European Transport Sustainability) Project. The Project was designed to improve the quality of natural environment, competitiveness of public transport and quality of life in urbanised areas. As a result of the Project, twelve new concepts were formulated, including: (1) services consisting in gathering people travelling in the same direction for optimizing the use of private cars (based on specialised software and the Internet), (2) a system of free bicycle rental, easily and quickly accessible for everyday users, particularly in city centres, (3) demand response services, based on reservations in advance (recommended in low-density areas), (4) more effective use of city transport infrastructure in urban goods delivery by employing modern technology, infrastructure modernisation and setting aside special zones available during specified hours, (5) night deliveries to city-centre shops (10 p.m. – 6 a.m.), (6) optimisation of home deliveries through delivery to nodal locations instead of doorstep deliveries, or specifying of the exact time of delivery by e.g. mobile phones, (7) providing long-term, stable conditions for users of “green” alternative-fuel cars and aiming at increasing a number of new groups of users, (8) the use of biogas in urban service vehicles aimed at reducing pollution of city environment, (9) organising joint tenders for the purchase of alternative-fuel vehicles in order to lower their unit prices and promotion campaigns for these technologies, (10) forming public-private partnership to improve the quality of transport system, (11) imposing fees and taxes on private car users to make public transport more competitive (the money gathered this way should be invested into improving the quality of public transport services), (12) long-term building of public awareness by organising events with participation of private partners, thus encouraging local communities to take interest in the issues of sustainable mobility.

Increasing the attractiveness of public transport without making use of instruments limiting the use of car is an ineffective strategy and in the long run
cannot secure a proper modal split from the point of view of sustainable mobility.

The renaissance of bicycle in well-developed countries results from a number of innovative solutions in its design and new forms of bicycle traffic organisation in big cities. In Chapter XII, Maja Włoszczowska, Polish Beijing Olympics medal winner for mountain biking, answers the question “Why is it rational to choose the bicycle as a means of transport and a way for a healthy lifestyle?”.

In the late 20th century, we observed a real bicycle boom which led to a large variety of these one-track vehicles. As a result, there are numerous kinds of bicycles to choose from: mountain, road and track racing, touring, BMX or classical city bikes. They differ from each other largely, and serve different purposes. In shaping a sustainable structure of city transport, bicycles designed to be of maximum use in commuting and recreation are most important; they must be: • easy to use, park and maintain; • equipped with luggage carriers (most preferably baskets); • suitable for riding up a slope (with modern reliable derailleurs); • safe in heavy traffic (white front and rear lighting (retroflectors), chainguards and mudguards, reliable kickstands).

Cycling innovations in big cities include also infrastructure facilities that enable a considerable shift from car traffic to cycling (even in countries with cold climate and long winters). Observations show that in Europe 30% of routes covered by cars are shorter than 3 km, and 50% - shorter than 5 km, although in such cases a bicycle is usually faster than a car. However, it must be easily available everywhere, and there must be a dense cycle path network. Some cities in the most highly developed European countries (Cambridge, Basel, Ferrara, Amsterdam, Parma, Bern) managed to create conditions suitable for quite intensive use of bicycles in urban traffic (15-33% of the total). It is possible to spread theses examples, cycle paths, however, must be built not only on the outskirts (for recreation purposes) but also along inner-city streets, where motor vehicles move with a speed of over 30 km/h. The cycle lanes should be designed to form a coherent system of connections, and their location should be accompanied by motor traffic reduction, particularly in the very centres, where there are many zones for non-motor traffic.

What is necessary for a larger share of cycling in city traffic is to develop new attitudes and remove psychological barriers. In the era of constant economic growth and a social welfare model, people are more and more attached to comfort, which is manifested in the fact that they tend to go shopping by car to avoid carrying bags where bicycle basket would do. We are more and more vulnerable to bad weather, although with suitable clothes and well-equipped bicycle we will get less wet cycling than when walking with an umbrella. However, our biggest problem is simply our laziness and being used to sedentary lifestyle. Overcoming these barriers is a greater challenge than implementation of difficult technological innovations. This situation can be changed through
nation-wide promotional campaigns aimed at people's greater environmental awareness, stressing the benefits of cycling, informing about facilities for cyclists, and making maps of paths widely available. Promoting healthy lifestyle and recreational cycling can contribute to making the bicycle “trendy,” thanks to which people would be more eager to use bicycles in everyday life.

A new instrument for promoting or even forcing the use of bikes in big cities is establishing institutions and services responsible for cycling policy and traffic management. A good example here is establishing an agency coordinating pro-cycling policies which assume cooperation of several administration sectors (town planning, public works, public transport, education, police), and also collaboration between the private sector, non-governmental organisations and the public. One of the coordinator's important responsibilities is to find every possible source of funding programmes for promoting cycling. Grants for promoting cycling can be obtained within safety, education, tourism, sports and recreation, environment and monument protection policies.

Bike-sharing systems, attractive for the inhabitants, play a key role in innovative use of bicycles in big cities. Bikes can become more important means of city transport if an average typical member of urban community will not have to be bothered about how to use or where to keep his/her own bike (this refers particularly to those living in high-rises with narrow staircases and no room for storing bikes). The most mature innovation in this respect is the Paris public bike rental system Vélib – a dense network of automated rental stations where bikes are available for a reasonable fee. Subscriptions can be purchased per day, week or year at _2, 5 and 29 respectively. With a subscription, bike rental is free for the first half hour of every individual trip; for each subsequent 30-minute period a fee of _1-4 is charged. The progressive price scale is intended to limit the number of bikes in circulation and encourage people to use public transport (the metro, buses, RER trams) on longer routes. The Vélib rental system is most convenient and flexible to use: a bike can be left at any station, and there is roughly one station every 300 metres. In practice, the greatest enemy of the Vélib system have been vandals, who managed to destroy (in the period between July 2007 and early 2009) the fleet of 20,000 bikes (11,600 vandalised, about half of the fleet stolen). Similar bike rental systems were launched in Barcelona (Bicing), Brussels, Copenhagen, Stockholm and Vienna. In Germany, there is a well-developed programme called Call a Bike (Berlin, Frankfurt, Cologne, Stuttgart, Munich, Karlsruhe), and in Great Brittan – OYBike.

However, modern forms of intensive bike use are not limited to big cities. There are attempts to encourage using bikes in long-distance travel. An initiative of the European Cyclists' Federation, the EuroVelo project, is a typical investment project: it aims at the development of 12 long-distance cycle routes of a total length of 60,000 km running across Europe. They are built on the basis of the existing network of local bike paths, integrating them into one system. The goal
of the project is to promote tourist cycling on the whole continent and to encourage people to try cycling instead of driving.

Both the principle of sustainable transport development and concentration of research efforts in the world are the reasons why road transport vehicles are an area with the highest incidence of successful innovative solutions. The issues of road cargo transport innovations are discussed in Chapter XIII by Krzysztof Szalucki and Andrzej Letkiewicz. The development and innovation of trucks are brought about mainly by the necessity to mitigate the environmental impact caused by this mode of transport. Activities undertaken are intended to modernise the existing technical solutions as well as seek entirely new ones. A general trend is to shift from crude oil as an essential source of energy to nuclear, solar and water energies or biomass for electricity production, and to develop technologies for the cheapest possible methods of generating pure hydrogen.

There are four types of innovation processes concerning truck propulsion: (1) application of solutions increasing the efficiency of classical diesel engines and lowering the level of pollutants emitted during diesel oil burning; (2) implementation of solutions designed to lower the level of fuel consumption (chiefly concerning power transmission systems and chassis); (3) implementation of alternative fuels for diesel engines (CNGs, LPGs and ethanol); (4) replacement of classical internal combustion engines with alternative propulsions (all-hydrogen, all-electric, or hybrid solutions, i.e. a combination of combustion and electric engines).

The first three types of the above-mentioned innovation processes do not fall into the category of disruptive technology, but they are going to be of great significance in practical large-scale modernisation of road cargo transport in every country within the nearest decades.

As for the solutions increasing the efficiency of classical diesel engines, the following are most significant: • homogenous mix combustion systems with direct fuel injection; • modern fuel injection systems with multi-point injection and variable valve timing gear; • solutions concerning feed systems and systems controlling valve closing and opening and inlet air supercharging, • Common Rail – injection system of diesel engine where injectors are controlled electrically, and the quantity of injected fuel is controlled by a computer, • variable valve timing systems, i.e. opening or closing valves according to load of feed unit and its rotational speed in order to boost the engine's performance without supercharging, retaining fuel-economising features, • gas-driven turbochargers utilising exhaust gases to improve conditions for burning injected fuel, thus increasing power and torque of the engine and its “flexibility”. The most significant innovations aimed at lowering fuel-consumption are: • replacing classical friction clutches and manual gearboxes with hydrodynamic clutches and automatic gearboxes; • using electronic diesel control (EDC) system, which together with other electronic appliances controlling other subassemblies, optimizes fuel burning, thus prolonging the engine's life span.
As for innovations aimed at using alternative fuels, the earliest ones focused on replacement of traditional diesel oil with ethanol (the Swedish company Scania is the leader in this area). The scope of alternative fuels has been widened lately, and in longer perspective the following fuels can facilitate combustion engine energy efficiency: HDRD (Hydrogenation-Derived Renewable Diesel); ULSD (Ultra-low Sulfur Diesel); DMF (Dimetylofuran), obtained from biomass, 40% more effective than ethanol; DME (Dimethyl-Ether), very effective in diesel engines, planned in the EU for 2030; other synthetic fuels: Gas to Liquids (GTL), Coal to Liquids (CTL), Biomass to Liquids (BTL).

While in 2009 all the world carmakers had their own prototypes or concepts of electric or hydrogen-powered cars, there were no mature concepts for alternative-fuelled trucks. The first attempts to use electric propulsion took place in the USA (container tractors in California seaports). The following prototypes of hydrogen-powered trucks appear in publications and the Internet: • Hytruck C8HE\(^{15}\), based on Mitsubishi Canter; • Tyrano HT\(^{16}\); • Mercedes Hybrid Econic NGT 2628 NLA\(^{17}\).

So far, truck producers have been and will keep introducing, numerous innovations in vehicle construction. New concepts of trucks aim at solutions based on universal technologies adjusted to the requirements of multimodal transport, so that the following goals are reached: • shortening transhipment time of load units within intermodal chains; • maximising transport safety and security of transferred loading units; • popularising standards for European intermodal loading unit transfer.

Transport innovations have a positive impact on the growth of the sector's companies value, and in many cases – also on the growth in the value of companies using more modern forms of transport. These issues are analysed by Danuta Rucinska in Chapter XIV.

The value of modern TL enterprises is built through mergers and strategic alliances, separation of transport organisation functions from production activities (rendering services), various forms of outsourcing enabling isolation of some activities from core business activities. An innovative aspect on the present-day market is horizontal or vertical links between interests of TL sector companies and those of other sectors, particularly IT, industrial and capital sectors. The links make it possible to utilise new options in service and delivery distribution, seek contractors and clients, sell services on-line, monitor cargo and mail in transit, shape new supply chains and make payments for purchased services. They also enable market monitoring, market and marketing research, shaping relations with the environment and multidimensional analyses of TL.

\(^{15}\) HYTRUCK – http://www.hytruck.nl/EN/nieuws_item1.html.


services buyers. These activities result in such new business processes as: market-to-sell, make-to-receipt, and procure-to-pay.

New concepts in the TL sector are not limited to technology and organisation of operations: they also appear in marketing which has to offer novel and unique services and individual programmes for passenger and cargo handling, improve operational activity procedures and introduce changes in a flexible way, adjusting the scope of services to customers' needs, because the assessment of economic effects of TL enterprises in the European market is based on the customer's benefit account and together with the evaluation of the trademark are a key strategic problems for many companies.

Transport innovation processes created in line with the idea of sustainable development should lead to positive changes in modal split. Observations of this process are described by Włodzimierz Rydzkowski and Marcin Hajdul in Chapter XV. What must be stressed here is the significance of multimodal transport in creating innovative transport solutions, considering the dominating role of road transport (76% in EU-25 in 2004 including only carriage by land, 46% including also sea transport within the EU). Road transport is also dominating in passenger traffic (74% of total transport effort). It is obvious that this kind of modal split is not favourable for sustainable development, and so the EU activities largely aim at structural changes in this area. One of the aspects of these activities is, among others, supporting research projects that could work out new solutions promoting the development of transport modes alternative to road transport. One of such projects is DIFFERENT (User Reaction and Efficient Differentiation of Charges and Tolls), carried out within the 6th Framework Programme. Differentiation of charges and tolls for transport users, studied by the project, is an important element stimulating the development of specific transport modes and solutions.

Aiming at the improvement (sustainability) of modal split, we must identify factors determining users' choice of transport mode. These factors can have a direct or indirect impact. Direct factors (with the greatest influence) include transport costs and specific features of a given mode, i.e. availability, infrastructure system determining the travelling distance, and characteristics of the fleet, and also outlays necessary for a given mode, natural resources consumption and environmental impact. Spending for the development of a given mode influences both the quality of services and, indirectly, modal split. It is a significant factor of transport policy, investment policy included, also in terms of technological progress.

Transport services supply depends on transport costs as well. The level of costs depends, among others, on infrastructure tolls. They are an economic instrument of fiscal and transport policies. The fiscal functions consist in raising funds for reimbursement of the spending on infrastructure development and maintenance and generating profit for the investor. As far as transport policy is concerned, tolls should facilitate achieving such goals as: control of the volume
of freight on a given route, shaping the modal split (transport means, domestic and international carriers), supporting alternative connections. It must be stressed, however, that excessive taxes may have a negative impact from the point of view of transport policy, e.g. low utilisation of new infrastructure facilities and congestion on alternative routes (free of charge). Therefore, it is necessary to adopt a comprehensive approach to the problem of differentiation of charges and tolls for transport users.

Another positive effect of transport innovation processes should be a better quality of transport services. This issue is analysed by Michel Savy in Chapter XVI. This chapter tries to prove that at present the quality of services is a key factor determining the growth of cargo transport. What must be taken into consideration here is the nature of transport from the point of view of technology, production and services, and also interrelations within transport processes. The quality measurement may be based on the assessment of the process according to its technical course, i.e. considering condition of vehicles, transport frequency, timely delivery, etc. Final effects may be assessed too, i.e. integrity of delivered goods, reliability in completeness and punctuality of deliveries, accuracy of documents and flexibility.

It must be noted that quality is specific for each transport operation, and its definition should be based on specified criteria depending on the carrier and the nature of shipment. Some of the criteria are measurable, others – very subjective. That is why quality assessment is difficult, and such a term as “overall quality” does not exist at all. Optimum quality does not mean maximum quality, because, on the one hand, logistics requirements and usability must be considered, and on the other – costs as well.

Quality of services should always be taken into account and treated as a never-ending process. That is why the role of agents and consultants is important, because they should contribute to a reduction of direct and hidden costs resulting from poor quality of services. The usual practice in this respect are various certificates, irrespective of bureaucratic threats they may cause. Another issue discussed in the chapter is new quality preferences of carriers and transport organisers. This results in higher reliability and flexibility of shipments, and in consequence the transport system's response is adjusted to new models of production, with supply segmentation responding to highly-diversified market demand.

Technological and innovative transformations in transport also influence the structure of transport markets and their business relations. Janusz Żurek in Chapter XVII tries to identify their influence on the shipping market. For years, crude oil and petroleum products have been a prevailing cargo on this market; however, their share in trade exchange total (in millions of tons) has been decreasing systematically: between 1990-2008 it dropped from 38.8% to 32.9%. In the same period, the volume of tankers in the global tonnage dropped at a slower pace: from 38.8% to 35.3%. Successful innovations concerning alterna-
tive propulsion will contribute to a future drop in global demand for crude oil and the volume of its transport by sea, as well as in a number of commissions for new tankers. In recent years, the most noticeable symptom of innovation processes in maritime transport was the evolution of container fleet: a characteristic trend is to build bigger and bigger ocean-going container ships, organisationally closely connected with feeder services, dedicated or commercial. Ships of 720-1200 TEU prevail in this group; however, ships of growing capacity are commissioned, which enables lower unit costs of a single container transport. Another characteristic trend in container shipping is more and more significant concentration of container operators, which is leading towards a stronger position of a certain group of operators and their far-reaching control of the market, and at the same time enhances their market effectiveness through mutual availability of container storage space. In the Baltic Sea Region, short-sea shipping will play an important role in future, because it will make it possible to shift some cargo from land to sea, thus mitigating congestion and increasing safety in road transport. The EU support for the development of short-sea shipping, through special funds and programmes (e.g. Marco Polo II), should be integrated with the development of an efficient land transport system.

Sea transport is complemented by port markets, more and more influenced by innovation processes taking place in transport generally. The analysis of trends in the development of seaports is presented by Stanisław Szwankowski in Chapter XVIII. In international cargo transport, there is a concentration of sea transport links handled by the biggest ships which call at a smaller and smaller number of the biggest seaports. A tendency to differentiate the role and importance of seaport is growing stronger. The growing importance of delivery standards and passenger traffic services is another, now often essential, element of the complexity of the world maritime trade. This requires from seaports –links in sea-land supply chains – to be able to adapt to transport users' growing and diversified quality requirements. International seaports will be clearly divided into three groups: • big basic centres for crude oil, dry bulk cargo and container transhipment and distribution, located on main ocean lanes (e.g. Rotterdam, Hamburg, Antwerp in Europe, Singapore or Hong Kong in Asia, Los Angeles and Houston in the USA); • regional and feeder ports, located off the main shipping lanes (e.g. on the Baltic, the Black Sea and the Mediterranean); • transhipment ports, handling mainly deep-sea container shipping and functioning as ports of call between big transhipment-distribution ports and smaller regional and feeder ports, still growing in number (e.g. Felixstowe, Gioia Tauro, Bre- men/Bremerhaven, Algeciras).

In recent years, ports started to evolve into powerful logistics centres, and many of them are offering logistics services directly within port areas or in distribution/logistics centres situated close to ports. A basic task of logistics is to reduce and accelerate all the processes of cargo, services and information flows at every stage of the supply chain. A need for rationalisation of activities in trade
and development of ports as land-sea logistics centres results also from transport users' higher demand for a wider scope of port logistics services, and a large share of transport and warehousing costs in global logistics costs. There are two tendencies in port planning: (1) the development of reserve areas; (2) more intense utilisation of space within existing limits. Expansion of spatial development over new areas does not hinder intensive transformations and concentration of investment activity within currently operated port areas. Many ports have limited options for spatial development; some of them do not have any reserve space, others encounter environmental restrictions.

Transport innovation processes and the environment of the sector are interrelated. On the one hand, the environment forces innovations that mitigate environmental and social impact of transport, on the other, innovations and breakthrough transport technologies create new prospects for the development of the sector in symbiosis with the environment. In Chapter XIX, Barbara Pawłowska presents the issues of modern environmental management in transport within the European Union. The demand for transport is growing constantly, but building new infrastructure and market expansion cannot be the only response to this tendency. In order to meet the requirements imposed by the idea of sustainable development, transport system needs optimising. A critical attitude towards unrestrained transport development and its impact on natural environment appeared as early as the late 1960s, and at first it was manifested through activities aimed at increasing transport safety. A modern transport system must be a sustainable one in the economic, social and environmental context. That is why the EU common policy must include activities targeted at the reduction of transport external costs and coping with growing congestion in transport networks. Published in July 2008, the Greening Transport Package presents a large scope of tools for environmental management, from economic instruments and regulations to investment in infrastructure and new technologies. In this respect, “making prices realistic” is of utmost significance. Economic instruments, “smart prices” in particular, can be an incentive for transport users to optimise transport behaviours or choose more environment-friendly vehicles and modes, use less crowded elements of infrastructure or travel at different times of the day.

New trends and concepts in international logistics are of special dimension, which Elżbieta Golemb ska analyses in Chapter XX. A new quality in the logistics sector is global logistics, being a complex of logistic activities performed between companies in many countries on different continents. Creating the world-wide commodity trade network is closely related to the establishment of transnational corporations, whose number amounts to over 60,000. The corporations' share in the world GDP amounts to ca. 30%, 80% of international transfer of technologies, and 70% of FDI deposits. It must be added that 80% of corporations are based in the USA, Canada, the EU countries, Japan and Singapore, and
the volume of sale of goods and services produced by their subsidiaries is nearly 50% higher than the volume of the world exports.

Global logistics is one of the powers stimulating information and IT innovations, without which global interrelations between logistics entities would be impossible. Big logistics providers very often have a strong potential capable of creating specialised software on the basis of their long practical experience.

Large urban areas are where production, commercial and distribution businesses concentrate. The fact that a great number of buildings and trade operations are crammed within a limited space has led to another kind of logistics, i.e. urban logistics. Cities with logistics systems adjusted to their character are more attractive for business and create better living conditions for their inhabitants. City logistics, in the full sense of the term, makes it possible to achieve the following effects: • improvement of accessibility and capacity of transport systems; • development of telematics as an intelligent transport control system; • development of ecologistics and waste management; • development of night and weekend transport; • development of public transport to retail centres. The experience of great world cities in creating efficient urban logistics systems can be spread elsewhere and applied in smaller places.

The development of a concept of logistics centres was one of the milestones in the development of modern economic logistics centres. The centres, complex logistics infrastructure facilities, do not have a specified form and constantly undergo transformation processes. The issues related to their development in Europe are discussed by Ireneusz Fechner in Chapter XXI. In Europe, the term “logistics centres” refers to logistics network hubs, where storage suprastructure and logistics services are concentrated, and which offer intermodal transport services, i.e. they have container terminals handling transhipment for at least two transport modes.

The idea of logistics centres was conceived because of such factors as: • shortage of modern storage space on the outskirts of big cities; • dynamic development of road transport; • specific requirements of growing intermodal transport; • growing conflicts caused by heavy trucks going through city centres. In future, single-mode transport logistics centres and warehouse clusters will be complemented with container terminals if conditions for intermodal transport are improved and state governments are more engaged in the implementation of sustainable transport policy.

Logistics costs constitute a big proportion (over 10%) of global costs of goods production and distribution. Their volume is not a fixed economic value; modern methods can and must be used to keep records of the costs, analyse and reduce them. These issues are discussed by Henryk Woźniak in Chapter 22. The studies of the volume of logistics costs in economy have been carried out quite regularly for many years; they have, however, one essential flaw: various methods are applied for cost account and estimation, which results in significant differences in presented results. The level of logistics costs depends on the branch
of economy: they are high in consumer goods sector, and lower in investment
goods sector. Moreover, logistics costs depend on the level of economic develop-
ment of a given country: in developing countries, their share in GDP amounts
to 20%, while in highly developed ones – less than 5%. Experts forecast that lo-
gistics costs are likely to grow in future because of such factors as: • shorter and
shorter time of goods flow, • growing customers expectations and higher stan-
dard of customer services; • constantly upgraded but more expensive tech-
niques of logistics management; • fiscal instruments of central governments' polices (growing costs of infrastructure availability).

Transport innovation processes are the main driving force of technological
progress and increase in productivity, but they are accompanied by high risk.
These issues are explained in Chapter XXIII by Przemys³aw Borkowski.

Innovative risk arises in transport and logistics wherever improvements are
applied, either technological and organisational or related to financing methods.
The risk may occur either when an enterprise fails to adapt its activities to dy-
namic market changes (then it becomes competitive risk), or during a process of
implementing innovations and resulting threats. An innovation-oriented trans-
port company takes a risk that innovations introduced may become a failure, or
rejected by the market, or their cost will be higher than originally planned.

Innovative risk must be differentiated according to an entity it refers to. The
forms it takes in transport, forwarding and logistics (TL) companies are different
from those in enterprises being infrastructural investors. In TL companies it
would refer to the transport process and can emerge at any of its stages, either
as technical defects of vehicles or wrong service organisation or performance,
etc. Usually, its effects will be noticeable right after a given risk factor has oc-
curred. The infrastructural investor's risk usually becomes apparent much later –
when a project is completed; at this stage, its mitigation is in fact impossible.

Innovative risk in transport most often refers to technology, as it causes, on
the one hand, a threat of stronger competition that will be more effective thanks
to the implementation of new solutions, and on the other – a risk of the com-
pany's own insufficient technological development. We can identify four kinds
of errors companies make, thus exposing themselves to innovative risk. Firstly,
they are mistakes in development strategies, which makes technological prog-
ress impossible. Secondly, lack of imagination, which means inability to put an
invention into practical innovative use. Thirdly, lack of vision, when a company
does not realise possible interrelations between the current technology and in-
novations, and the impact the innovations can have on the market, population,
culture and customers' habits. Fourthly, lack of resilience, necessary to imple-
ment one's own good project.

Apart from technology, innovative risk in transport can take the form of
project, organisational, financial or specific risks. The project risk will occur du-
ring the implementation of innovations related to material investment (then it
can take various forms, e.g. losses caused by insufficient skills of the personnel,
changes in competitive structure of the market after the implementation of innovation, etc.). The organisational aspect will consist mainly in a lack of acceptance by transport customers of changes in the way the services are rendered, market communications, principles of related services production, and the like. Its internal dimension includes the company personnel's possible reluctance, who may actively or passively oppose any changes. The financial dimension will include all the innovative aspects which will have a negative impact on the company's cash flow, i.e. temporary drop in revenues during the implementation of innovation, growth of service production costs, etc. A specific risk will include all the other effects that cannot be easily categorized as functional risks and result from unique character of a given innovation.

The aim of risk management in innovation processes is identification of areas of uncertainty that arise due to innovations and protection from their possible negative impact. Because the very process of innovation involves a possibility of the development of various scenarios, impossible to predict a priori – which results from the nature of innovation that is supposed to go beyond the current way of thinking – planning risk strategies for innovation processes must be of framework character only. Risk management in transport innovation processes must be oriented at eliminating incidents that could diminish the positive impact of innovations rather than elimination of divergences from the original plan.

Innovative risk is one of the least measurable risks. In this case, from the practical point of view, it is best to base on quantitative assessment of risk, particularly on the assessment of potential threats to potential additional cash flow that is supposed to be the effect of innovation. However, in transport – because of the nature of services – it is difficult to estimate the exact value of possible risk, because risk factors are hard to measure. Moreover, it is difficult to specify unambiguously the impact of abortive innovations on potential loss of company value, because in the case of innovation there is no benchmark with which it could be compared. This is why quantitative assessment should be supplemented with qualitative methods. Of a wide range of tools for qualitative estimation of risk parameters in the assessment of innovativeness in transport, the list of risk, risk mapping and risk matrix methods deserve particular attention. All these methods enable the description of individual components of innovation, which in turn enables identification of its weaknesses and determination of the probability of their occurrence. This probability juxtaposed with the strength of impact (i.e. a maximum possible loss a given factor may generate) makes it possible to estimate the level of risk during the implementation of a given innovation.

Formalised transport innovative risk assessment, replacing the previous – often intuitive – kinds of assessment, is necessary for maintaining a reasonable time frame of risk analysis and appropriate allocation of resources (material and human) for risk assessment, so that the cost of this activity would not be higher
than potential profits the innovation could generate. Innovative risk assessment, however, will always have an element of uncertainty, because this kind of risk requires unconventional thinking, i.e. dealing with threats when they arise.

Creating transport and logistics innovation processes requires knowledge, human resources, material resources (often unique and rare) and large financial resources. The problems of innovative transport infrastructure financing are analysed by Elżbieta Adamowicz in Chapter XXIV.

The analysis of the situation in most of the countries shows that there are problems with gathering financial resources for infrastructure maintenance and development. The problem is particularly important in countries where needs are much higher than traditional sources of funding available. The growing deficit in public finance has a special impact on the transport sector. Difficulties in public finance management are reflected in infrastructure management (which is also public), thus affecting the development of transport infrastructure. By and large, all the European countries battle with problems of low public finance, and this is why – despite traditional forms of financing – new solutions are constantly sought. This refers to international, national and regional levels. Since traditional sources of financing do not meet current needs, seeking and implementing new (innovative) solutions to facilitate infrastructure development are becoming particularly important.

Innovative transport financing is defined widely as a combination of specifically created methods that complement traditional financing (most often public). Financial innovations in transport are very often novelties in this sector, but have already been implemented in other economic sectors. Transport financing innovations can be analysed in the context of both gathering and expending financial resources, including availability of new financial products, new methods and techniques of fundraising, new principles of their allocation, new methods of infrastructure management (shifting responsibility for infrastructure development from public authorities to other entities), new methods of investment projects management.

There are several lines of seeking new and more effective system solutions in transport infrastructure financing. The research carried out for many years has been focusing on charging transport infrastructure expenses on its users. Moreover, the main areas where innovative solutions are sought include making better use of the existing public resources – for example, through better management of infrastructure projects, higher competences of local governments in establishing charges and tolls, transport infrastructure financing and management, and, especially, higher employment of private capital.

The areas of seeking innovative transport infrastructure financing focus not only on creating new financial products or gathering transport-generated financial means but also on their rational allocation and better management of investment projects. A forerunner in the area of innovative forms of transport infra-
structure financing is the USA, where the selection of instruments for financing infrastructure projects depends on the level of profitability of a given project.

It must be added, however, that although carried out for many years, debates on transport infrastructure financing and development have not materialized in a good financing model. Undoubtedly, it is difficult to create a universal model applicable to transport systems in every country. The existing regional and national conditions make it necessary to adjust models to current needs and specificity of a given area. It is worthwhile, however, following best practices and seeking ways to implement them in the existing circumstances. Seeking possibilities of implementing international solutions of transport infrastructure financing in Poland, we might verify selected elements so that they would make it possible to create an efficient system of financing and management of transport infrastructure in the Polish conditions.
PODSUMOWANIE I WNIOSKI
(Jan Burnewicz)

Innowacje w transporcie i logistyce są zjawiskami dynamicznymi, ulotnymi, szybko starzejącymi się, ale stwarzającymi największe szanse dla sektora na przyszłość. Przeprowadzona w poszczególnych rozdziałach niniejszej monografii analiza została podporządkowana potrzebie określenia jasnej i w miarę pewnej perspektywy zrównoważonego i jakościowo nowego rozwoju sektora w ciągu najbliższych 15-20 lat. Uważna obserwacja procesów innowacyjnych na świecie wskazuje, że druga dekada XXI wieku może stać się okresem zmasowanego przełomu technologicznego w transporcie.

Punktem wyjścia dla oceny obserwowanych zmian w sektorze transportu i logistyki jest przejrzysta i nie budząca kontrowersji ich klasyfikacja z punktu widzenia innowacyjnego charakteru. Praktyczne znaczenie ma rozróżnianie zmian prostych, przełomowych technologii i rewolucyjnych koncepcji. Te ostatnie mają często jedynie teoretyczny charakter i nie są wykonalne w danych warunkach gospodarczych i społecznych. Uporządkowaniu pojęć w tym zakresie służy rozdział pierwszy monografii autorstwa S. Pangsy-Kania, w którym Autorka przedstawiła teoretyczne ramy procesów innowacyjnych we współczesnej gospodarce. Należy je rozpatrywać w szerokim rozumieniu, biorąc pod uwagę:

• innowacje funkcyjne (koncepcje zaspokajania nowych dotychczas niezaspokojonych potrzeb społecznych, tworzenia nowych funkcji produktów i usług),
• innowacje przedmiotowe (pomysły nowych przedmiotów w miejsce dotychczas używanych, znacznie lepiej spełniających zadania i funkcje),
• innowacje procesowe (wprowadzające nowe metody wytwarzania usprawniające produkcję, czynią ją tańszą oraz przynoszące poprawę warunków pracy i środowiska),
• innowacje organizacyjne (usprawniające organizację pracy i produkcji, poprawiające stan bezpieczeństwa i higieny pracy).

Na ogół uważa się, że innowacje mają charakter postępowy, ale należy też zauważyć przypadki kreowania innowacji szkodliwych (nowe rodzaje broni, używek, narkotyków, środków dopingujących, fast-foodów, itd.). W transporcie również takie negatywne innowacje pojawiają się, a motywem ich powstawania jest z reguły chęć unieszkodliwienia lub zneutralizowania pewnych mechaniz-
mów regulacyjnych i zakazów (antyradary, CB radio, szkodliwe dodatki do paliw) lub chęć urozmaicenia form rozrywki ruchowej (quady¹, mini-poduszkowce). W strukturze narodowych lub regionalnych systemów transportowych wdrażane są jednak innowacje wyłącznie o charakterze postępowym (usprawniające procesy, zmniejszające zużycie energii, poprawiające bezpieczeństwo, itd.).

Innowacja jest zjawiskiem społecznym implikującym tworzenie proinonowacyjnej kultury, przedsiębiorczości, społecznej akceptacji i uznania kluczowego znaczenia innowacji w rozwoju gospodarczym. Ograniczone znaczenie ma innowacja powstająca jedynie w zamkniętym środowisku naukowym. Innowacje mające masowy społeczny rezonans mogą powstawać jedynie w warunkach silnej współpracy nauki z przemysłem, przedsiębiorstwami wdrażającymi nowe technologie, instytucjach publicznych i samorządowych oraz ugrupowaniami konsumentów.

Motywami kreowania innowacji są zarówno istniejące możliwości twórcze ośrodków naukowo-badawczych i przemysłu, jak i naście szery wiedzy konsumpcyjnej na urozmaicenie gamy produktów i usług oraz usunięcie wad rzeczy i procesów będących w powszechnym użytkowaniu i stosowaniu. Biorąc pod uwagę te dwa rodzaje motywów, wyróżnia się takie modele procesów innowacyjnych jak: • model innowacji pchanej przez naukę, • model innowacji ciągnionej przez rynek, • model interakcyjny (sprzężenia), • model zintegrowany (siedem), • model symultaniczny (systemowy). Obserwacje wskazują, że w współczesnym świecie następuje ewolucyjne przejście od modeli pchanych przez naukę lub ciągnionych przez rynek do modeli zintegrowanych i systemowych. Wyrazem tego są nowe formy organizacyjne procesów innowacyjnych w postaci platform technologicznych⁷.

Intensywność innowacji we współczesnym świecie jest równomierna ani w skali przestrzennej, ani w skali sektoralnej. Można wskazać regiony czy aglomeracje będące przysłowiowymi kolebkami lub lokomotywami innowacji: słynna Dolina Krzemowa (Silicon Valley),³ europejski cluster motoryzacyjny Bel-CAR⁴ (Region Stuttgartu, Wschodnia Anglia, Górna Austria, Lombardia, Katalonia), naukowe miasteczko Kansai⁵ w Japonii (między Tokio a Osaką), Tsukuba Science City⁶ w Japonii i inne. Jest też szereg ambicjonalnych inicjatyw tworzących nowe formy organizacyjne procesów innowacyjnych w postaci platform technologicznych⁷.

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² Innowacje transportowe w Europie są kreowane przez takie platformy technologiczne jak: ERRAC, ERTRAC, WATERBORNE i ACARE.
⁶ Tsukuba Science City – http://www.tsukuba.ac.jp/english/about/tsukuba.html.
nia od podstaw w wybranych regionach centrów innowacyjnych (RIS – Regional Innovation Strategy), których znaczenie na tle realnie istniejących znanych „zagłębi innowacyjnych” trudno jest przecenić. W Europie krajami zaliczanymi w 2008 r. do liderów innowacyjnych były: Dania, Finlandia, Niemcy, Szwecja, Szwajcaria i Wielka Brytania.

W przemyśle wyróżnia się sektory produkcji zaliczane do innowacyjnych i tworzących podstawy do rozwoju dla innych sektorów. Są nimi współcześnie sektory specjalizujące się w dziedzinie nanotechnologii, biotechnologii, technologii informacyjnych, technologii ekologicznych, technologii energetycznych, inżynierii kwantowej, spintroniki (elektroniki mezoskopowej) i innych nowych technologii (high-tech industry). Tradycyjne sektory produkcji w coraz większej mierze stwarzają zapotrzebowanie na powstawanie innowacyjnych segmentów specjalizujących się w tworzeniu nowej generacji podzespołów, instrumentów i systemów recyklingu.

Perspektywę innowacyjną sektora transportu i logistyki należy rozumieć i programować na podstawie dotychczasowych wieloletnich doświadczeń (sukcesów i niepowodzeń) w zakresie rozwoju cywilizacji techniczno-organizacyjnej tego sektora, którą tworzyły odkrycia, wynalazki i innowacje. Istnieją zasady podobne między tymi pojęciami. Odkrycie jest pozytywnym przełomem w istniejącej wiedzy, jest wyrazem postępu naukowego. Jest nim opisana i wiażomością, a także dowiedziona eksperymentalnie obserwacja zjawiska występującego w naturze, które dotąd nie było jeszcze zauważone. Odkrycie ma w głównej mierze charakter teoretyczny (koncepcyjny). Wynalazek jest z kolei nowym rozwiązaniem technicznym nie występującym w naturze takim jak np. koło, samochoód, radioodbiornik czy komputer. Wynalazkami są także przełomowe zmiany organizacyjne, takie jak: kalendarz, kodeks praw, taśma produkcyjna. W wyniku wynalazków kreowane są długookresowe cykle rozwoju przemysłu. Innowacja jest najbardziej uniwersalną zmianą w zakresie wiedzy i umiejętności ludzkich polegającą na nieustannym ciągu udoskonaleń rozwiązań opartych na wcześniejszych odkryciach i wynalazkach. Nie każda jednak nowość jest innowacją - nie jest nią, jeżeli nie oznacza istotnej zmiany funkcjonalności produktów (na przykład zmiana design, kolorystyki, asortymentu). Pojęcie innowacji jest często nadużywane w marketingu i akcjach reklamowych, a także przez twórców programów komputerowych i polityków zajmujących się innowacjami.

Ważne dla sektora transportu i logistyki innowacje powstają w dużej mierze nie w nim samym lecz w sektorach zaopatrujących go w czynniki produkcji (głównie w przemyśle). Wdrożenie innowacji zależy jednak od zdolności absorpcyjnej szeroko pojętej sfery transportu i logistyki, kierującej się zarówno

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bieżącymi, jak i długofalowymi racjami oraz różnorodnymi motywacjami podejmowania decyzji. Sektorową logikę i uwarunkowania wdrażania innowacji przedstawił w drugim rozdziale R. Tomanek, charakteryzując otoczenie naukowe współczesnego sektora transportu, do którego zaliczają się takie dyscypliny, jak ekonomika transportu, nauki techniczne, nauki przyrodnicze i nauki społeczne. Transportowe prace naukowe mają coraz częściej charakter interdyscyplinarny, choć poszczególne raporty badawcze klasyfikowane są zazwyczaj odrębnie w dorobku poszczególnych dziedzin i dyscyplin nauki. Realizacja tych prac przestała być już zamkniętą domeną wyspecjalizowanych ośrodków naukowych. Rozwiązania mające charakter innowacyjny powstają w wyniku impulsów pochodzących zarówno ze strony świata nauki, przemysłu środków transportu, zarządców infrastruktury, przedsiębiorstw transportowych, operatorów logistycznych, federacji konsumentów i użytkowników środków transportu. Dojrzałe koncepcje i przełomowe technologie transportowe rodzą się w wyniku wielokrotnego powtarzania i modyfikowania formułowanych idei i dobieranych środków materialnych w formie wielostronnych konwersacji i „burz mózgów” między wyżżej wymienionymi grupami podmiotów. Innowacje spełniające wymogi sprawności, efektywności i społecznej dogodności mogą zostać stworzone tylko wówczas, gdy w całym procesie analiz teoretycznych i prac inżynierskich przeprowadza się komplementarne czynności weryfikacyjne w wymiarze technicznym, ekonomicznym, przyrodniczym i społecznym.

W Unii Europejskiej badania naukowe i innowacje są jednym z 32 obszarów wspólnej polityki10. Problemy transportu i aeronautyki są we wszystkich programach ramowych przede wszystkim priorytetowe. Projekty realizowane przez międzynarodowe i interdyscyplinarne zespoły przynoszą konkretne efekty w postaci nowych rozwiązań konstrukcji w kilku najważniejszych grupach problemowych sektora transportu i logistyki, takich jak: nowe rodzaje napędów pojazdów, nowe systemy informacji transportowej (telematyki), elektroniczne systemy pobierania opłat za korzystanie z infrastruktury transportowej, nowe systemy poprawiające bezpieczeństwo przewozów i ruchu, nowe środki zmniejszania ekologicznej uciążliwości transportu. Dzięki realizacji tych badań na płaszczyźnie wspólnotowej przyspieszone jest upowszechnianie ich wyników i praktyczne wdrażanie w państwach członkowskich.

W kreowania procesów innowacyjnych w transportie i logistyce bierze udział szereg grup podmiotów: ośrodki naukowo-badawcze, przemysł środków transportu, przewoźnicy i operatorzy logistyczni, użytkownicy transportu, władze państwowe i samorządowe oraz organizacje pozarządowe. Sukces przedsięwzięć innowacyjnych zależy od współdziałania ze sobą tych grup podmiotów oraz od istnienia pragmatycznej polityki proinnowacyjnej państwa. Wyступające w tym ujęciu problemy przedstawił w rozdziale trzecim P Niedziel-

Strategicznym (nadzrodnym) celem polityki innowacyjnej w transporcie jest kształtowanie zrównoważonego systemu transportowego, przyczyniającego się do zapewnienia sprawnego i szybkiego rozwoju społeczno-gospodarczego kraju z uwzględnieniem obecnych realiów życia społecznego, gospodarczego i politycznego. System transportowy i jego wszystkie elementy muszą przyczyniać się do zwiększania konkurencyjności i efektywności gospodarki. Realizacja tej polityki wymaga utrzymywania wysokiego poziomu nakładów na badania naukowe i innowacje (przynajmniej 2% PKB, w tym przynajmniej 0,2% PKB na badania transportowe), tworzenia postaw proinnowacyjnych (zwalczanie konserwatyzmu technologicznego), usuwanie barier biurokracyjnych, proceduralnych i fiskalnych.

Dalsza część monografii jest nakreśleniem szerokiej panoramy tendencji i procesów innowacyjnych we współczesnym transporcie i logistyce. Najpierw został przedstawiony kompletny obraz współczesnych innowacji w całym transporcie (rozdział czwarty), a następnie – paleta głównych procesów innowacyjnych w logistyce (rozdział piąty). Następne rozdziały są charakterystyką i analizą wybranych szczegółowych zmian we współczesnym transporcie, które mają cechy innowacyjne.

Rozdział czwarty niniejszej monografii autorstwa J. Burnewicza jest szczegółową i kompleksową analizą trendów innowacyjnych we współczesnym transporcie na świecie. Punktem wyjścia jest rozpoznanie mianowicie istniejących systemów w poszczególnych gałęziach transportu stwarzających „efekt ciągniony” procesów innowacyjnych. Potrzeba tworzenia i wdrażania nowych koncepcji i nowych środków w transporcie wynika z wciąż niskiej sprawności wielu jego elementów technicznych i występujących w nim procesów, co jest widoczne w niezadowalającej wydajności, przepustowości, zawodności, powstawaniu straży czasu i środków oraz jawiuczą kosztów działalności. Motywem poszukiwania nowych rozwiązań w transporcie jest także konieczność poprawy jego relacji z otoczeniem, przez zwiększenie dostępności przestrzennej i czasowej, podniesienie jakości usług i zmniejszenie uciążliwości ekologicznej.

Perspektywę rozwoju transportu determinuje świadomość, że za 40-50 lat wyczerpią się zasoby opłacalnej w wydobyciu ropy naftowej. Innowacje muszą iść w kierunku rozwoju alternatywnych paliw i alternatywnych rodzajów napędu. Poziom jakości życia społeczeństwa przestaje się podnosić po przekroczeniu wysokich wskaźników motoryzacji indywidualnej (ponad 400 samochodów na 1000 mieszkańców), co zmusza do innowacji stanowiących alternatywę dla tradycyjnego używania samochodów osobowych powodujących chroniczne zatory drogowe i uliczne. Bołączącą łądowych systemów transportu ładunków jest separatyzm techniczny transportu kolejowego i samochodowego spowodowany rozejściem się w XIX wieku koncepcji pojazdów mechanicznych poruszających się na kołach żelaznych i pojazdów na kołach ogumionych. Potrzebne są innowacje integrujące te dwie gałęzie transportu w sposób znacznie doskonałys niż znane dotychczas systemy transportu kombinowanego.
Historia rozwoju techniki transportowej wskazuje, że niepowodzeniem kończyły się następujące rodzaje wynalazków i innowacji: 1) wynalazki nie zrodzone z konkretnej potrzeby, 2) wynalazki oparte na koncepcjach bardzo ryzykownych (sterowce, pasażerska kolej rurowa, samolot supersonomiczny, pociąg odrzutowy, pojazdy antygrawitacyjne), 3) wynalazki w postaci gigantycznie wielkich konstrukcji (gigasamochody, superstatki, supersamoloty), 4) wynalazki mające istotne wady wrodzone trudne do usunięcia w wyniku udoskonalen po-mysłu (kolej pneumatyczna, poduszkowce, barkowce, kontenery pasażyerskie, szybkie lądowe terminale kontenerowe, kolejy jednosznynowe, żyrosbusy i inne). Ryzyko tworzenia i lansowania chybionych innowacji transportowych wiąże się z takimi czynnikami jak: • wąski zakres zastosowania (mały popyt, ograniczony rynek), • wysoka kapitałochłonność prac badawczych, wdrożeniowych i realizacji inwestycji użytkowych, • obciążenie trwałymi wadami (uciągliwość dla otoczenia, zawodność, energochłonność), • szybkie starzenie się pomysłu (duża liczba potencjalnych substitutów), • niska konkurencyjność w stosunku do istniejących technologii tradycyjnych. Istniejące miankenty systemowe i gałęziowe współczesnego transportu skłaniają do badań i innowacji zarówno w zakresie środków transportu i ich napędu, jak i w zakresie infrastruktury liniowej i punktowej, z której muszą korzystać.

Dla przyszłego rozwoju systemów transportowych największe znaczenie będzie miało wdrożenie najbardziej obiecujących innowacji przełomowych, nad którymi trwają prace w wielu ośrodkach naukowych i przemysłowych na świecie.

Na perspektywę innowacyjną transportu samochodowego składają się przełomowe rozwiązania w zakresie: a) nowej generacji pojazdów, b) nowej generacji infrastruktury drogowej. Głównym motywem innowacji jest zastąpienie aktualnie eksploatowanej floty pojazdów samochodowych pojazdami czystymi ekologicznie, bardziej funkcjonalnymi, bezpieczniejszymi i zajmującymi mniej przestrzeni. Bogata gama innowacji obserwowanych w zakresie pojazdów samochodowych i ich wyposażenia jest ukierunkowana głównie na nowe rodzaje napędu oraz alternatywne paliwa. Obejmuje ona następujące najbardziej znaczące przypadkowe rodzaje konkretnych rozwiązań: • samochody całkowicie elektryczne (All-Electric Vehicle, Battery Electric Vehicle – BEV), • samochody o napędzane ogniwami paliwowymi (Fuel Cell Vehicles – FCVs), • hybrydowe pojazdy samochodowe (Hybrid Electric Vehicle – HEV), • samochody napędzane sprężonym powietrzem (Compressed-Air Cars), • drogowe pojazdy prowadzone automatycznie (Road Automatic Guided Vehicles – AGV), • konstrukcje samochodów osobowych o zwiększonej przedniej widoczności (Full Transparent Front Vehicle), • rozwijane w Australii, USA i zachodniej Kanadzie pociągi drogowe (Road Trains).

W ostatnich latach skrystalizowała się wielka szansa dokonania przełomu technologicznego w transporcie samochodowym w oparciu o dojrzałą koncepcję i udane prototypy samochodów elektrycznych. Ambicją wynalazców i kon-
struktorów samochodów elektrycznych jest zachowanie ich cech jako środka transportu indywidualnego niezależnego od infrastruktury zasilania elektrycznego (jak to ma miejsce w przypadku trolejbusu). Aby samochód elektryczny zachował wszystkie walory użytkowe samochodu spalinowego i był symbolem pojazdu o zerowej emisji (ang. ZEV – Zero-Emission Vehicle) konieczne jest aby: 1) był wyposażony o dużej mocy stacjonarne lub wymienne akumulatory nowej generacji, znacznie lżejsze od akumulatorów tradycyjnych, dobrze sprawujące się zarówno w klimacie ciepłym, jak i zimnym, eksploatowane pod elektroniczną kontrolą, 2) zapewniał zadowalający zasięg jazdy po jednorazowym naładowaniu akumulatorów i nie zmuszał do częstych przerw w podróży (w miastach 80-200 km, w ruchu pozamiejskim przynajmniej 300 km), 3) był wyposażony w akumulatory po przystępnej cenie i eksploatowany po koszcie będącym na poziomie porównywalnym lub niższym od kosztu zakupu paliwa silnikowego i smarów wysokotemperaturowych używanych w tradycyjnych samochodach, 4) istniała dobrze rozwinięta na terenie kraju sieć energetyczna dostosowana do szybkiego ładowania lub wymiany nowej generacji akumulatorów samochodowych dużej mocy. Pierwszy warunek – wydajne akumulatory nowej generacji o dużej mocy – jest już od 2008 r. w dużej mierze spełniony. Od kilku lat producenci samochodów elektrycznych mogą w swych pojazdach instalować nowej generacji akumulatory napędowe: • sodowe (odporne na niskie temperatury), • litowo-titanowe, • litowo-fosforanowe, • litowo-jonowe (SCIB), litowo-polimerowe.

Największa potrzeba upowszechniania bateryjnego samochodu elektrycznego (BEV) jako substytutu tradycyjnego samochodu spalinowego istnieje w aglomeracjach i dużych miastach. W tych dużych skupiskach ludzkich brak już miejsca zarówno na ruch, jak i parkowanie oraz garażowanie dotychczas kupidych i eksploatowanych samochodów o typowych wymiarach. Na początku 2009 r. istniało już na świecie ponad 100 modeli i prototypów samochodów elektrycznych różnych marek przygotowanych do wprowadzenia na rynek w najbliższych latach. Wszystkie znane koncerny motoryzacyjne przyjęły za punkt honoru przygotowanie własnego modelu samochodu elektrycznego dostosowanego albo do ruchu miejskiego, albo do ruchu pozamiejskiego lub jako samochodu szosowego (na razie najczęściej jako samochodu sportowego). Ukształtowała się grupa kilkudziesięciu firm wywodzących się z różnych branż przemysłu, czyniących z samochodu elektrycznego swój sztandarowy produkt.

Wśród wprowadzonych do eksploatacji i sprzedaży bateryjnych elektrycznych samochodów miejskich (city BEV) dotychczas największą uwagę przykuwały modele: • przygotowany do masowej produkcji na rynek skandynawski i amerykański norweski elektryczny samochód TH!NK City zasięgu 170-180 km, • hinduskie samochody elektryczne firmy REVA, • małe samochody miejskie brytyjskie firmy NICE, • włoskie mikrosamochody elektryczne firmy Micro-Vett Ydea, • amerykański Tango T600 – wąski (99 cm) niezwykle szybki i sprawny w korkach ulicznych amerykański samochód elektryczny firmy Com-
muter Cars Corporations, • kanadyjski samochód elektryczny firmy ZENN,
• duże miejskie samochody elektryczne Dynasty Electric Car Corporation,
• mały 2-osobowy elektryczny samochód miejski Kurrent amerykańskiej firmy American Electric, • mały miejski samochód elektryczny Maya Mobility kanadyjskiej firmy Electrovaya, • chiński mały miejski samochód elektryczny Flybo XFD-6000ZK, • elektryczny mini-samochód Toyota FT-EV. Perspektywa upowszechnienia tej kategorii samochodów w dużych miastach jest bardzo bliska, bowiem są to pojazdy o bardzo wysokich walorach technicznych i eksploatacyjnych, wystarczającym zasięgu i przystępnych cenach. W wielu krajach po roku 2020 pojawią się regulacje ruchu miejskiego zakazujące używania innych pojazdów niż elektryczne, wodorowe lub na sprężone powietrze.

Nieco bardziej odległą jest perspektywa upowszechnienia elektrycznych samochodów w ruchu pozamiejskim Aby do tego ruchu bateryjne samochody elektryczne przystosować potrzeba zapewnić im wystarczająco dużą zasięg jazdy na jednym szybkim ładowaniu. W tym celu konieczne jest wyposażenie samochodów w większy blok najbardziej nowoczesnych akumulatorów, co zwiększa ich ciężar i koszt. Do najbardziej dojrzalych eksploatacyjnie i rynkowo modeli BEV tej kategorii na początku 2009 r. należały: • bardzo reklamowana sportowa Tesla Roadster amerykańskiej firmy Tesla Motors (Google) o zasięgu do 390 km, • dostępna na rynku Kalifornii Toyota eBox o zasięgu do 240 km, • mający bardzo wysoką cenę luksusowy sportowy Lightning GT brytyjskiej firmy Lightning Car Company, dostępny na rynku od 2010 r., mający zasięg do 400 km, • kalifornijski ZAP-X Crossover EV o zasięgu do 350 km, • Chrysler Dodge ZEO o zasięgu do 400 km, • wysoko zaawansowany technologicznie Koenigsegg NLV Quant wyposażony w w akumulatory przepływowe firmy NLV Solar AG, które zapewniają 500 km zasięgu. Oprócz samochodów osobowych, powstają prototypy autobusów i samochodów ciężarowych poruszających się poza miastem za pomocą napędu bateryjnego. W upowszechnianiu całkowicie elektrycznej floty samochodów liderem jest rząd Szwecji, który zakłada zniknięcie w tym kraju po 2030 roku wszelkich pojazdów napędzanych silnikami spalinowymi. W kraju tym rząd już obecnie wspiera finansowo zakupy elektrycznych samochodów przyznając dwa razy wyższe premie niż przy zakupie samochodów napędzanych biopaliwami.

Drugi przełomową technologią w transporcie samochodowym staje się napęd wodorowy. Wodór jest powszechnie uważany za „najczystsze” ekologicznie i najbardziej przyjazne środowisku paliwo, gdyż w wyniku jego spalania w po-wietrzu lub tlenie produkowana jest wyłącznie woda. Samochody napędzane ogniwami paliwowymi (Fuel Cell Vehicles – FCVs) są innowacją technologiczną.

12 Sweden favours electric cars over ethanol. The Local Europe AB – http://www.thelocal.se/12054/20080528.
opracowana z myślą o ograniczeniu emisji spalin do atmosfery przez silniki samochodowe. Istnieją różne sposoby wykorzystywania wodoru jako paliwa do samochodów. Może on być spalany w tradycyjnym silniku o spalaniu wewnętrznym lub wykorzystywany w ogniwach paliwowych do wytworzenia energii napędzającej silnik. Ogniwo paliwowe generuje energię elektryczną z reakcji utleniania stałe dostarczanego do niego z zewnątrz paliwa. Większość ogniw paliwowych do produkcji energii elektrycznej wykorzystuje wodór na anodzie oraz tlenu na katodzie (jako paliwo stosuje się także wodorotlenek potasu, kwas fosforowy, metan i metanol). Nowralgicznym elementem ogniwa paliwowego typu PEFMC (Proton Exchange Membrane Fuel Cell) jest membrana polimerowa, która z uwagi na nasycenie wodą musi być chroniona przed niskimi temperaturami w czasie dłuższego postoju lub garażowania.

Optymistyczna perspektywa wodorowego napędu samochodów wiąże się z faktem, iż od kilku lat cały przemysł motoryzacyjny na świecie testuje udane prototypy tych pojazdów. Zalety ogniw paliwowych jako napędu środków transportu to: • wysoka sprawność (65% dla ogniwa paliwowego w porównaniu z 35% dla silnika spalinowego), • brak wibracji i hałasu towarzyszącego wytwarzaniu energii, • produkcja energii bezpośrednio napędzającej silniki elektryczne, • brak spalania paliwa w czasie postoju, • stałość momentu obrotowego i wiele innych. Głównym problemem w komercjalizacji samochodów FCV jest ich wysoka cena.

Na świecie w latach 1994-2009 zostało skonstruowanych i przetestowanych około 105 modeli samochodów wodorowych lub wodorowo-spalinowych. Na początku 2009 r. na gamę samochodów wodorowych składały się następujące dojrzale technologicznie modele: • Honda FCX Clarity o zasięgu na jednym tankowaniu sprężonego wodoru do 430 kilometrów – jest to pierwszy na świecie samochód osobowy o napędzie wyłącznie wodorowym, • BMW serii 7 Hydrogen posiadający podwójny napęd: wodorowy i na tradycyjne paliwo benzynowe, • Toyota FCHV wyposażona w wysokociśnieniowe (70MPa) zbiorniki wodoru dające pojazdowi zasięg do około 830 km po jednym tankowaniu, • hybrydowa benzynowo-wodorowa Mazda RX-8 Hydrogen RE z silnikiem Wankla wyposażona w dodatkowy 110 litrowy zbiornik sprężonego wodoru pozwalający na jazdę wylecznicowo wodorowym, • wodorowo-elektryczny Nissan X-Trail FCV mający zasięg na wodorze do około 100 km, • wodorowo-elektryczny Suzuki Hydrogen Fuel-Cell SX4-FCV o zasięgu do 250 km, • DaimlerChrysler Mercedes-Benz B-Class F-Cell Tourer o zasięgu do 410 km, • Fiat Panda Hydrogen o zasięgu do 200 km. Szczególną wagę przywiązuje się do upowszechnienia autobusów wodorowych w dużych miastach, z uwagi na konieczność zmniejszenia smogu i hałasu. Na początku 2009 r. na świecie były realizowane 44 projekty związane z wdrożeniem technologii autobusów miejskich napędzanych wodorem lub metanolem. Do udanych technologicznie modeli autobusów z tym rodzajem napędu należą: • Daimler Mercedes-Benz Citaro fuel cell bus, • gazowo-wodorowy Flyer Invero LF Bus (F40LF), • wodorowa Toyota FCHV-BUS,
• wodorowy MAN Lion’s City (H2ICE), • wodorowy Irisbus Iveco (Fiat) City
Class hydrogen.

Obiecującą odświeżoną innowacją są także koncepcje związane z rozwójem technologii samochodów napędzanych sprężonym powietrzem (Air Powered Car). Z uwagi na zmienny proces techniczny sprężania i gromadzenia sprężone-go powietrza w celu jego dystrybucji będzie to technologia mniej konkurencyj-na niż samochody elektryczne i wodorowe, ale mająca dużą wartość ekologiczną w miastach wyposażonych w infrastrukturę dystrybucji sprężonego po-wietrza.

Istnieje pilna potrzeba innowacji w transporcie kolejowym, służąca poprawie wizerunku tej gałęzi transportu w oczach społeczeństwa i wzmocnieniu jej pozycji na rynku. Koleje dużej prędkości przestały być już innowacją, są technologią znana w Japonii od 40 lat, a w Europie (francuskie TGV) od 1981 r. Ich rozwój staje się w poszczególnych krajach elementem kluczowego procesu inwestycyjnego. Natomiast wśród opisywanych w publikacjach i źródłach internetowych nowych koncepcji i innowacyjnych technologii kolejowych na szczególną uwagę zasługują: • pasażerskie dwupozycyjne pociągi dużej prędkości (Double-Deck High-Speed Trains), • tramwaj dwusystemowy (Tram-Train), • systemy optymalizacji rozkładów jazdy pociągów (Train Scheduling Optimizer), • telematyczne systemy sterowania kolejowymi przewozami ładunków, • nowoczesne systemy bimodalne i podziemne przewozów ładunków w miastach, • energooszczędne systemy napędu pojazdów szynowych (Hybrid Train).

Największe producentki taboru kolejowego na świecie priorytetyowo traktują poszukiwanie rozwiązań innowacyjnych, prezentując prototypy nowej generacji pociągów przystosowanych do ruchu dalekobieżnego, regionalnego lub miejskiego. Istnieją jednak poważne bariery w kreowaniu kolejowych procesów innowacyjnych tkwiące w zmonopolizowanym modelu tego sektora, politycznym charakterze decyzji dotyczących zmian strukturalnych i technicznych, niedostatku własnych funduszy firm kolejowych na inwestycje, niskich kwalifikacjach personelu, narodowej orientacji spółek kolejowych i inne.

Transport lotniczy jest przykładem sektora transportu, który w całej swej historii wywoływał „efekt ciągniony” w zakresie procesów innowacyjnych. Wciąż coś należało radykalnie poprawiać w konstrukcji samolotów, silników, systemów nawiązywych, systemów sterowania ruchem, kontroli bezpieczeństwa, funkcjonowaniu lotnisk. Presja tego sektora na dalsze innowacje wciąż trwa, gdyż istniejące systemy lotnicze są jeszcze dalekie od doskonałości.

Najintensywniejszy postęp techniczny ma miejsce w lotnictwie wojskowym, w którym powstaje szereg wynalazków o charakterze negatywnym (slużyczacych zabijaniu wrogów). Lotnictwo cywilne niejako przy okazji korzysta z osiągnięć techniki wojskowej, a dokonujące się w nim procesy innowacyjne współcześnie obejmują: 1) koncepcje nowej generacji samolotów, 2) nowej generacji wyposażenia nawiązywych tradycyjnych samolotów, 3) oparte na technologiach informatycznych i satelitarnych systemy organizacji ruchu lotniczego, 4) nowej gene-
racji lotniska i lądowiska. Wśród opisanych w literaturze i źródłach internetowych innowacji w tej gałęzi za najważniejsze można uznać: • koncepcje i prototypy samolotów pionowego startu o zmiennej geometrii krzydeł (Rotorcraft, Til-trotor), takich producentów jak Textron, Erica i innych, • nowej generacji sterowców towarowych (Airship, Dirgeable), • konstrukcje samolotów przyjaznych dla środowiska o niskiej emisji hałasu i CO₂ (eco-friendly planes), a przykładem jest koncepcja samolotu Cryoplane napędzanego wodorem, • samoloty nowej generacji typu „latające skrzydło” (bez tradycyjnego kadłuba), • bardzo duże samoloty pasażerskie (typu Airbus 380, prototypu 1000-miejscowego Boeinga 797 Blended Wing, eksperymentalnego samolotu Boeing i NASA X-48B) dla zmniejszenia liczby startów i lądowań na lotniskach i ograniczenia na nich kongesti, • lotniska nowej generacji (w tym Smart Automated Airports, Highway in the Sky, Off-Shore Air Stations), • fuże wielkich lotnisk z miastami i przekształcanie ich w centra logistyczne (Aéropolis), • samoobsługowe terminaly obsługi pasażerów, • technologie zautomatyzowanego bezpiecznego sterowania ruchem lotniczym (ATS).

Oryginalność innowacji lotniczych nie przekłada się w prosty sposób na ich upowszechnienie w masowym ruchu pasażerskim. Trudno jest na przykład kreślić perspektywy rozwojowe przed takimi koncepcjami jak samoloty na energię słoneczną (typu HP-SIA Solar Impulse szwajcarskiego konstruktora Bertranda Piccarda). O eksploatacyjnym i handlowym powodzeniu innowacji decydują w głównej mierze takie czynniki jak: • niezawodność techniczna samolotów, • przydatność samolotów w masowym ruchu pasażerskim, • możliwość zainteresowania przemysłu lotniczego koncepcją nowego samolotu, • możliwość korzystania przez samoloty nowej generacji z tradycyjnej infrastruktury portów lotniczych, bez konieczności jej kosztownej modernizacji, • gwarancja, że koszty eksploatacji samolotów nowej generacji są trwale niższe od kosztów modeli dotychczas użytkowanych.

Należy zauważyć dużą aktywność ośrodków naukowych, przemysłu stoczniowego i władz państwowych w kreowaniu innowacji zmieniających charakter współczesnego transportu i portów morskich. Jednak w praktyce, mimo intensywnych prac naukowych i wdrożeniowych, w sektorze tym procesy innowacyjne nie mają zbyt spektakularnego charakteru. Wśród opisywanych w publikacjach nowych rozwiązań w tej gałęzi zwraca uwagę: • projektowanie i budowa szybkich statków pasażerskich (HSC - High Speede Craft) o prędkości 35-45 węzłów i superszybkich statków kontenerowych (Super High Speed Container Ship – HTH) o prędkości powyżej 50 węzłów, • wdrażanie zaawansowanych systemów bezpieczeństwa żeglugi morskiej (Automatic Identification Systems – AIS, Ship Security Alert Systems and Long-Range Tracking – SSAS, US Container Security Initiative – CSI), • koncepcje przyjaznych dla środowiska statków napędzanych sprezynonym gazem ziemnym (np. concept vessel E/S Orcelle), • zautomatyzowane operacje kontenerowe w portach (Automated Container Handling Technology), • koncepcje zautomatyzowanych systemów logistycznych w portach morskich
Rysuje się coraz jaśniejsza perspektywa stosowania alternatywnych napę-
dów statków morskich (wodorowych, elektrycznych) pozwalających zmniejszyć
zużycie energii, emisji CO₂, obniżenie hałasu maszynowni, poprawę komfortu
podróży. Ważnym celem pozostaje proces innowacyjny pozwalający stwo-
rywać statki całkowicie niezatapialne.

Przyroda w bardzo poważnym stopniu ogranicza ludzką inwencję w zakre-
sie kreowania innowacji w żeglugie śródlądowej. Wprawdzie można w tej
gałązi zastosować te same wynalazki energetyczne co w transporcie samocho-
dowym (napęd wodorowy, elektryczny), ale radykalna zmiana jakościowych
parametrów statków śródlądowych i parametrów dróg wodnych jest bardzo
utrudniona. Nie można bowiem zwiększyć ani prędkości ani gabarytów statków
z uwagi na ochronę strefy brzegowej dróg wodnych. Mimo istniejących ograni-
czeń procesy innowacyjne mają miejsce i w tej gałęzi transportu. Na uwagę
zasługują: • koncepcje nowej generacji statków śródlądowych (w tym kontene-
rowych statków śródlądowych energooszczędnych i czystych pod względem
ekologicznym, statków typu ro/ro catamaran lub articulated container vessel with pi-
viot system, statków przystosowanych do żeglugi na płytkich drogach wodnych
typu INBAT13), • rozwiązywania promujące przeniesienie ładunków z transportu
samochodowego do wodnego śródlądowego, • nowoczesne systemy i technolo-
gie informacji rzecznej (River Information Services – RIS), • nowe technologie eks-
ploatacji dróg wodnych wydłużające okres nawigacji w warunkach zimowych
(istotne w krajach północnych). Ze względów ekologicznych konieczne jest za-
chowanie równowagi między funkcjami transportowymi a pozostałymi funkcja-
mi dróg wodnych, co sprawia że w tej gałęzi nie ma silnej presji na poszukiwa-
nie innowacji i technologii przełomowych.

Transport miejski jest sferą charakteryzującą się wyjątkową koncentracją
ruchu na małym obszarze i siłą rzeczy utrzymuje się tu od lat bardzo silny „głód
innowacyjny”. Istnieje jednak duży kontrast między zapotrzebowaniem na in-
nowacje miejskie, a możliwościami sfery naukowo-badawczej i przemysłowej
stworzenia koncepcji i środków łagodzących skutki tłoku uliczno-go ruchu, zanieczyszczenia powietrza, hałasu i wypadków. Dzieje się tak, mimo
iż istnieje na świecie bardzo wiele instytucji, ośrodków i inicjatyw służących kre-
owaniu innowacji oraz tworzeniu systemów zrównoważonego transportu miej-
skiego. Coraz częściej odnoszą się one nie tylko do transportu osób, ale także do
transportu ładunków (logistyki miejskiej).

Tworzenie skutecznych innowacji służących uzdrowianiu miejskich syste-
mów transprowalnych wymaga czasu i cierpliwości. Mimo niepowodzeń lub

13 Zob.: INBAT – Innovative barge trains for effective transport on inland shallow waters. Projekt
koordynowany przez DST z Duisburga w ramach V Programu Ramowego UE –
wątpliwych efektów wdrażania nowych koncepcji i środków w niektórych aglomeracjach zaczyna się tworzyć większy ład i harmonia w sposobach przemieszczania mas mieszkańców. Perspektywiczny pozytywny charakter mogą mieć następujące kierunki kreowania nowej organizacji i nowych technologii transportu miejskiego: • radykalne przestawienie ruchu miejskiego na transport zbiorowy przez reorganizację i przebudowę urbanistyczną dzielnic miast, • czyste ekologicznie pojazdy miejskie (napęd elektryczny, gazowy, wodorowy, hybrydowy, na sprężone powietrze), • systemy automatycznych pojazdów miejskich typu PRT (Personal Rapid Transit), będących specyficznie zindywidualizowanymi pojazdami poruszającymi się po własnych drogach oddzielonym od tradycyjnych ulic, • tworzenie stref o niskiej emisji spalin (The Low Emission Zone – LEZ) funkcjonujących w zaostrzonym reżimie wjazdu i parkowania pojazdów spalinowych, • usługi wspólnotowe transportu indywidualnego w miastach (Urban Lift-sharing Services, nazywany także Car-Pooling, Car-Sharing lub Ride-Sharing), • systemy zamawianych przewozów mikrobusowych (Call-a-Bus Services nazywany także Demand Responsive Transport – DRT) i inne.

Bardzo ważnym obszarem innowacji transportowych jest ogół działań związanych z budową i utrzymaniem infrastruktury transportowej. Sprawność i efektywność tych działań można podwyższać poprzez: a) innowacje w sferze projektowania i integrowania infrastruktury z otoczeniem, b) innowacje materiałowe, c) koncepcje dodatkowych elementów wyposażenia, d) systemy usprawniające ruch i zwiększające jego bezpieczeństwo, e) rozwiązania międzygałęziste (intermodalne).

Dobry system infrastruktury transportowej powstaje wówczas, gdy na samym początku jego gruntownej przebudowy i modernizacji istnieje zintegrowany plan uwzględniający zarówno przyszłe zapotrzebowanie na przepustowość szlaków i węzłów, jak i interesy oraz odczucia podmiotów obecnych w sąsiedztwie sieci infrastruktury, ale w ograniczonym stopniu z niej korzystających. Współcześni stan wiedzi z zakresu inżynierii materiałowej i budowlanej pozwala stosować przy budowie dróg, szlaków kolejowych, pasów startowych na lotniskach i w terminalach morskich materiały o specjalnych właściwościach (nanomateriały) podwyszające walory użytkowe i trwałości obiektów. Symptomem nowoczesności i innowacyjności jest też wyposażenie tradycyjnych elementów liniowych i punktowych infrastruktury w inteligentne systemy monitorowania ruchu, kontroli bezpieczeństwa, elektronicznego pobierania opłat za ich użytkowanie.

W zakresie infrastruktury drogowej największe perspektywiczne znaczenie mają następujące kierunki innowacyjnych zmian: • stosowanie materiałów alternatywnych wobec tradycyjnego kruszywa skalnego (alternative materials in road construction, recycling materials in road construction), • nowe materiały uzupełniające tradycyjny asfalt, beton lub beton asfaltowy (geotekstyli, geosyntetyki, kompozyty, polimery i inne), • bezpośrednio nawierzchniowe (skid-resistant
road surfaces), • kolektory energii słonecznej służące podgrzewaniu nawierzchni dróg i usuwaniu lodu (de-icing the road surface in winter), • nawierzchnie dróg absorbujące hałas w osiedlach (new noise-absorbing road surfaces), • systemy nawigacji satelitarnej i kontroli ruchu drogowego, • systemy zarządzania drogowymi miejscami postojowymi, • budowa podziemnej infrastruktury do przewozów ładunków drogowych.

Innowacje infrastrukturalne w sektorze kolejowym mogą mieć dwojaki charakter: 1) doskonalące klasyczną drogę szynową i jej elementy (rozjazdy i połączenia torów), 2) wprowadzające niekonwencjonalne rozwiązania dróg kolejowych (lewitacja magnetyczna, SkyTrain i inne). Istotne znaczenie dla jakości i bezpieczeństwa ruchu kolejowego ma zastosowanie takich innowacyjnych materiałów i podzespołów jak: • podkłady i zamocowania redukujące i pochłaniające hałas pojazdów szynowych, • prefabrykowane nawierzchnie przejazdów kolejowych i przejazdów tramwajowych eliminujące wstrząsy pojazdów drogowych na szynach, • innowacyjne materiały do konstrukcji kolejowych ekranów dźwiękowych.

Nowe materiały konstrukcyjne w infrastrukturze lotniczej są najbardziej przydatne przy budowie, modernizacji i recyklingu pasów startowych. Poszukiwane cechy tych materiałów to większa żywotność (odporność na pękanie), lepsza widzialność dla pilotów (beton lub asfalt z dodatkiem granulek szkła), odpowiednia gładkość i szorstkość nawierzchni, zapobieganie poślizgowi (hydroplaning) w czasie dużego deszczu.

Specyficzny charakter ma poszukiwanie innowacyjnych rozwiązań w zakresie infrastruktury portów wodnych, w których innowacje materiałowe są inspirowane takimi wyzwaniami, jak: zabezpieczenie infrastruktury przed niszczącym działaniem fal wodnych, ograniczenie skutków działania prądów morskich (zamulanie kanałów i basenów piaskiem). W tym sektorze transportu innowacje materiałowe są znacznie trudniejsze niż w transporcie ładowym, gdyż ograniczone są możliwości wdrażania metod recyklingu (materiały hydro-techniczne muszą być długowęczne (long life cycle), nietoksyczne, przyjazne dla środowiska wodnego).

Dotychczasowy rozwój infrastruktury transportu intermodalnego i kombinowanego skoncentrowany był na budowie dużych, sprawnych i szybko funkcyjujących terminali na styku dwóch gałęziowych podsystemów przewozów. Istniejące dotychczas rozwiązania mają jednak niewiele wspólnego z rzeczywistą intermodalnością rozumianą jako zdolność do płynnego poruszania się danego środka transportu w różnych środowiskach drogi (kołowej, szynowej, wodnej). W kierunku tak rozumianej intermodalności idą takie innowacje jak koncepcja DMV - pojazdów drogowo-szynowych (road-rail vehicle, road-rail buses, dual-mode transit) zdolnych bez korzystania z terminali do równie swobodnego samodzielnego poruszania się zarówno po drodze kołowej, jak i szynowej.

Kolejnym krokiem w naświetleniu innowacyjnej perspektywy sektora było przeanalizowanie przez A. Koźlak w piątym rozdziale palety rodzajów się na
świecie koncepcji i nowych rozwiązań logistycznych. Innowacyjność w sferze usług logistycznych może odnosić się zarówno do usługi jako produktu, jak i do procesu jej świadczenia, organizacji i zarządzania przedsiębiorstwem, czy relacji z otoczeniem. Zmiany zachodzące w logistyce związane są przede wszystkim ze zmianami makroekonomicznymi, rosnącymi wymaganiami klientów oraz z wdrażaniem nowoczesnych technologii. Dzięki postępowi w dziedzinie technologii informatycznych i nowym modelom biznesowym możliwe było powstanie i rozwój "nowej gospodarki", która wywoła konieczność wdrażania nowych rozwiązań również w logistyce.

Głownym motywem innowacji w logistyce jest konieczność wzrostu nowoczesności i konkurencyjności firm poprzez poprawę efektywności i satysfakcji klientów. Przedsiębiorstwa logistyczne muszą zwracać szczególną uwagę na nawiązywanie współpracy i tworzenie sieci w celu poprawy efektów działalności w zakresie obsługi przepływu towarów i śledzenia tego przepływu, technologii przepływu informacji i innych zaawansowanych procesów. Występują dwa rodzaje procesów innowacyjnych logistycznych: • innowacyjne koncepcje i rozwiązania, • innowacje technologiczne.

Innowacje organizacyjne to nowoczesne formy outsourcingu w obsłudze logistycznej i nowe modele biznesowe, począwszy od prostych łańcuchów dostaw do rozbudowanych sieci logistycznych, określanych jako 5PL. Organizacje te są prawie całkowicie wirtualne, gdyż nie posiadając typowych aktywów, skupiają się na zdobywaniu niezbędnych umiejętności zarządzania i koordynacji działalności innych usługodawców poprzez dedykowane rozwiązania informacyjne, a także kojarzą strony popytową i podażową poprzez elektroniczne rynki usług logistycznych. Kluczem do sukcesu w tej dziedzinie są technologie informacyjne i integracja systemów komputerowych. Kategoria nowych modeli biznesowych została nazwana „wirtualne konsorcja sieciowe” (ang. Virtual Network Consortia – VNC).

Innowacje technologiczne, zgodnie z zakresem działalności logistycznej, można podzielić na cztery kategorie: • technologie identyfikacji i gromadzenia danych, • technologie informacyjne, • technologie magazynowania, • technologie w zakresie transportu.

W łańcuchach dostaw wykorzystywanych jest wiele technologii określanych wspólnym mianem systemów automatycznej identyfikacji. System automatycznej identyfikacji to zespół środków i urządzeń technicznych służących do automatycznego gromadzenia, przetwarzania i przesyłania danych. Umożliwiają one zbieranie i bezpośrednie wprowadzanie danych do bazy danych systemu informatycznego bez użycia klawiatury. Najczęściej stosowanym systemem automatycznej identyfikacji są kody kreskowe, ale stopniowo coraz częściej stosowany jest system identyfikacji częstotliwości radiowej RFID, z którym związane są bardzo duże nadzieje.

Rozwój nowoczesnych technologii informatycznych jest związany z integracją różnych systemów informatycznych i wykorzystaniem istniejących stan-
dardów wymiany danych. Do nowoczesnych technologii tego typu, które są stosowane w branży logistycznej zalicza się elektroniczną wymianę danych (EDI), internet, sieci "z wartością dodaną" (VAN), logistyczne systemy informatyczne, punkty sprzedaży (POS), elektroniczne systemy zamówień (EOS), telefonię VOIP oraz portale informacyjne przedsiębiorstw. Bardzo ważnym aspektem wykorzystania technologii informatycznych jest budowanie zintegrowanych systemów wspomagających zarządzanie różnymi obszarami działalności, a przedsiębiorstwa coraz szerzej korzystają w tym celu z systemów informatycznych. Operatorzy logistyczni wykorzysują technologie informatyczne do zarządzania łańcuchem dostaw (systemy SCM), albo tylko niektóre moduły, takie jak WMS do zarządzania magazynem, czy systemy TMS do skutecznego zarządzania transportem.

Innowacje w zakresie technologii magazynowania są wymuszone przez charakter współczesnej gospodarki, w której bardzo duże znaczenie przywiązuje się do zapewniania ciągłego strumienia przepływów towarowych i do możliwości elastycznego reagowania na zapotrzebowania odbiorców. Automatyczna informacja o stanie materiałowym lub rozłożeniu materiałów w magazynie, jest nie tylko dużym usprawnieniem pracy, ale coraz częściej staje się koniecznym warunkiem konkurencyjności przedsiębiorstwa na rynku. Systemy automatyczne przejmują wiele procesów związanych z przemieszczaniem i składowaniem ładunków. Technologie magazynowe, które są powszechnie stosowane w branży logistycznej obejmują m. in. automatyczny system przechowywania i wyszukiwania oraz sortowania, wspomagany komputerowo system wybierania towarów do wysyłki, czy system utrzymywania temperatury w magazynie. Innowacyjną technologią stosowaną coraz częściej w zarządzaniu gospodarką magazynową są systemy głosowe. Stanowią one przełom w komunikacji między systemem komputerowym zarządzającym magazynem, a człowiekiem. Systemy głosowe są w stanie zapewnić szybki i efektywny sposób wyszukiwania i wysyłania przechowywanych produktów z magazynu. Są one technologią komplementarną wobec popularnych rozwiązań wykorzystywanych w magazynach np. RFID.

Innowacje technologiczne w zakresie transportu wykorzystywanego przez logistykę obejmują między innymi systemy informacji transportowej w czasie rzeczywistym i system informacji geograficznej (GIS), Globalny System Pozycjonowania (GPS), urządzenia zapisu danych np. tachografię. Technologie te wykorzystywane są do śledzenia pojazdu i przesyłki, analizy i planowania tras, zarządzanie składowaniem, a także planowanie przejazdu i załadunków środków transportu. Poprzez wdrażanie współpracujących ze sobą rozwiązań telematycznych, bazujących na technologii informatycznej, komunikacji bezprzewodowej i elektronice pojazdowej powstają inteligentne systemy transportowe (ITS), które w następnych latach będą stosowane w coraz szerszym zakresie.

Procesy innowacyjne w infrastrukturze transportowej obejmują zarówno nowe rodzaje materiałów stosowanych do ich budowy i utrzymania, nowe techn-
nologię budownictwa infrastrukturalnego, jak i nowej generacji obiektów infrastrukturalnych. Szósty rozdział niniejszej monografii autorstwa K. Wojewódzkiej-Król prezentuje tendencje w zakresie projektowania i budowy dużych obiektów infrastrukturalnych nowej generacji.

Znaczną część obiektów infrastrukturalnych nowej generacji spełnia kilka najważniejszych współczesnych zadań: • ograniczają kongestię, • są przyjazne dla środowiska (zwiększają bezpieczeństwo, wkomponowane w otoczenie, trwałe), • realizowane są przy zastosowaniu najnowocześniejszych rozwiązań, często w warunkach ekstremalnych, zachowania ciągłości pracy w otoczeniu, • mają często dodatkowe walory architektoniczne.

Do największych wyzwań należy budowa dużych połączeń stałych – mostów i tuneli - w miejsce przepraw promowych, często tam, gdzie dawniej nie było takiej potrzeby lub możliwości technicznych. Innowacyjność tych obiektów polega na śmiałości technicznej i oryginalności konstrukcji. Mosty tej kategorii mają niezwykłe parametry, czego przykładem jest Most Akashi Kaikyo między wyspami Honshiu i Awaji w Japonii (najdłuższy most wiszący na świecie), czy Viaduc de Millau nad doliną rzeki Tarn we Francji (najwyższy tego rodzaju obiekt na świecie). Podobny charakter ma projektowany drogowo-kolejowy most nad Cieśniną Messyńską mający parametry techniczne znacznie przewyższające typowe mosty.

Innowacje w zakresie budowy mostów polegają nie tylko na spektakularnych ich wymiarach i oryginalności konstrukcji lecz także na lepszym wkomponowaniu w środowisko naturalne. Celowi temu służy stosowanie różnego rodzaju środków ochrony czynnej (ekrany dźwiękochłonne, przeprawy dla ludzi i zwierząt itp.) oraz środków ochrony biernej (odpowiednia lokalizacja infrastruktury, omijanie terenów szczególnie wrażliwych na zagrożenia środowiska, trawowanie drogi w sposób pozwalający na płynną organizację ruchu lub mniejsza ingerencję w środowisko itp.). Koncepcje innowacyjnych rozwiązań w tym zakresie zostały zaproponowane w projekcie badawczym UE „COST 341. Habitat Fragmentation due to Transportation Infrastructure”, zrealizowanym w latach 1996-2003. Odwrotnym (negatywnym) przykładem była w Polsce próba zbudowania obwodnicy Augustowa zaprojektowanej przez teren chroniony „Natura 2000” (Dolina Rospody).

Innowacje i koncepcje nowej generacji tuneli są mniej liczne i mniej spektakularne niż wielkie mosty i wiadukty, chociaż budowa długich tuneli podmorskich czy górskich jest dużym wyzwaniem technicznym i finansowym. Na świecie istnieje ponad 50 tuneli o długości większej niż 10 km, wśród których wyróżniają się dwa podmorskie: • kolejowy tunel Seikan o długości 53,85 km (między wyspami Honshiu oraz Hokkaido w Japonii) przebiegający na głębokości dochodzącej do 240 m pod dnem morza, • kolejowy Eurotunnel łączący na długo-

ści 50,45 km Calais we Francji z Folkestone w Wielkiej Brytanii. W roku 2012 zostały one zdetronizowane przez budowany najdłuższy lądowy tunel na świecie – tunel Św. Gotharda (57 km) łączący Erstfeld w Szwajcarii i Bodio we Włoszech. Innowacje i ciekawe koncepcje polegają także na specjalnym wyposażeniu dużych tuneli w zaawansowane systemy bezpieczeństwa ruchu i zabezpieczenia przeciwpożarowego.

Każe działanie człowieka wywiera wpływ na otoczenie, budowa infrastruktury, ze względu na swoje cechy wywiera wpływ trwały, powoduje często nieodwracalne zmiany w środowisku. Ważne więc, żeby w tym procesie minimalizować negatywne skutki rozwoju infrastruktury dla otoczenia, w miarę możliwości kształtować struktury gałęziowe transportu i technologie przyjazne dla środowiska. Degradacyjny wpływ infrastruktury na środowisko jest złagodzony poprzez stosowanie różnego rodzaju środków ochrony czynnej (ekrany dźwiękochłonne, przeprawy dla ludzi i zwierząt itp. i biernej (odpowiednia lokalizacja infrastruktury, omijanie terenów szczególnie wrażliwych na zagrożenia środowiska, trawowanie drogi w sposób pozwalający na płynną organizację ruchu lub mniejszą ingerencję w środowisko itp.). Przykładem niwelowania negatywnych skutków w środowisku może być również budowa wiaduktów, które w znacznie mniejszym stopniu zmieniają środowisko niż drogi konwencjonalne.

Infrastruktura punktowa (dworce, terminaly, stacje) od dziesięcioleci stanowiła dla architektów i konstruktorów duży poligon do eksperymentowania innowacyjnych kształtów budowli składających się na jej strukturę. Współczesne tendencje w tym zakresie polegają na nadaniu tym budowlom unikalnego kształtu pozwalającego na ich powszechną identyfikację w społeczeństwie oraz na rozszerzenie funkcji czysto transportowych o inne funkcje (handlowe, wystawowe, artystyczne).

Szczególnie owocnym i perspektywicznie ważnym kierunkiem innowacji w transporcie jest rozwój technik satelitarnego wspomagania ruchu. Problematyka ta została w ogólnym zarysie przedstawiona w rozdziale siódmym przez M. Bąk. Komisja Europejska postrzega rozwijanie systemu nawigacji satelitarnej jako niezbędny instrument sprzyjający realizacji nie tylko polityki transportowej, ale też energetycznej, rolnej, ekologicznej, a ponadto w zakresie ochrony cywilnej, zarządzania kryzysowego czy ratownictwa. Zastosowanie nawigacji satelitarnej w transporcie jest bezsprzecznie efektywne poprzez możliwość automatycznej identyfikacji poruszających się pojazdów, ale też sterowanie ich ruchem, dostarczanie kierującemu odpowiednich informacji czy ostrzeganie o potencjalnych zagrożeniach. Obok tych podstawowych możliwości można wskazać na szersze perspektywy zastosowań, z uwzględnieniem specyfiki poszczególnych gałęzi transportu.

Zagadnienie nawigacji satelitarnej znalazło się w dokumencie programowym kształtującym kierunki polityki transportowej UE – Białej Księdze z 2001 r. Zostało ono ujęte w dwóch pakietach instrumentów tej polityki: • pakietie szóstym odnoszącym się do rozwoju sieci transeuropejskich, gdzie na listę sieci

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TEN wpisany został projekt europejskiego systemu nawigacji satelitarnej Galileo, pakiecie dwunastym poświęconym zarządzaniu efektami globalizacji, gdzie za jeden z celów cząstkowych uzna się osiągnięcie niezależności w zakresie nawigacji satelitarnej poprzez rozwój własnego systemu Galileo. Jednak wykorzystanie systemu nawigacji satelitarnej jest możliwe czy wręcz konieczne w odniesieniu do realizacji wielu innych celów polityki transportowej UE, np. w zakresie poprawy bezpieczeństwa drogowego czy przyjęcia zasad efektywnych opłat w transporcie. Ponadto po opublikowaniu Białej Księgi w 2001 r. nastąpił szybki postęp technologiczny w transporcie, zaś wyzwania ekologiczne traktowane są coraz poważniej, co upoważnia do stwierdzenia, że powszechność i zakres stosowania nawigacji satelitarnej w transporcie będą szersze niż to przewidywano w ostatnim dokumencie programowym europejskiej polityki transportowej.

Zastosowanie nawigacji satelitarnej w transporcie dotyczy nie tylko drogowego transportu pasażerskiego czy towarowego, gdzie obecnie dynamicznie wprowadzany jest do powszechnego użytku system GPS. Pozostałe gałęzie transportu również mogą, dzięki wykorzystaniu nawigacji satelitarnej, rozwijać się w sposób sprzyjający poprawie bezpieczeństwa, optymalnemu zużyciu energii, redukcji kongestii itp. Dlatego nie sposób przecenić walorów systemów satelitarnych w zakresie realizacji polityki transportowej, która zarówno na poziomie Unii Europejskiej, jak i większości krajów europejskich wskazuje na potrzebę zrównoważonego rozwoju, zmiany struktury gałęziowej, redukcji kosztów zewnętrznych. Trzeba więc zintensyfikować działania sektora publicznego, a również aktywizować sektor prywatny w kierunku technicznego usprawnienia istniejącego amerykańskiego systemu GPS lub też zbudowania nowego europejskiego systemu Galileo.

Jeżeli Unia Europejska nie będzie zdolna do pomyslnego sfinalizowania swoich zamierzeń związanych z pierwszym w historii kontrolowanym przez instytucje cywilne systemem nawigacji satelitarnej Galileo, to w sposób naturalny dojdzie do ekspansji już funkcjonujących i rozwijających się dynamicznie rozwiązań amerykańskich (GPS) czy rosyjskich (GLONAS). Trzeba też wspomnieć o ekspansji chińskiej na tym rynku w postaci systemu nawigacji BEIDOU w pierwszym etapie obejmującego Chiny i kraje sąsiadujące, z możliwością rozszerzenia na całą kule ziemską. System GPS po prawie 20 latach eksploatacji jest poważnie zużyty i wymaga od 2010 r. wymiany najstarszych satelitów.

Pomimo, że polskie podmioty nie są członkami konsorcjum tworzącego Galileo i jedynym przejawem polskiego udziału jest instalacja jednej z wielu stacji pomiarowo-obserwacyjnych systemu EGNOS w Warszawie, to trzeba podjąć wysiłki zmierzające do zaangażowania polskich ośrodków badawczych w projekty badawczo-naukowe finansowane przez Komisję Europejską, które służą rozwijaniu innowacyjnych rozwiązań w zakresie nawigacji satelitarnej. Istotne jest ponadto powszechne informowanie użytkowników transportu i całe
Społeczeństwo na temat potencjalnych możliwości i coraz szerszych perspektyw praktycznych zastosowań nawigacji satelitarnej w sektorze transportu.

Pokrewnym obszarem innowacji transportowych mającym przed sobą duże perspektywy rozwojowe jest telematyka, której użyteczność w transporcie drogowym przedstawiły w rozdziale ósmym J. Łacny i W. Zalewski. Systemy telematyczne są przydatne zarówno dla podejmowania prawidłowych decyzji w zarządzaniu przedsiębiorstwem transportu drogowego jak i zwiększania bezpieczeństwa w transporcie.

Rozbudowane systemy nawigacyjne i pozycjonujące, pracujące zarówno w reżimie on-line jak i off-line, pozwalają na bardziej efektywne wykorzystanie zasobów ludzkich i sprzętowych przedsiębiorstwa. Pozwalają nadzorować zużycie paliwa, miejsca tankowań, zabezpieczenie ładunku, kontrolować nacisk osi pojazdu, pracę tachografu, monitorować stan pojazdu (czy pojazd w danej chwili stoi lub jedzie, czy ma włączony silnik lub nie), odtwarzać trasę przejazdu na podstawie informacji cyfrowych gromadzonych w SQL-owych bazach danych czy wręcz zatrzymać pojazd w przypadku zagrożenia. Pozwalają nawet prowadzić nasłuch kabiny kierowcy lub przestrzeni ładunkowej.

Największa użyteczność telematyki w drogowych przewozach ładunków to funkcja programowania tras przejazdu samochodów według ważnych dla przewoźnika kryteriów: optymalizacji struktury kosztów i ich wysokości, skrócenia czasu przejazdu, unikania płatnych dróg, itp. Stosowanie rozwiązań informatycznych czy teleinformatycznych może mieć bardzo istotny wpływ na określanie efektywności przewozów w międzynarodowym transporcie drogowym rzeczy. Dzięki nim można np. określić rzeczywisty przychód na każdy przejechany przez pojazd kilometr w każdym zamkniętym cyklu transportowym.

Ważnym nurtem specyficznych innowacji jest wyposażenie współczesnej zaawansowanej logistyki w dostosowane do jej funkcji i potrzeb technologie informacyjne, które w rozdziale dziewiątym przeanalizowała H. Brdulak. Jeżeli przyjrzymy się obecnym oczekiwaniom klientów w zakresie czasu i niezawodności usług logistycznych, to możemy uznać, że mogą one być realizowane jedynie poprzez zwiększenie nasycenia informatyzacją tradycyjnych usług, co prowadzi do zmiany modelu biznesu. W firmach zorientowanych na e-biznes zdecydowanie wzrasta udział czynności realizowanych za pomocą platform informatycznych, poczynając od zamówień elektronicznych, płatności on-line, śledzenia drogi przesyłki i odchylen powstających w trakcie realizacji zlecenia, potwierdzenia dostawy a także śledzenia zwrotów, odpowiedzi na reklamacje czy generowania raportów.

Przedsiębiorstwa logistyczne korzystają obecnie zarówno z dobrodziejstw rozwoju technologii IT, jak i muszą sprostać wyzwaniom wynikającym z takich tendencji jak: • integracja systemów informatycznych nie tylko w obrębie przedsiębiorstwa i jego poszczególnych działów, ale również w obrębie całego łańcucha dostaw/sieci, • zapewnienie wysokiego poziomu bezpieczeństwa dla informacji, przepływających między poszczególnymi ogniwami łańcucha do-
staw/ w ramach sieci dostaw (certyfikaty ISO 27001), • wyodrębnianie się rozwiązań dedykowanych dla poszczególnych branż, np. farmaceutyki, przemysł motoryzacyjny, FMCG, elektroniczna.

Wśród zintegrowanych ze sobą systemów informatycznych w sieciach logistycznych szczególne znaczenie mają: • systemy elektronicznej wymiany danych, jako pewnego rodzaju „szyna integracyjna” pomiędzy innymi systemami, • systemy do przyjmowania i ewidencji zamówień po stronie klienta, • systemy umożliwiające złożenie zlecenia transportowego do operatora logistycznego, a także umożliwiające przygotowanie dokumentacji przewozowej, • systemy mobilne dla kierowców, jako rodzaj końcówek zintegrowanych systemów wspierających procesy wewnętrz organizacji operatora logistycznego, • systemy stworzone do planowania i optymalizacji dostaw oraz odbiorów po stronie operatora logistycznego, • zintegrowane systemy zarządzania wspierające procesy wewnętrz organizacji operatora logistycznego, • systemy klasy WMS (Warehouse Management System) w przypadku oferowania logistycznych usług magazynowych, • systemy raportowe, w tym systemy umożliwiające śledzenie realizacji zlecenia (Tracking) oraz kontrolę wskaźników jakości w łańcuchu (KPI).

Technologia integracyjna stała się już pewnego rodzaju nowym produktem, dostępnym na rynku. Oferowana jest pod różnymi nazwami, takimi jak „szyna integracyjna” czy rozwiązania SOA (Services Oriented Architecture) czy też plataforma EDI. Może ona wystepować w postaci określonego pakietu oprogramowania do wyboru przez klienta, w zależności od wykorzystywanych przez niego technologii, polega na ustaleniu standardów wymiany informacji (EDIFACT, XML), kanałów szyfrowania (jak HTTPS, SFTP) aż do pomocy (help desk) dla użytkowników rozwiązania oraz serwisu informatycznego dostępnego przez 24 godziny.

Z rozwojem technologii IT wiąże się szereg zagrożeń dla bezpieczeństwa operacji logistycznych, brzemiennych w skutkach szczególnie w przypadkach awarii systemów. Wymaga to stosowania innowacyjnych sposobów zmniejszania ryzyka, obok tradycyjnych rozwiązań, takich jak tworzenie zdublowanych centrów przetwarzania a także podwojenia łącznego sieci rozległych.

Pełną perspektywę możliwych innowacji transportowych można najtrafniej określić analizując zapotrzebowanie na nowe rozwiązania w poszczególnych gałęziach i formach transportu. Istnieje duża różnica zarówno w zakresie sektorowych potrzeb innowacyjnych, jak i w zakresie możliwości kreowania innowacji na rzecz transportu pasażerskiego i transportu towarowego transportu na duże odległości i transportu lokalnego, transportu w masowych i rozproszonych łańcuchach przewozowych.

Obrazem największego zapotrzebowania na innowacje jest transport miejski, w którym występuje najwięcej symptomów niewydolności systemów przewozowych i ich uciążliwości dla otoczenia przyrodniczego i społecznego. Przewyższeniu słabości tych systemów mogą służyć zarówno innowacje technolo-
giczne, jak i nowe koncepcje organizacyjne i nowe wzorce mobilności mieszkańców.

Tendencje rozwoju nowoczesnych systemów organizacji transportu miejskiego w Europie zostały przedstawione w rozdziale dziesiątym autorstwa O. Wyszomirskiego. Podstawowe znaczenie ma odejście od monopolu świadczenia usług transportowych w miastach przez jednego przewoźnika stworzonego przez władzę publiczną na rzecz systemu konkurencyjnego świadczenia tych usług według standardów ustalonych przez publicznego organizatora transportu miejskiego (tworzy się w tym celu jednostkę realizującą zadania wyłącznie regulacyjne i organizacyjne). Rozwiązania stosowane w tym zakresie w poszczególnych krajach cechują znaczne różnice. Przykładowo w W. Brytanii zapewniony jest nieograniczony dostęp do rynku przewoźników, którzy spełniają określone wymagania techniczne, podczas gdy we Francji dostęp do rynku na ścisłe określony czas ma tylko jeden przewoźnik, który wygrał przetarg na obsługę komunikacyjną całego miasta. Kraje te różni też zakres regulacji działalności przewozowej przez władze publiczne (większy jest we Francji). Transport miejski w stolicach tych państw funkcjonuje na odrębnych zasadach. W innych krajach europejskich powstały systemy mające charakter zbliżony albo do modelu brytyjskiego, albo do modelu francuskiego, z wyjątkiem Niemiec, gdzie nadal funkcjonuje system tradycyjny oparty na angażowaniu przez związki gmin przewoźników komunalnych i dopłacaniu do wykonywania usług transportu miejskiego.

Innowacyjne trendy w transporcie miejskim są inspirowane i przyspieszone w wyniku powszechnej akceptacji idei zrównoważonego rozwoju transportu. Zachwianie równowagi transportu miejskiego w ciągu ostatniego ćwierćwiecza nastąpiło w wyniku agresywnego rozwoju motoryzacji indywidualnej, a zwłaszcza w wyniku upowszechnienia się irracjonalnego stylu korzystania z samochodu osobowego w miastach (zbyt duże pojazdy, średnie zapelnienie samochodu w czasie jazdy poniżej 2 osób, nadmierna liczba przejazdów na krótkie odległości, koncentracja ruchu w ciągu kilku godzin doby, itp.). Przyczyną tego zjawiska jest proces suburbanizacji przejawiający się ekstensywnym rozwoju przestrzennym miast, w których liczba mieszkańców obszarów podmiejskich rośnie kosztem obszaru centralnego. Problemem zrównoważonego rozwoju transportu miejskiego został poświęcony rozdział jedenasty autorstwa M. Wołka. Nowym trendem jest coraz powszechniejsze stosowanie zintegrowanego podejścia w zarządzaniu mobilnością mieszkańców miast. Zintegrowane podejście polega na szerszym niż dotychczas umywaniu problematyki transportowej miasta, uwzględniając: • rozwój infrastruktury transportowej, • zarządzanie ruchem na obszarze miasta, • rozwój transportu publicznego, • finansowanie transportu publicznego, • planowanie przestrzenne. Zarządzanie zintegrowanym podejściem w miastach Europy Środkowej i Wschodniej odbywa się w odmiennych (trudniejszych) warunkach niż w miastach Europy Zachodniej, gdzie koncentruje się ono na „działaniach miękkich” (bezinwestycyj-
nych), takich jak wprowadzanie różnego rodzaju opłat dla użytkowników infrastruktury transportowej czy też tworzenia planów transportowych. Działania inwestycyjne mają na celu przede wszystkim wzrost efektywności już istniejącej infrastruktury transportowej.

Dla stworzenia zestawu najbardziej obiecujących innowacyjnych rozwiązań w szeroko pojmowanej dziedzinie mobilności miejskiej przeprowadzono badania w ramach projektu NICHERS (New and Innovative Concepts for Helping European Transport Sustainability). Projekt miał za zadanie przyczynić się, w szczególności, do poprawy jakości środowiska naturalnego, podniesienia konkurencyjności transportu zbiorowego oraz jakości życia na terenach zurbanizowanych. Efektem tego projektu jest sformułowanie 12 nowych koncepcji obejmujących:
1) usługi polegające na gromadzeniu osób podróżujących w tym samym kierunku w celu optymalnego wykorzystania samochodów osobowych (do tego celu wykorzystuje się specjalistyczne oprogramowanie oraz internet),
2) system bezpłatnego wypożyczenia rowerów w mieście, cechujący się szybkim i łatwym dostępem dla codziennych użytkowników w szczególności w centrum miasta,
3) usługi na żądanie, oferowane w oparciu o wcześniejsze zamówienia użytkowników (rekomendowana na obszarach o niewielkiej gęstości zaludnienia),
4) podniesienie efektywności wykorzystania miejskiej infrastruktury transportowej przez dostawców towarów dzięki wykorzystaniu nowoczesnej technologii, modernizacji infrastruktury oraz wydzieleniu specjalnych stref dostępnych w określonych porach dnia,
5) dostawy do sklepów zlokalizowanych w centrum miasta w porze nocnej (22-6),
6) optymalizacja pracy dostawców poprzez dostarczanie przesyłek do zbiorczych lokalizacji zamiast do domów lub określenie pory w której przesyłka zostanie doręczona z wykorzystaniem m.in. usług telefonii komórkowej,
7) zapewnienie w długim okresie stabilnych warunków dla użytkowników pojazdów przyjaznych dla środowiska, wykorzystujących paliwa alternatywne raz pozyskiwanie nowych grup użytkowników,
8) wykorzystanie biogazu w pojazdach obsługujących miasto w celu obniżenia zanieczyszczenia środowiska miejskiego,
9) organizacja wspólnych przetargów na zakup pojazdów na paliwa alternatywne w celu obniżenia ich ceny jednostkowej oraz upowszechniania technologii wśród społeczeństwa,
10) kształtowanie partnerstwa publiczno-prywatnego w celu podnoszenia jakości system transportowego,
11) nakładanie opłat i podatków na użytkowników samochodów w celu podniesienia konkurencyjności transportu zbiorowego (wprawy powinny być inwestowane w podnoszenie jakości usług transportu zbiorowego),
12) długoterminowe budowanie świadomości poprzez organizację wydarzeń udziałem partnerów prywatnych, angażujących społeczność lokalną wokół tematyki równoważonej mobilności.

Podnoszenie atrakcyjności transportu zbiorowego bez wdrażania instrumentów mających na celu ograniczanie korzystania samochodów jest strategią nieefektywną i w długim okresie czasu nie jest w stanie zapewnić właściwego
z punktu widzenia zrównoważonej mobilności podziału zadań przewozowych w mieście.

Innowacyjny renesans roweru w krajach wysoko rozwiniętych jest efektem wprowadzenia szeregu udoskonaleń w jego konstrukcji i stworzenia nowych form organizacyjnych ruchu rowerowego w dużych miastach. Na pytanie dlaczego racjonalne jest wybieranie roweru jako środka transportu i sposobu na zdrowy styl życia w dwunastym rozdziale odpowiada polska medalistka olimpijska z Pekinu w kolarstwie górskim M. Włoszczowska.

W końcu XX wieku obserwowaliśmy prawdziwy boom rowerowy, który doprowadził do olbrzymiej różnorodności pojazdów jednoosobowych. W efekcie tego procesu mamy obecnie do wyboru następujące rodzaje rowerów: górskie, szosowe, torowe, trekkingowe, bmx-y czy klasyczne rowery miejskie. Wszystkie one istotnie różnią się od siebie i różni się ich wykorzystanie. W kształtowaniu zrównoważonej struktury transportu miejskiego największe znaczenie w dużych miastach mają rowery skonstruowane pod kątem maksymalnego ich wykorzystywania przez mieszkańców w codziennych dojazdach do pracy, szkół, na zakupy i w celach rekreacyjnych: • łatwe w użytkowaniu, parkowaniu i konserwacji, • wyposażone w bagaże (najlepiej w kształcie dość dużego koła), • pozwalające na pokonywanie wzniesień (z nowoczesnymi niezawodnymi przerzutkami), • bezpieczne w masowym ruchu pojazdów ulicznych (białe reflektory i światełka pozycyjne (odblaskowe), osłony łańcuchów i błotniki nad kołами, niezawodne stopki).

Na innowacje rowerowe w dużych miastach składają się także udodnienia infrastrukturalne pozwalające na przeniesienie znaczącej części ruchu samochodowego na ruch rowerowy (nawet w krajach o surowym klimacie i długich okresach zimowych). Obserwacje pokazują, że w Europie 30% tras przejazdów samochodowych jest krótszych niż 3 km, a 50% krótszych niż 5 km, a przeciętnie na takich dystansach rower w większości przypadków jest znacznie szybszym środkiem transportu. Wystarczy, że będzie on powszechnie i bezstresowo dostępny i będzie istniała gęsta sieć ścieżek rowerowych. W niektórych miastach najwyższej rozwiniętych gospodarczo państw europejskich (Cambridge, Bazylea, Ferrara, Amsterdam, Parma, Berno, Vestras) udało się już stworzyć warunki dla dość intensywnego wykorzystywania rowerów w ruchu ulicznym (15-33% całego ruchu miejskiego). Upowszechnienie przykładów tych miast wymaga budowy ścieżek rowerowych nie tylko na obszarach miast (o przeznaczeniu rekreacyjnym), ale także ścieżek w ciągach ulic śródmiejskich, na których pojazdy poruszają się z prędkością większą niż 30 km/h. Budowane ścieżki powinny tworzyć spójny system połączeń, a ich lokalizacja powinna być łączona z ograniczeniem ruchu samochodowego zwłaszcza w ścisłych centrach miast, w których istnieje dużo stref dla ruchu niezmechanizowanego.

Warunkiem zwiększenia udziału rowerów w ruchu ulicznym dużych miast jest rozwój nowych postaw i usuwanie barier mentalnych. W erze dążenia do ciągłego wzrostu gospodarczego i upowszechniania modelu społeczeństwa do-

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brobytu ludzie stają się coraz bardziej przywiązani do wygody, czego wyrazem jest permanenna skłonność do jazdy samochodem do sklepu po cokolwiek by uniknąć konieczności noszenia zakupów, a przecież wystarczyłby koszyk w rowerze. Jesteśmy coraz bardziej wrażliwi na niekorzystne warunki pogodowe, tymczasem przy odpowiednim ubiorze i wyposażeniu naszego sprzętu jadąc rowerem zmokniemy znacznie mniej niż idąc pieszo z parasolem. Jednak największym naszym problemem jest po prostu lenistwo i przyzwyczajenie do siedzącego trybu życia. Przezwyciężenie tych barier jest większym wyzwaniem niż wdrożenie trudnych innowacji technologicznych. Zmienić to z pewnością mogą ogólnokrajowe kampanie promocyjne mające na celu podnoszenie świadomości ekologicznej społeczeństwa, zwrócenie uwagi na korzyści płynące z wykorzystania roweru jako środka transportu, informowanie o udobrzańach dla rowerzystów oraz udostępnianie map ścieżek rowerowych. Propagowanie zdrowego trybu życia i popularyzacja jazdy rekreacyjnej mogą się przy czynić do wykreowania „mody na rower” dzięki czemu społeczeństwo zacznie chętniej z niego korzystać w życiu codziennym.

Nowym instrumentem promowania lub wręcz przymuszania do korzystania z roweru w dużym mieście jest tworzenie instytucji i służb odpowiedzialnych za politykę oraz zarządzanie ruchem rowerowym. Dobrym wzorem są miasta mające urząd koordynatora do spraw polityki pro-rowerowej, w której zakłada współpracę kilku sektorów administracji (urbanistyka, roboty publiczne, komunikacja publiczna, szkolnictwo, policja), a także współpracę sektora prywatnego, organizacji pozarządowych i całego społeczeństwa. Ważnym zadaniem takiego koordynatora jest także znajdowanie wszelkich możliwych źródeł finansowania programów dotyczących upowszechniania ruchu rowerowego. Dotacje na ten cel można pozyskać w ramach polityki bezpieczeństwa, edukacji, turystyki, sportu i rekreacji czy ochrony środowiska i zabytków.

Kluczową rolę w innowacyjnym wykorzystywaniu rowerów w dużych miastach odgrywają atrakcyjne dla mieszkańców systemy publicznego udostępniania tych pojazdów (bike-sharing). Rola roweru może radykalnie się zwiększyć, jeśli typowy członek społeczności miejskiej nie będzie musiał troszczyć o to, jak posłużyć się i jak przechowywać własny rower (zwłaszcza mieszkańc wielokondygnacyjnego budynku o wąskich klatkach schodowych bez specjalnego garażu rowerowego). Najbardziej dojrzałą innowacją w tym zakresie jest paryski Vélib, polegający na istnieniu w mieście gęstej sieci elektronicznych parkingów rowerów dostępnych automatycznie dla użytkowników uszczególniających umiarkowaną opłatę. Opłata za subskrypcję może być dzienna, tygodniowa lub roczna w wysokości odpowiednio: 2, 5 lub 29 EUR. Mając subskrypcję użytkownik może nieodpłatnie korzystać z rowerem przez pierwsze pół godziny każdej jazdy, a potem ponosi opłatę dodatkową za każde następne 30 minut w wysokości 1 do 4 EUR. Rosnąca z czasem progresywne opłata ma na celu ograniczenie liczby rowerów w ruchu oraz zachęcenie na dłuższych dystansach do korzystania z transportu zbiorowego (metro, autobusów, tramwajów kolei RER). Korzy-
stanie z systemu Vélib jest niezwykle wygodne i elastyczne – rower można odstawiać na dowolnej stacji, a znajdują się one średnio co 300 metrów. W praktyce głównym wrogiem systemu Vélib okazały się wandalowie, którzy od jego powstania w lipcu 2007 r. do początku 2009 r. zdewastowali park 20000 udołstępnionych pojazdów (11600 sztuk uszkodzonych, około połowy skradzionych). Podobnie do paryskiego projekty ruszyły w innych europejskich miastach: Barcelonie (Bicing), Brukseli, Kopenhadze, Sztokholmie i Wiedniu. Na szerokiej skalę funkcjonuje także niemiecki program Call a Bike (Berlin, Frankfurt, Kolonia, Stuttgart, Monachium, Karlsruhe) oraz brytyjski OYBike.

Nowoczesne formy intensywnego korzystania z rowerów nie ograniczają się jednak do wielkich miast. Podejmowane są także projekty promowania roweru w ruchu pozamiejskim. Projektem typowo inwestycyjnym jest inicjatywa Europejskiej Federacji Cyklistów - projekt EuroVelo, w którym zaplanowano budowę dwunastu długodystansowych szlaków rowerowych biegnących przez całą Europę o łącznej długości 60 000 km. Są one budowane w oparciu o istniejącą sieć lokalnych ścieżek i dróg, łącząc je w jeden system. Celem EuroVelo jest rozwój turystyki rowerowej na całym kontynencie oraz zachęcenie ludzi do częstszego podróżowania rowerem zamiast samochodem.

Zarówno zasada zrównoważonego rozwoju transportu, jak i koncentracja wysiłku badawczego na świecie sprawia, że sferę o wyjątkowym nasileniu uznanych rozwiązań innowacyjnych jest tabor transportu samochodowego. Problematyce innowacyjności ciężarowego taboru samochodowego został poświęcony rozdział trzynasty autorstwa K. Szaluckiego i A. Letkiewicza. Rozwój i innowacyjność rozwiązań w zakresie tego taboru wywoływany jest w głównej mierze koniecznością zmniejszania szkodliwego oddziaływania tej gałęzi transportu na środowisko naturalne. Kierunki podejmowanych działań dotyczą działań usprawniających obecnie stosowane rozwiązania techniczne oraz poszukiwania nowych zmieniających radykalnie technikę. Generalnym kierunkiem zmian jest odchodzenie od ropy naftowej jako podstawowego źródła energii na rzecz szerokiego wykorzystania energii jądrowej, słonecznej, energii wody, czy biomasy do produkcji energii elektrycznej oraz rozwój technologii możliwie najtańszych wytwarzania czystego wodoru.

Można wyróżnić cztery typy procesów innowacyjnych w zakresie napędu samochodów ciężarowych: 1) stosowanie rozwiązań podnoszących sprawność klasycznych silników wysokoprężnych oraz zmniejszających poziom emisji szkodliwych substancji powstających w wyniku spalania oleju napędowego, 2) wdrażanie rozwiązań pozwalających na zmniejszenie poziomu zużycia paliwa (głównie w zakresie układów przeniesienia napędu i układu jezdniego), 3) wprowadzanie alternatywnych rodzajów paliwa stosowanego w silnikach wysokoprężnych (gazy CNG i LPG oraz etanol), 4) zastępowanie klasycznych silników spalinowych alternatywnymi jednostkami napędowymi (napęd wyłącznie wodorowy, napęd wyłącznie elektryczny, rozwiązania hybrydowe, czyli połączenie jednostki spalinowej z jednostką elektryczną).
Trzy pierwsze typy procesów innowacyjnych nie mają charakteru mieszczącego się w pojęciu technologii przełomowej, ale przez najbliższe dekady będą miały duże masowe praktyczne znaczenie w usprawnianiu ciężarowego transportu samochodowego we wszystkich krajach.

W zakresie rozwiązań podnoszących sprawność klasycznych silników wysokoprężnych istotne znaczenie mają: • systemy spalania homogenicznej mieszanki z bezpośrednim wtryskiem paliwa, • nowoczesne układy zasilania wtryskowego uwzględniających wtrysk wielopunktowy i zmienne fazy rozrządu, • rozwiązania w zakresie układów zasilania i układów sterowania cyklem otwierania i zamykania zaworów oraz doładowania powietrza dolotowego, • *Common Rail* - układ wtryskowy silnika wysokoprężnego, w którym wtryskiwacze są sterowane elektrycznie, a komputer decyduje o ilości wtryskiwanego paliwa, • systemy zmiennych faz rozrządu polegające na przestawieniu faz rozrządu, a więc momentów otwarcia lub zamknięcia zaworów w zależności od obciążenia jednostki napędowej oraz jej prędkości obrotowej w celu zwiększenia osiągalności bez doładowania z zachowaniem ekonomiki zużycia paliwa, • turbosprężarki gazowe wykorzystujące energię gazów wydechowych silnika do podniesienia ciśnienia powietrza podawanego do komór spalania w celu poprawy warunków spalania wtryskiwanego paliwa, a co za tym idzie wzrostu mocy i momentu obrotowego silnika oraz jego „elastyczności”.

W zakresie innowacji pozwalających na zmniejszenie poziomu zużycia paliwa istotne znaczenie ma: • zastępowanie klasycznych sprzęgła ciernych i manualnych skrzyń biegów sprzęglami hydrokinetycznymi i automatycznymi skrzyniami przelóżen, • stosowanie elektronicznego systemu sterowania silnikami wysokoprężnymi (*EDC – electronic diesel control*), który w połączeniu z innymi elektronicznymi urządzeniami sterującymi pracą innych podzespołów umożliwia doprowadzenie do optymalnego spalania paliwa w silniku, przez co przedłuża się jego żywotność.


O ile w 2009 r. wszyscy producenci samochodów osobowych na świecie mieli już własne prototypy lub koncepcje samochodów elektrycznych lub wodorowych, o tyle brak jeszcze było dojrzałych koncepcji samochodów ciężarowych o
napędzie alternatywnym. Pierwsze próby stosowania napędu elektrycznego znane są w USA (ciągniki kontenerowe w portach morskich Kalifornii). Wodorowe prototypy samochodów ciężarowych znane z publikacji i informacji internetowych to: • Hytruck C8HE\textsuperscript{15} skonstruowany na bazie Mitsubishi Canter, • Tyrano HT\textsuperscript{16}, • Mercedes Hybrid Econic NGT 2628 NLA\textsuperscript{17}.

Tak jak było dotychczas, producenci ciężarowego transportu samochodowego wprowadzają i nadal będą wprowadzać liczne innowacje w konstrukcji pojazdów. Nowe koncepcje tego taboru idą w kierunku rozwiązań opartych na uniwersalnych technologiach dostosowanych do wymogów systemów transportu multymodalnego, tak aby doprowadzić do: • minimalizacji czasu prac przeładunkowych jednostek ładunkowych w ramach funkcjonowania łańcuchów intermodalnych, • maksymalizacji warunków bezpiecznego transportu i zabezpieczenia przemieszczanych jednostek ładunkowych, • upowszechniania standardów przemieszczania europejskich intermodalnych jednostek ładunkowych.

Innowacje w sektorze transportu mają pozytywny wpływ na wzrost wartości przedsiębiorstw tego sektora, a w wielu przypadkach także na wzrost wartości firm korzystających z bardziej nowoczesnych form transportu. Kwestie te zostały przeanalizowane przez D. Rucińską w rozdziale czternaście.

W nowoczesnych przedsiębiorstwach sektora transportu i logistyki wartość coraz częściej buduje się poprzez kapitałowe fusje i strategiczne alianse, oddzielanie funkcji organizatora transportu od działalności produkcyjnej (świadectwa usług), różne formy outsourcingu umożliwiające oddzielanie niektórych czynności od podstawowej koncepcji prowadzonego biznesu. Innowacją na współczesnym rynku są horyzontalne lub wertykalne powiązania interesów firm sektora transportu i logistyki z firmami innych sektorów, zwłaszcza IT, przemysłowych i kapitałowych. Umożliwiają one wykorzystywanie nowych możliwości dystrybucji usług i zaopatrzenia, poszukiwanie kontrahentów, sprzedaż usług przez internet, monitorowanie przewozów ładunków i przesyłek pocztowych, kształtowanie nowych łańcuchów dostaw oraz dokonywanie płatności za nabyte usługi. Umożliwiają one również monitorowanie rynku, prowadzenie badań rynkowych i marketingowych, kształtowanie relacji z otożczeniem oraz wielowymiarową analizę nabywców usług TSL. Konsekwencją takich działań są nowe procesy biznesowe typu: „marketing i sprzedaż” (ang. market - to - sell), „produkcja” (ang. make - to - receipt), „logistyka i usługi” (ang. procure- to – pay).

Nowe koncepcje w sektorze transportu i logistyki nie ograniczają się do technologii i organizacji działalności. Pojawiają się one także w sferze marketingu,

\textsuperscript{15} HYTRUCK – http://www.hytruck.nl/EN/nieuws_item1.html.
\textsuperscript{17} Mercedes Hybrid Econic – http://www.daimler.com.
który musi opracowywać nowatorskie i wyjątkowe oferty usług, zindywidualizowane programy obsługi pasażerów i ładunków, doskonalić operacyjne procedury działalności, elastycznie wprowadzać zmiany dostosowując zakresy świadczonych usług do potrzeb odbiorców. Pomiary ekonomicznych wyników przedsiębiorstw TSL na eurorynku opierają się bowiem na rachunku korzyści uzyskiwanych przez klienta i łącznie z wyceną wartości marki stanowią wiodący problem strategiczny dla wielu firm.

Procesy innowacyjne w transporcie kreowane pod wpływem idei zrównoważonego rozwoju powinny prowadzić w konsekwencji do pozytywnych zmian w strukturze gałęziowej przewozów (modal split). Obserwacje tego procesu zostały opisane przez W. Rydżkowskiego i M. Hajdula w rozdziale piętnastym. Należy tu wskazać na znaczenie przewozów multimodalnych dla kształtowania innowacyjnych rozwiązań transportowych, biorąc pod uwagę wciągającą rolę transportu drogowego (76% w UE-25 w 2004 r. uwzględniając tylko przewozy lądowe, 46% przy uwzględnieniu również wewnątrzspółnotowych przewozów drogą morską). Zdecydowana przewaga transportu drogowego występuje również w zakresie transportu pasażerów (74% ogółu pracy przewozowej). Oczywiście jest, że tak ukształtowana struktura gałęziowa nie sprzyja zrównoważonemu rozwojowi transportu i działania Unii Europejskiej ukierunkowane są w dużym stopniu na zmiany strukturalne w tym zakresie. Jednym z aspektów tych działań jest m.in. wsparcie realizacji projektów badawczych, które wypracować mogą nowe rozwiązania promujące rozwój tzw. alternatywnych wobec drogowego gałęzi transportu. Jednym z takich projektów jest DIFFERENT (User Reaction and Efficient Differentiation of Charges and Tolls), zrealizowanym w 6 Programie Ramowym. Badane w projekcie zróżnicowanie opłat i obciążeń użytkowników transportu jest ważnym elementem, który stymulować może rozwój określonych gałęzi transportu i rozwiązań transportowych.

Dążąc do poprawy (zrównoważenia) istniejącego gałęziowego podziału przewozów, należy zidentyfikować czynniki determinujące wybór gałęzi transportu przez użytkowników. Wyróżnić tu można czynniki oddziaływujące w sposób bezpośredni i pośredni. Do czynników bezpośrednich (mających największy wpływ) należą koszty transportu oraz specyficzne cechy danej gałęzi transportu, czyli dostępność, system infrastrukturalny wpływający na odległość przewozu oraz charakterystyka parku pojazdów, a ponadto niezbędne nakłady dla rozwoju danej gałęzi transportu oraz zużycie zasobów naturalnych i wpływ na środowisko. Nakłady na rozwój danej gałęzi wpływają zarówno na jakość usług, jak i pośrednio na podział gałęziowy transportu. Jest to istotny czynnik polityki transportowej, w tym inwestycyjnej, również w zakresie postępu technologicznego.

Podaż usług transportowych zależy również od kosztów transportu. Na poziom kosztów wpływają m.in. opłaty za korzystanie z infrastruktury. Są one ekonomicznym instrumentem polityki fiskalnej i polityki transportowej. Funk-
cja fiskalna polega na zebraniu środków na zwrot nakładów na rozwój i utrzymanie infrastruktury transportowej, a również wygnerowanie zysku dla inwestora. W odniesieniu zaś do polityki transportowej opłaty powinny sprzyjać osiągnięciu takich celów, jak: regulowanie wielkości przewozów na danej trasie, kształtowanie struktury przewozów (środki transportu, przewoźnicy krajowi i międzynarodowi), wspieranie alternatywnych połączeń. Trzeba jednak podkreślić, że nadmierny fiskalizm powodować może z kolei skutki negatywne z punktu widzenia polityki transportowej, np. niskie wykorzystanie nowych obiektów infrastrukturalnych i przeciążenie tras alternatywnych (na których nie występują obciążenia). Niezbędne jest więc kompleksowe podejście do problemu różnicowania obciążeń użytkowników transportu.

Innym pozytywnym skutkiem procesów innowacyjnych w transporcie powinien być wzrost jakości usług przewozowych. Kwestię tę w rozdziale szesnastym analizuje M. Savy. Celem tego rozdziału jest dowodzenie, że jakość usług jest obecnie kluczowym czynnikiem w kontekście rozwoju transportu ładunków. Należy tu brać pod uwagę naturę transportu z punktu widzenia technologicznego, produkcyjnego i usługowego, a również wzajemne zależności występujące w procesie transportowym. Pomiar jakości może opierać się na ocenie procesu zgodnie z jego technicznym przebiegiem, czyli można uwzględniać stan pojazdów, częstotliwość transportu, punktualność odbioru przesyłki, itp. Można jednak również oceniać rezultaty końcowe, czyli np. integralność przesyłki, niezawodność w rozumieniu kompletności i punktualności dostawy, ścisłość dokumentów oraz elastyczności.

Należy zauważyć, że jakość jest specyficzna dla każdej operacji transportowej, a nawet jej definicja powinna być określona względem określonych kryteriów zależnych od przewoźnika i charakterystyki przewozu. Niektóre z tych kryteriów są mierzalne, inne zaś bardzo subiektywne. Dlatego ocena jakości jest trudna, zaś pojęcie „jakości całkowitej” w ogóle nie występuje. Optymalna jakość nie oznacza maksymalnej jakości, ponieważ uwzględniać należy wymagania logistyczne i użyteczność z jednej strony, ale również koszty z drugiej strony.

Jakość usług powinna być zawsze na uwadze i musi być traktowana jako nigdy niekończący się proces. Dlatego ważną rolę agentów i konsultantów, którzy przyczyniają się powinni do redukcji bezpośrednich i ukrytych kosztów niedostatecznej jakości. Zwykle stosowaną praktyką są w tym zakresie różnego rodzaju certyfikaty, niezależnie od zagrożeń biurokracyjnych, które niosą ze sobą. W rozdziale zwrócono uwagę na nowe preferencje jakościowe przewoźników i organizatorów transportu. W konsekwencji mamy do czynienia ze wzrostem niezawodności i elastyczności przewozów. Oznacza to, że reakcja ze strony systemu transportowego jest dostosowana do nowych modeli produkcji z segmentacją podażowej odpowiadającą na wysoce zróżnicowany popyt występujący na rynku.
Przemiany technologiczne i innowacyjne w transporcie wywierają też wpływ na strukturę rynków transportowych i na panujące na nich stosunki handlowe. Próby zidentyfikowania tego wpływu na rynek żeglugi morskiej dokonał w rozdziale siedemnastym J. Żurek. Na rynku tym od lat dominującym ładunkiem jest ropa i produkty naftowe, jednak ich udział w masie wymiany handlowej ogółem (w mln ton) systematycznie maleje: w latach 1990-2008 obniżył się z 38,8% do 32,9%. W okresie tym znacznie wolniej zmniejszał się udział zbiornikowców w globalnym tonażu floty światowej: z 38,8% do 35,3%. Pójścień się udanych innowacji w zakresie alternatywnych środków napędu w przyszłości przyczyni się w przyszłości do zmniejszenia globalnego popytu na ropę naftową i na wielkość jej przewozów drogą morską oraz na wielkość zamówień budowy nowych zbiornikowców w stoczniach. Najbardziej widocznym symptomem procesów innowacyjnych w żegludze morskiej była w ostatnich latach ewolucja floty kontenerowych. Charakterystyczną tendencją jest budowa coraz to większych kontenerowców eksploatowanych w relacjach oceanijskich i organizacyjnie ścisle powiązanych z funkcjonowaniem serwisów dowozowych, dedykowanych bądź komercyjnych. Dominują w tej grupie statki o zdolności załadunowej 720-1200 TEU, ale armatorzy zamawiają statki o coraz większej zdolności załadowczej, co pozwala na obniżenie kosztów jednostkowych przewozu kontenery. Oprócz tego charakterystyczną tendencją w żegludze kontenerowej jest coraz wyraźniej zaznaczająca się koncentracja operatorów kontenerowych, która zawsze w kierunku umocnienia na rynku pewnej grupy operatorów i pozwala na daleko idącą kontrolę rynku, a przy tym sprawia efektywniejsze funkcjonowanie na rynku poprzez wzajemne udostępnienie miejsc pod kontenery. W Regionie Morza Bałtyckiego szczególną rolę w przyszłości będzie miała do odegrania żegluga bliskiego zasięgu, której rozwój umożliwi przemieszanie części ładunków z lądu na morze, a tym samym, zmniejszy zjawisko kongestii oraz poprawi bezpieczeństwo w ruchu drogowym w transporcie lądowym. Wspieranie rozwoju żeglugi bliskiego zasięgu, w który zaangażowane są fundusze i programy unijne np. program Marco Polo II, winno być połączone z rozwojem sprawnego systemu transportu lądowego.

Komplementarną formę do żeglugi morskiej stanowią rynki portowe, na które zachodzące w całym transporcie procesy innowacyjne wywierają coraz większy wpływ. Analizę trendów w rozwoju portów morskich przedstawił w rozdziale ośmiennym S. Szwankowski. W międzynarodowych przewozach towarów następuje koncentracja morskich połączeń transportowych obsługiwanych przez największe statki, zawijające do coraz mniejszej liczby największych portów morskich. Coraz silniej zaznacza się tendencja do różnicowania roli i znaczenia portów morskich. Dodatkowym, a obecnie często podstawowym elementem złożoności światowego handlu morskiego, rzutującym na rozwój portów morskich, jest ciągle rosnące znaczenie standardu dostawy ładunków, a także obsłuży morskiego ruchu pasażerskiego. Wymaga to od portów morskich będących ogniwami lądowo-morskich łańcuchów dostaw, umiejętności dostoso-
wania się do wzrastających, różnorodnych wymagań jakościowych użytkowników transportu. Wśród portów morskich na świecie wyraźnie zaznaczy się podział na trzy grupy: • duże, bazowe centra przeladunkowo-dystrybucyjne ropy naftowej, ładunków masowych suchych i kontenerów, zlokalizowane na głównych, oceanicznych szlakach żeglugowych (np. Rotterdam, Hamburg, Antwerpia w Europie, Singapur czy Hongkong w Azji, Los Angeles i Houston w Ameryce Pół.), • porty regionalne i dowozowe, zlokalizowane poza głównymi szlakami żeglugowymi (np. nad morzami Bałtyckim, Czarnym, Śródziemnym), • porty przeladunku na statek (transshipment-ports), obsługujące głównie oceaniczne przewozy kontenerowe i funkcjonujące jako porty pośrednie między wielkimi portami przeladunkowo-dystrybucyjnymi a coraz większą liczbą mniejszych portów regionalnych i dowozowych (np. Felixstowe, Gioia Tàuro, Brema/Bremerhaven, Algeciras).

W ostatnich latach porty coraz silniej zaczynają się rozwijać jako centra logistyczne a wiele spośród nich jest zainteresowanych w oferowaniu usług logistycznych bezpośrednio na obszarze portu lub w centrach dystrybucyjno-logistycznych na terenach przyportowych. Podstawowym zadaniem, jakie stawia logistyka, jest skrócenie i przyśpieszenie wszystkich procesów przepływu ładunków, usług i informacji na każdym etapie łańcucha dostaw. Potrzeba racjonalizacji działań w sferze wymiany oraz rozwoju portów jako lądowo-morskich centrów logistycznych wynika także ze wzrostu zapotrzebowania użytkowników transportu na rozszerzanie zakresu portowych usług logistycznych oraz wysokiego udziału kosztów transportu i kosztów utrzymania zapasów w globalnych kosztach logistycznych. W rozwoju przestrzennym portów występują dwie tendencje: 1) rozwój na terenach rezerwowych, 2) zwiększenie intensywności wykorzystania przestrzeni w istniejących granicach. Wyjącie z rozwojem przestrzennym na nowe tereny nie przeszkadza temu, że na dotychczas eksplorowanych terenach wewnętrznych portów nasila się zjawisko ich przekształceń i koncentracji aktywności inwestycyjnej. Wielu portów natrafi na ograniczone możliwości rozwoju przestrzennego; niektóre nie posiadają rezerw przestrzennych, inne natrafiają na ograniczenia środowiskowe.

Pomiędzy procesami innowacyjnymi w transporcie a otaczającym sektorem środowiskim występują obustronne oddziaływania. Z jednej strony środowiskowy wymusza innowacje służące zmniejszeniu ekologicznej i społecznej uciążliwości transportu, z drugiej strony – innowacje i przełomowe technologie transportowe stwarzają nowe perspektywy rozwoju sektora w symbiozie ze środowiskiem. W rozdziale dziewiętnastym B. Pawłowska przedstawiała problematykę współczesnego zarządzania środowiskowego w transporcie w Unii Europejskiej. Skoro popyt na transport stale rośnie racjonalną reakcją na tę tendencję nie może być po prostu na budowaniu nowej infrastruktury i dalsze otwieranie rynków. Zbędy spełnić wymagania wynikające z idei zrównoważonego rozwoju, system transportowy wymaga optymalizacji. Krytyczna postawa wobec żywiołowego rozwoju transportu oraz jego oddziaływania na środowisko natural-
ne uwidoczniła się już pod koniec lat sześćdziesiątych, początkowo w działaniach mających na celu podniesienie bezpieczeństwa w transporcie. Nowoczesny system transportu musi być systemem trwałym z punktu widzenia ekonomicznego, socjalnego i środowiskowego. Dlatego też wspólna polityka UE musi uwzględniać działania zmierzające do obniżenia kosztów zewnętrznych transportu oraz uporania się z narastającym na sieci transportowej zjawiskiem kongestii. Opublikowany w lipcu 2008 roku Pakiet „Zielony Transport” prezentuje szeroki pakiet narzędzi zarządzania środowiskowego, poczynając od instrumentów ekonomicznych i środków regulacyjnych, po inwestycje winfrastrukturę i nowe technologie. Zasadnicze znaczenie w tym względzie ma „urealnienie cen”. Instrumenty ekonomiczne, a zwłaszcza tzw. „inteligentne opłaty” (ang. smart prices) mogą być zachętą dla użytkowników transportu do optymalizacji zachowań transportowych czy też wyboru bardziej ekologicznych pojazdów, form transportu, do korzystania z mniej przeciążonych elementów infrastruktury lub do podróżowania o innych porach dnia.

Specjalny wymiar mają nowe tendencje i nowe koncepcje w logistyce międzynarodowej scharakteryzowanej w rozdziale dwudziestym przez E. Golembską. Nową jakość stanowi w sektorze logistyka globalna będąca zespołem operacji logistycznych przeprowadzanych pomiędzy firmami wielu państw na różnych kontynentach. Tworzenie światowej sieci obrotu towarami pozostaje w ścisłym związku z powstaniem korporacji transnarodowych, których liczba przekracza obecnie ponad 60 tys. Udział korporacji w wytwarzanym produkcji krajowym brutto na świecie wynosi około 30%, przypada na nie 80% międzynarodowego transferu technologii i 70% lokat bezpośrednich inwestycji zagranicznych. Warto dodać, że 80% korporacji ma swoje siedziby w USA. Nadzieje krajów UE oraz Japonii i Singapuru, a wartość sprzedaży towarów i usług, wytworzonych przez filie korporacji jest blisko 50% wyższa od wartości światowego eksportu.

Logistyka globalna jest jedną z sił kreujących innowacje informacyjne i informatyczne, bez których światowe powiązania podmiotów funkcjonujących w tym sektorze nie byłyby możliwe. Bardzo często wielcy operatorzy logistyczni dysponują silnym potencjałem zdolnym do tworzenia specjalistycznego oprogramowania informatycznego konstruowanego na podstawie gromadzonych przez wiele lat praktycznych doświadczeń.

Wielkie aglomeracje są miejscami koncentracji działalności produkcyjnej, handlowej i dystrybucyjnej. Stłoczenie na ograniczonej przestrzeni wielu obiektów i wielu operacji przepływu mas towarowych doprowadziło do powstania kolejnego rodzaju logistyki, jaką jest logistyka miejska. Miasta wyposażone w system logistyczny dostosowany do ich charakteru cechuje wyższa atrakcyjność dla biznesu i lepsza jakość warunków do życia dla mieszkańców. Dzięki logistyce miejskiej w pełni tego słowa znaczenia osiąga się takie efekty jak:

• zwiększenie dostępności i przepustowości układów komunikacyjnych miasta,
• rozwój telematyki jako inteligentnego systemu kierowania transportem i ko-
munikacją miejską, • rozwój ekologistyki i gospodarki odpadami, • rozwój komunikacji nocnej i weekendowej, • rozwój komunikacji miejskiej do centrów handlowych. Doświadczenia wielkich metropolii światowych w tworzeniu sprawnych systemów logistyki miejskiej mogą być z czasem przenoszone gdzie indziej i wykorzystywane w mniejszych miastach.

Jednym z kamieni milowych w rozwoju nowoczesnej logistyki gospodarczej było powstanie koncepcji centrów logistycznych. Te złożone obiekty infrastruktury logistycznej nie mają ustalonej formy i wciąż ulegają procesom transformacyjnym. Problematykę ich rozwoju w Europie w rozdziale dwudziestym pierwszym przestawił I. Fechner. W praktyce europejskiej pojęcie to odnoszone jest do węzłów sieci logistycznych stanowiących miejsca koncentracji infrastruktury magazynowej i usług logistycznych, w których istnieje możliwość obsługi przewozów intermodalnych, a więc istnieją w nich terminale kontenerowe obsługujące przeładunki realizowane na rzecz co najmniej dwóch gałęzi transportu.

Koncepcja centrum logistycznego narodziła się pod wpływem takich czynników jak: • braku nowoczesnych powierzchni magazynowych na obrzeżach dużych aglomeracji miejskich, • dynamicznego rozwoju przewozów samochodowych, • specyficznych wymagań stawianych przez rozwój przewozów intermodalnych, • narastania konfliktów wywoływanych przejazdem wielkotonożnych samochodów ciężarowych przez centra miast. W przyszłości montransportowe centra logistyczne i skupiska magazynów będą uzupełniane terminalami kontenerowymi, o ile poprawią się warunki funkcjonowania transportu intermodalnego i zwiększy się zaangażowanie państw w realizację polityki zrównoważonego funkcjonowania transportu.

Koszty logistyczne stanowią wysoki odsetek (ponad 10%) globalnych kosztów wytwarzania i dystrybucji towarów. Ich wysokość nie pozostaje sztywną wielkością ekonomiczną, można i należy stosować nowoczesne metody ewidencji, analizy i obniżenia tych kosztów. Zagadnienia te w rozdziale dwudziestym drugim przedstawił H. Woźniak. Badania nad wielkością kosztów logistycznych w gospodarce prowadzone są względnie regularnie od wielu lat, są one jednak obarczone podstawową wadą, którą są stosowane różne metody rachunku bądź szacowania tych kosztów, co skutkuje znaczącymi różnicami w prezentowanych wynikach. Koszty logistyczne są zależne od branży gospodarczej; są wysokie w przemyśle dóbr konsumpcyjnych, niższe w produkcji dóbr inwestycyjnych. Koszty logistyczne są ponadto zależne od poziomu rozwoju gospodarczego kraju: w produkcie krajowym brutto krajów mniej rozwiniętych ich udział wynosi do 20%, w krajach uprzemysłowionych mniej niż 5%. Przewidywanie specjalistów wskazuje, że koszty logistyczne w przyszłości będą raczej rosły pod wpływem takich czynników jak: • coraz krótsze czasy przepływu mas towarowych, • rosnące oczekiwania klientów i rosnący poziom ich obsługi, • stosowanie coraz bardziej nowoczesnych ale kosztownych technik zarządzania.
nia logistycznego, · stosowanie fiskalnych instrumentów polityki państwa (zwiększenie kosztów dostępu do infrastruktury).

Procesy innowacyjne w transporcie są główną siłą motoryczną postępu technicznego i poprawy efektywności, ale wiąże się z nimi wysoki poziom ryzyka. Problematykę tę w rozdziale dwudziestym trzecim objaśnił P. Borkowski.

Ryzyko innowacyjne pojawia się w transporcie i logistycze wszędzie tam, gdzie wprowadzane są udoskonalenia czy to techniczne, czy też organizacyjne lub dotyczące metod finansowania transportu. Ryzyko to dotyczy zarówno sytuacji, w której przedsiębiorstwo trzyma się utartych i nieprzystających do dynamicznie zmieniającego się rynku sposobów funkcjonowania – wówczas przyjmuje ono postać ryzyka konkurencji, jak też procesu wprowadzania innowacji i wynikających z niego zagrożeń. Nastawiona na innowacyjność firma transportowa ryzykuje, iż wprowadzane rozwiązania okażą się nietrafione, zostaną odrzucone przez rynek, albo też koszt ich wprowadzenia będzie daleko większy niż pierwotnie planowano.

Należy również wprowadzić rozróżnienie ryzyka innowacyjnego ze względu na podmiot, którego dotyka. W odmienny sposób przejawia się ono w działalności przedsiębiorstw przewozowych, spedycyjnych i logistycznych, a w inny w przypadku przedsiębiorstw – inwestorów infrastrukturalnych. W tym pierwszym przypadku będzie ono dotyczyło procesu przewozowego i mogło objawić się na każdym z jego etapów czy to w postaci wad technicznych taboru, niewłaściwego zorganizowania usługi, błędów przy jej realizacji itp. Na ogół jego konsekwencje będą widoczne niemal natychmiast po ujawnieniu się danego czynnika ryzyka. Ryzyko inwestora infrastrukturalnego ujawnia się na ogół z dużym opóźnieniem – wówczas, kiedy inwestycja oddana jest do użytku. W istocie często brak jest na tym etapie możliwości jego zneutralizowania.

Ryzyko innowacyjne w transporcie najczęściej przejawia się poprzez technologię, bowiem z jednej strony przekłada się na niebezpieczeństw wo wzrostu konkurencji, która będzie skuteczniejsza ze względu na wprowadzanie nowych rozwiązań, z drugiej na ryzyko własnego niedostatecznego rozwoju technicznego. Można wyróżnić cztery rodzaje błędów, które popełniają przedsiębiorstwa i narażają się na ryzyko innowacyjne Po pierwsze błędy w założeniach rozwojowych, uniemożliwiające postęp technologiczny. Po drugie brak wyobraźni, oznaczający nieumiejętność przełożenia odkrycia na konkretne innowacyjne zastosowanie w firmie. Po trzecie, gdy firma nie dostrzega możliwych powiązań między istniejącą technologią, a innowacjami, oraz wpływu, jaki mogą one wywierać na rynek, społeczeństwo, kulturę, nawyki klientów, mówić można o braku wizji. Czwartym błędem jest brak odporności psychicznej, niezbędnej do realizacji własnego, dobrego projektu.

Poza technologią ryzyko innowacyjne w transporcie ma też charakter ryzyka: projektu, organizacyjnego, finansowego i specyficzne. Ryzyko projektu przejawiać się będzie w działaniach związanych z wprowadzaniem innowacji związanej z inwestycją materialną (i przyjmie cały szereg postaci np.: strat spo-
wodowanych niewystarczającymi kwalifikacjami pracowników, zmianami warunków konkurencyjnych na rynku po wprowadzeniu innowacji itd.). Aspekt organizacyjny polegał bydzie przede wszystkim na niezaakceptowaniu przez klientów transportu wprowadzanych zmian w sposób świadczenia usług, komunikacji rynkowej, zasad realizacji usług towarzyszących itp. Natomiast jego wymiar wewnętrzny oznacza możliwy opór ze strony pracowników przedsiębiorstw przeciwdziałających w sposób czynny lub bierny zmianie. Wymiar finansowy obejmuje te przejawy innowacji, które negatywnie wpłyną na strumienie przepływów pieniężnych firmy – a więc czasowy spadek przychodów w momencie wdrożenia innowacji, wzrost kosztów świadczenia usług itd. Natomiast ryzyko specyficzne innowacji obejmuje te efekty, które wymykają się łatwemu zaszerzegowaniu w którejś z funkcjonalnych kategorii ryzyka i wynikają z elementu niepowtarzalnego danej innowacji.

Celem zarządzania ryzykiem w procesach innowacyjnych jest identyfikacja obszarów niepewności, jakie powstają na skutek innowacji i ochrona przed ewentualnymi negatywnymi skutkami innowacji. Ponieważ sam proces innowacji determinuje możliwość zaistnienia różnych, niedających się przewidzieć a priori scenariuszy, – co wynika z natury innowacji, która ma przecież wykazywać poza przyjęte dołaj ramy myślenia, zaplanowanie strategii ryzyka w odniesieniu do procesu innowacyjnego musi mieć charakter ramowy. Proces zarządzania ryzykiem w procesach innowacyjnych w transporcie nastawiony musi być, zatem nie na eliminację odchylen od zakł欸anego planu, lecz na usuwanie tych zdarzeń, które mogą zmniejszyć pozytywny wpływ innowacji.

Ryzyko innowacji należy do najtrudniej mierzalnych rodzajów ryzyka. Z praktycznego punktu widzenia najlepiej w takim przypadku opierać się na ilościowych miarach ryzyka, w szczególności na ocenie potencjalnych zagrożeń dla potencjalnego dodatkowego strumienia pieniężnego, który ma być efektem wprowadzenia innowacji. Tymczasem w transporcie, z uwagi na usługowy charakter działalności i cechy usługi, dokładne zliczenie wartości narażonej na ryzyko jest wątpliwe, bowiem czynniki ryzyka są trudne do zmierzenia. Trudno jest też jednoznacznie sprecyzować wpływ chybionych innowacji na potencjalne obniżenie wartości firmy, bo w przypadku innowacji brak jest benchmarku, do którego można by ją porównywać. Z tego względu oceny ilościowe należałoby uzupełnić metodami jakościowymi. Spośród szerokiej gamy narzędzi służących ocenie jakościowej parametrów ryzyka w ocenie innowacyjności w transporcie na uwagę zasługują zwłaszcza metoda list ryzyka, mapowanie ryzyka i macierze ryzyka. Wszystkie one umożliwiają opis poszczególnych składowych innowacji, co pozwala z kolei na identyfikację słabych punktów innowacji i przypisanie im prawdopodobieństwa wystąpienia. Prawdopodobieństwo to zastawione z silą oddziaływania (a więc maksymalną możliwą stratą, jaką dany czynnik może generować) pozwala na oszacowanie poziomu ryzyka w realizacji danej innowacji.

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Formalizacja oceny ryzyka w innowacjach transportowych i zastąpienie nią dotychczas często intuicyjnych jego szacunków jest niezbędna dla zachowania rozsądnych ram czasowych analizy ryzyka oraz właściwej alokacji zasobów przeznaczonych na ocenę ryzyka (rzeczowych i osobowych) tak, aby koszt tego działania nie stał się większy niż zyski, jakie potencjalnie innowacja generuje. W ocenie ryzyka innowacyjnego pozostanie jednak zawsze pierwiastek niepewności jest ono, bowiem tym typem ryzyka, w przypadku, którego niezbędne jest też myślenie niekonwencjonalne przejawiające się w opracowaniu na bieżąco odpowiedzi na pojawiające się zagrożenia.

Kreowanie procesów innowacyjnych w transportie i logistyce wymaga wiedzy, kadł, zasobów rzeczowych (często rzadkich i unikalnych) oraz dużych środków finansowych. Problemy innowacyjnego finansowania infrastruktury transportowej w rozdziale dwudziestym czwartym scharakteryzowała E. Adamowicz.

Analiza sytuacji w większości krajów wskazuje na istniejące trudności w pozyskiwaniu środków finansowych na utrzymanie i rozwój infrastruktury. Problem ten nabiera szczególnego znaczenia w krajach, w których istniejące potrzeby znacznie przekraczają dostępne tradycyjne źródła finansowania. Pogłębiający się deficyt finansów publicznych w szczególny sposób odbija się właśnie na sektorze transportu. Istniejące trudności w zarządzaniu finansami publicznymi, przekładają się na zarządzanie infrastrukturą pozostającą w gestii władz publicznych, a w efekcie wpływają na rozwój infrastruktury transportu. W zasadzie wszystkie państwa europejskie borykają się ze słabością finansów publicznych i dlatego, pomimo tradycyjnie stosowanych form finansowania nieustannie poszukuje się nowych rozwiązań. Dotyczy to zarówno poziomów regionalnych, jak i poziomów narodowych oraz międzynarodowych. Ponieważ dotychczas stosowane tradycyjne źródła finansowania nie zaspokajają istniejących potrzeb, istotnej rangi nabiera poszukiwanie oraz wdrażanie nowych, a więc innowacyjnych rozwiązań wspierających rozwój infrastruktury.

Innowacyjne finansowanie w transporcie jest szeroko definiowane jako kombinacja specjalnie stworzonych metod, które uzupełniają tradycyjne finansowanie (najczęściej publiczne). W transporcie bardzo często wdrażane innowacje w finansowaniu są nowe dla tego sektora, ale wcześniej występowały w innych sektorach gospodarki. Innowacje w zakresie finansowania transportu można analizować zarówno w zakresie pozyskiwania środków finansowych, jak i ich wydatkowania. W aspekcie dostępności nowych produktów finansowych, nowych metod i technik gromadzenia środków, nowych zasad alokacji środków, nowych sposobów zarządzania infrastrukturą (przesunięcia odpowiedzialności za rozwój infrastruktury z władz publicznych na inne podmioty), nowych sposobów zarządzania projektami inwestycyjnymi.

Poszukiwanie nowych i efektywniejszych rozwiązań systemowych w finansowaniu infrastruktury transportowej przebiega wielokierunkowo. W prowadzonych od wielu lat badaniach główny nacisk kładzie się na obciążanie użytko-
wników infrastruktury transportowej jej kosztami. Ponadto do głównych obszarów, w których poszukuje się innowacyjnych rozwiązań należy poprawa wykorzystania istniejących środków publicznych – np. poprzez lepsze zarządzanie projektami infrastrukturalnymi, zwiększenie kompetencji samorządów w zakresie ustanawiania opłat, zarządzania i finansowania infrastruktury transportowej, a przede wszystkim wzrost zaangażowania kapitału prywatnego.

Obszary poszukiwań innowacyjnego finansowania infrastruktury transportu koncentrują się nie tylko na kreowaniu nowych produktów finansowych, gromadzeniu środków finansowych generowanych przez transport, ale również racjonalnym ich alokowaniu oraz poprawieniu zarządzania projektami inwestycyjnymi. Prekursorem w zakresie innowacyjnych form finansowania infrastruktury transportowej są Stany Zjednoczone, w których obecnie dobór instrumentów finansowania projektów infrastrukturalnych jest zależny od stopnia dochodowości projektu.

Nadmienić jednak należy, że trwające od wielu lat debaty nad finansowaniem i rozwojem infrastruktury transportu nie doprowadziły do stworzenia wzorcowego modelu finansowania infrastruktury. Niewątpliwie trudno jest stworzyć uniwersalny wzorzec możliwy do implementacji w systemie transportowym każdego kraju. Istniejące uwarunkowania regionalne i narodowe stwarzają konieczność dostosowywania wzorców do istniejących potrzeb i specyfiki określonego obszaru. Warto jednak wzorować się na dobrych praktykach i poszukiwać sposobów ich implementacji przy zachowaniu istniejących uwarunkowań. Poszukując możliwości implementacji świadomych rozwiązań zakresie finansowania infrastruktury transportu w Polsce można dokonać weryfikacji wybranych elementów, które przy uwzględnieniu istniejących polskich uwarunkowań umożliwiłyby stworzenie sprawnego systemu finansowania i zarządzania infrastrukturą transportową.
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