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Transportation Research Procedia 25 (2017) 2660–2676

Transportation Research Procedia

www.elsevier.com/locate/procedia

World Conference on Transport Research - WCTR 2016 Shanghai. 10-15 July 2016

Do Information and Communications Technologies influence transport demand? An exploratory study in the European Union

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Abstract

ICT, as a General Purpose Technology, influences changes in global production, consumption and organizational models. Due to the fact that it improves competitiveness, enables process and product innovations and influences business processes along the entire value chain, promotion of ICT is one of the priorities of European Commission.
This paper aims at providing a broad empirical analysis of the use of ICT by individuals and in companies involved in passenger and freight transportation processes in the EU. There is a need to examine the potential relations between the wider distribution of ICT and changes in demand for transport services, in case of both individuals and enterprises. The aim of this study is also to examine some future directions of ICT implementation in the transportation area and its influence on the economy in general.

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.

Keywords: ICT; transport demand; transport; European Union; decoupling;

1. Introduction

The development and uptake of ICT in the 1990s resulted in a wave of optimism and some unrealistic – from the perspective of time - expectations for revolutionizing all aspects of life and economic activity. Researchers in various disciplines pointed out the opportunities resulting from the application of ICT both in everyday life and business activity of enterprises. The Internet bubble burst in 2001 generated – to a large extent – a result contrary to the planned

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2352-1465
Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.
10.1016/j.trpro.2017.05.156

one, thus the expectations concerning the possible use of ICT and advantages they offer were mostly substantially limited. However, the decade that followed instituted the expected, more common application of ICT and improvement in many aspects of activity. In a way, one may say that the expectations, reduced after the crisis in 2001, began to find reflection in business and social reality (van Dijk, 2006).

Universal access to Internet, ever cheaper computers, mobile phones, and other mobile devices – connected with the development of e-commerce and e-services – influences changes in behaviour of both individuals and enterprises. Consumers use the possibilities provided by e-commerce increasingly often, in any time and place convenient for them. More and more enterprises offer the possibility of teleworking to their employees. Changes in consumer behaviour result in changes in demand for passenger and freight transport.

Most of the studies concerning the influence of ICT upon transport were conducted in a twofold manner. On the one hand, the studies examined how the utilization of ICT influences both passenger and freight transport, from the point of view of how the application of new technologies may change (usually enhance) the provision of transport services (in both passenger and freight transport) by companies, or how it changes (improves) travelling of individuals. On the other hand, studies which comprised a wider social and economic context have been conducted, trying to identify and present the influence of ICT application by individuals and enterprises, as regards changes in demand for transport services. The authors attempt to provide a synthesis of both types of influences of ICT in and upon transport.

This paper looks closely at the European Union, as the development of ICT and the ever increasing use of ICT in all branches of the economy has for many years been one of the main priorities of common policy of the European Union (EU). The European Union provides financial support for undertakings, within the framework of programmes it has established, it also monitors the achievement of targets set. The European Union is an interesting subject for studies, because its 28 member states demonstrate a great variety regarding the rate and level of economic development, dependence of their economies upon transport, and adoption of ICT in different sectors of the economy.

The methodology adopted in this study is based on literature review and the examination of statistical sources – mainly analyses from Eurostat, which is the statistical office of the European Union. An exploratory approach was taken, which means that the research is based on the analysis of how ICT solutions adopted by individuals and in companies influence the demand for transportation services. The results of exploratory study gives opportunities for further research.

2. The influence of ICT upon passenger and freight transport – study review

Studies concerning the influence of ICT upon transport go back to 1990s, still they mostly dealt with some separated areas of the activities of transport and logistics companies. Perego, Perotti, Mangiaracina (2011), in their review of early studies concerning the use of ICT in companies from transport sector, indicated the fragmentary character of studies conducted so far, which referred to specific types of technologies and were limited to selected types of companies. To present the situation more clearly, one could indicate the typical research problems in the areas mentioned:

- the use of ICT in firms specializing in freight transport (Yoshimoto and Nemoto, 2005; Marchet et al. 2009; Crainic et al., 2009),
- the use of ICT in intermodal transport (Dotoli et al., 2010; Schilk and Seemann, 2012; Harris et al., 2015), as well as attempts to develop a model that describes the influence of ICT upon intermodal transport (Marchet et al., 2012),
- the possibility of tracking consignments and their contents (Wang and Potter, 2007; Meyer et al., 2014), as well as the utilization of RFID and GPS technologies in transport (Ferrer et al., 2010; Popovič and Habjan, 2012),
- managing of stock level and integration of supply chain (Helo and Szekely, 2005; Mongare and Nasidai, 2014),
- development and possible implementation of autonomous or self-driving vehicles, both for passenger and cargo transportation, are gaining more interest from both academic researches and business entities. (e.g. Cepolina, Farina, 2014; Rifkin, 2015; International Transport Forum - OECD, 2015; DHL Trend Research, 2014),
- the use of ICT in urban transport (Obogne and Lidasan, 2005; Dridi et al., 2005; Baptista et al., 2012; Fierek and Zak, 2012) and possible influence of ICT utilization upon environmental protection (Rolim et al., 2012, Wang et al., 2015).

The mutual influence of transport and telecommunications was the subject of studies conducted long before one could speak about common or commercial use of ICT and the Internet. The reciprocal relations of telecommunications and transport may take the following forms (Salomon, 1985; Mokhtarian, 1990; Lyons, 2002; Choo and Mokhtarian, 2007):

- substitution – reduction of demand for transport, by means of telecommunication,
- enhancement – telecommunication may directly stimulate the demand for transport,
- operational efficiency – telecommunication rationalizes travelling by increasing the efficiency and effectiveness of transport system,
- indirectly, over a long term – e.g. telecommunication may influence planned land development, which in turn will influence travelling.

Initially, attention was paid mainly to the possibility of emergence of the substitution effect and enhancement of transport through the use of telecommunication. Mokhtarian (1990) distinguishes the following applications of telecommunication, the use of which will be substitution of transport: telecommuting, teleconferencing, teleshopping, telebanking, tele-entertainment, tele-education, tele-medicine, tele-justice. The determination of the way by which telecommunication may influence the stimulation of transport demand turned out to be more complicated, and dependent upon behaviour changes in individuals. The following three types of effects of communication use have been indicated, which stimulate travel (Mokhtarian, 1990):

- short term and direct ones – consisting of stimulating the demand for travel, through:
  A. easier access to information about people, places, and events, which may result in willingness to visit/meet;
  B. wide adoption of mobile telecommunications – equipping vehicles with communication devices may discourage from route optimization, car-sharing, or use of public transport,
  C. interactive passenger information systems, which make journey planning easier,
- medium term and indirect ones – the time saved thanks to using telecommunication may be utilized for other journeys,
- long term ones – the above-mentioned possibility of introducing changes in the land development plan, which may in future influence the increase of single journeys or overall number of journeys made.

Later studies, conducted at the time when access to Internet and ICT in developed countries became common, began to focus on a specific issue: which of those new technologies may influence most substantially the changes in transport, both passenger and freight one (Golob, 2000; Golob and Regan, 2001). The following have been included among the areas, whose technological progress potentially is of the greatest importance for changes in transport behaviour and needs of individuals and transport companies: dynamic progress in manufacturing of computers, in particular the reduction of production costs and progressing miniaturization of devices; the ever more universal access to cheap and fast Internet connections; the development of mobile phone technologies, and other mobile devices, which enable mobile access to Internet; commonly available private commercial (tele)communication systems for corporate customers; the development of special software designed for transport and logistics companies.

The changes, indicated by Golob and Regan (2001) influenced by ICT and affecting transport behaviour, comprise both changes in individual demand for transport, and potential influence upon business activities of commercial transport companies. In the former case, the following uses of ICT have been distinguished, which exert the influence upon:

- demand of individuals for transport: electronic shopping (B2C, C2C), other Internet-enabled services (telemedicine in particular), flexible organization of work (including telework from home or especially arranged telework centre), increase of self-employment, conditional employment and part time work, remote work understood as work with the use of mobile devices, provided from other locations than those listed in case of telework), advanced traveller information systems (ATIS) for private vehicles, education,
- the activity of commercial transport companies – electronic purchases (B2B market), structural changes in freight transport and logistics sector, ATIS for commercial vehicles.

With the widespread use of ICT and changes it caused in the behaviour of individuals and business units, more and more attention has been devoted to the necessity of adjusting transport policy to the changing market conditions (Lyons, 2002; Lyons et al., 2002). Taking into account the two dominating trends concerning the influence of ICT upon transport (substitution and stimulation), the main recommendations which should be accounted for in the course of adjusting policies to the new situation comprised (Lyons, 2002): searching for positive aspects of transport substitution by ICT, which may be developed by market forces, without further intervention; as well as the correction and adjustment of policies, so that the new demand for transport can be met by means of bicycle riding, walking, and public transport, in order to limit the negative effects resulting from higher demand.

Further studies concerning the influence of ICT upon transport and demand for transport made attempts to properly arrange and systematize the main issues. Mokhtarian (2003) systematized the views that existed so far, and suggested division into the following types of dependencies between ICT and demand for transport (mainly in reference to passenger and private transport):

- substitution (replacement or elimination),
- complementary character (in other words: stimulation or boosting) – the use of one type of communications may stimulate the demand for another one, through:
  A. reinforcement – the use of one type of communications/transport is directly transposed into demand for another one, e.g. access to information results in the willingness to visit a place, but also a journey to a place may result in the willingness to hold a conversation with a family member or friend who stayed at home,
  B. increased efficiency – when use of one type of communications/transport is required for the execution of another one (or appears as a side effect), e.g. the use of mobile phone for modification of meeting time, due to delays in travel,
- modification – when one type of communications/transport causes changes in another one, e.g. the use of car navigation system for changing the route during the journey,
- neutrality – when there are no mutual interactions between ICT and demand for transport.

Nevertheless, there are more and more opinions that the relation between ICT and demand for transport in not so simple. For example, the studies concerning consumer behaviour and consumer inclination to do e-shopping may have a twofold influence upon transport. Consumers may chose not to visit a shop to purchase something, yet they expect the delivery of purchased goods to a point of delivery they have selected, which may influence the increase in demand for freight transport, with simultaneous modification of the size of cargo and lengths of routes (Mokhtarian, 2004; Tight et al., 2004; Yoshimoto and Nemoto, 2005).

Riding the wave of criticism applied to the types of mutual relations between ICT and transport, Banister and Stead (2004) suggested a new approach, which takes the social aspects of ever more common use of ICT into account. The accessibility of ICT and the Internet influences the increased flexibility of behaviour and emergence of new forms of activity (often being more complex) – which is not insignificant for demand for transport. That is why, instead of using the differentiations applied so far, they have suggested three levels of activities: production, living, working, and made an attempt to holistically demonstrate both the indirect and direct influences exerted by ICT on transport. In each of the areas named, attention was paid to specific applications of ICT and their influence on transport (Banister and Stead, 2004):

- in the area of production:
  A. e-commerce and e-everything – in certain cases the demand for transport may be reduced,
  B. just-in-time manufacturing – changes the frequency and volume of deliveries,
  C. logistics and planning of transportation – enhances the reliability, cuts down the transport time, but may increase distances; possibility to plan routes, shipments, and transshipment of goods better, etc.,
  D. e-marketing – it may reduce/replace other kinds of marketing activities, but it seems it will rather supplement the existing ones.
- in the sphere of living:
  A. planning of public transport– it may enhance the attractiveness and use of this form of transport (particularly in cities),

B. planning of private journeys – potential reduction of road traffic congestion and cutting down travel time, possibly at the expense of extending travel distances,
C. e-everything (commerce and services) – it may reduce the demand for transport by individuals, yet it may cause changes in the working hours and necessity to adjust transport demand; it may replace or generate transport demand,
D. last minute offers – the possibility of increasing the revenue of a business, by creating additional demand for transport.

- in the area of working:
  A. e-office – it may potentially reduce the frequency of journeys but increase distances, it may lead to substitution of business travels with private ones, or to more frequent use of mobile technologies and work during travelling,
  B. e-meetings – possible reduction of demand for travel, but it is not sure to what extent, as certain face-to-face meetings cannot be replaced; it is possible to substitute business travels with private ones,
  C. e-information – reduces the demand for travelling in relation to the distribution of routine information.

The influence of ICT upon transport system has been presented in a synthetic and simplified way in Table 1, with division between passenger and freight transport.

Table 1. Simplified model of the influence of ICT upon transport, from the perspective of changes in transport system.

Type of influence	Passenger transport	Freight transport
Stimulation	Stimulation of travelling, creation of new possibilities, enhanced availability to services	Stimulation of freight transport development, new possibilities of exchanging information and concluding transactions
Substitution/Complementarity	Replacement of action, which previously required travelling, with remote contact	Some goods, which previously required to be transported, became electronic goods, sent remotely to consumers
Modification	Change in transport behaviours, attempts to use the passenger transport integration potential	Change of behaviour of market participants, consolidation of shipments, development of intermodal transport and operators in logistics
Neutrality	No influences	No influences

In later research, attempts to somehow straighten out the changes in demand for transport influenced by the use of ICT, both by individuals and businesses, were continued. Black and Geenhuizen (2006) modified the earlier three levels of activities (production, living, working) and tried to put together the utilization of various types of ICT by individuals and businesses, and from that perspective consider the changes taking place in demand for transport. Thus, depending upon the entity utilizing various types of ICT, one can note the following changes in demand for transport (Black and Geenhuizen, 2006):

- in case of individuals and businesses and the following types of ICT: e-shopping, e-service, last minute offers, e-networking, e-working, e-office, e-meeting; one can observe:
  A. reduced demand for transport,
  B. extended travel routes, with shortening travel time as offset,
  C. replacement of journey types (e.g. those related to work with those not related to work),
  D. creation of new demand for transport,
  E. adding an extra communication channel,
- in case of businesses and the following types of ICT: e-business (B2C, B2B), in/outbound logistics, real-time guidance in freight distribution, configuration of value web, remote development and design, remote diagnostic; one can find out:
  A. in specific cases – reduction of the demand for transport (intangible goods),
  B. and/or addition of an extra channel of communication/distribution,
  C. changes in: the frequency of shipments, volume of single deliveries, distance, time,

D. reduction of demand for transport,
E. extended travel routes, with shortening travel time as offset,
F. limited application, due to legal requirements.

Once more, attention was drawn to the necessity of analyzing the mutual relations between ICT and demand for transport, from a wider perspective. Various types of ICT cause changes in behaviour and lifestyles of individuals, as well as in strategies of company activities, and the changes in demand for transport result from them, to a large extent. One should pay attention to both the short- and long-term, and direct as well as indirect changes in behaviour of entities, related to the use of ICT. Black and Geenhuizen (2006) indicated the necessity of taking up studies concerning new, not yet considered directions, making at the same time a reservation concerning limited access to data that would permit conducting those studies. The main directions of such research may be suggested:

- conditions which cause replacement of transport by ICT, and which influence the generation of additional demand for transport (individuals and businesses),
- indirect negative consequences:
  A. short-term ones, e.g. replacement of travel type – from business travel to travel not related to business,
  B. long-term ones, e.g. relocations of employees and suppliers over longer distances, suitably for place of work and main customers,
- studying the cause-and-effect relations between the use of ICT and transport, in the context of various business strategies and lifestyles, with the distinction of roles played by ICT, in case of individuals and businesses, in:
  A. reinforcing the existing trends (e.g. globalization and individualization),
  B. development of new phenomena (new strategies, new lifestyles).

Despite the limitations concerning access to statistical data, research in the directions mentioned was continued in the years that followed. Thus, for example, Mokhtarian (2009), when trying to explain the conditions under which transport substitution by ICT could take place, concluded that substitution does not occur as often as it may seem. The author prepared a list of negatives, indicating the main reasons for absence of transport substitution by ICT. The list has been divided into factors, which explain – in a passive manner – the absence of substitution, as well as those factors, which actively stimulate travels by means of ICT. The indicated conditions are as follows:

- passive reduction of transport substitution by ICT results from the fact that:
  A. it is not always possible; absence of an equivalent ICT,
  B. if an alternative exists, it is not always feasible or practicable,
  C. if an alternative is feasible, it is not always desired,
  D. the travel may be an advantage in itself,
  E. the use of ICT shall not always replace travel, it may replace not taking any action whatsoever,
- active generation of transport services through the use of ICT:
  A. allows to save time/resources for other activities, e.g. travelling,
  B. allows to find cheaper offers,
  C. increases the efficiency of transport system, thus enhancing its attractiveness ,
  D. the private use of ICT may increase productivity/pleasure from travelling,
  E. directly stimulates demand for travelling more,
  F. influences increased globalization of trade,
  G. influences increasing decentralization and less intense/dense use of land

However, detachment from the concept of lack of transport substitution by ICT is not complete, as there are certain conditions that may influence the occurrence (and development, in foreseeable time) of transport substitution phenomenon by ICT. The types of ICT influence upon activities are presented in Fig. 1. Among the prerequisites of the phenomenon of substitution, the following may be listed (Mokhtarian, 2009):

- sometimes ICT really is used instead of travelling,

- ICT requires resources/time, which would be used for the purpose of travelling,
- the increase of costs/threats related to travelling shall increase the substitution by ICT,
- ICT may simplify car sharing and make it more attractive.

Research has also been undertaken regarding the consequences of individual ICT applications, such as telework and its impact on transport (von Lier et al., 2012), the willingness to use carpooling in commuting to work (Seyedabrishami et al., 2012). Unfortunately, the results of such research were ambiguous, in case of short-term effects of telework, reduction of passenger traffic in working hours was noticed, yet attention was also paid to the fact that at the same time another person from the same household may use the car available and travel for a different purpose, thus passenger transport remains at the same level and transport redistribution via the use of ICT would be the case (Hubers and Lyons, 2013).

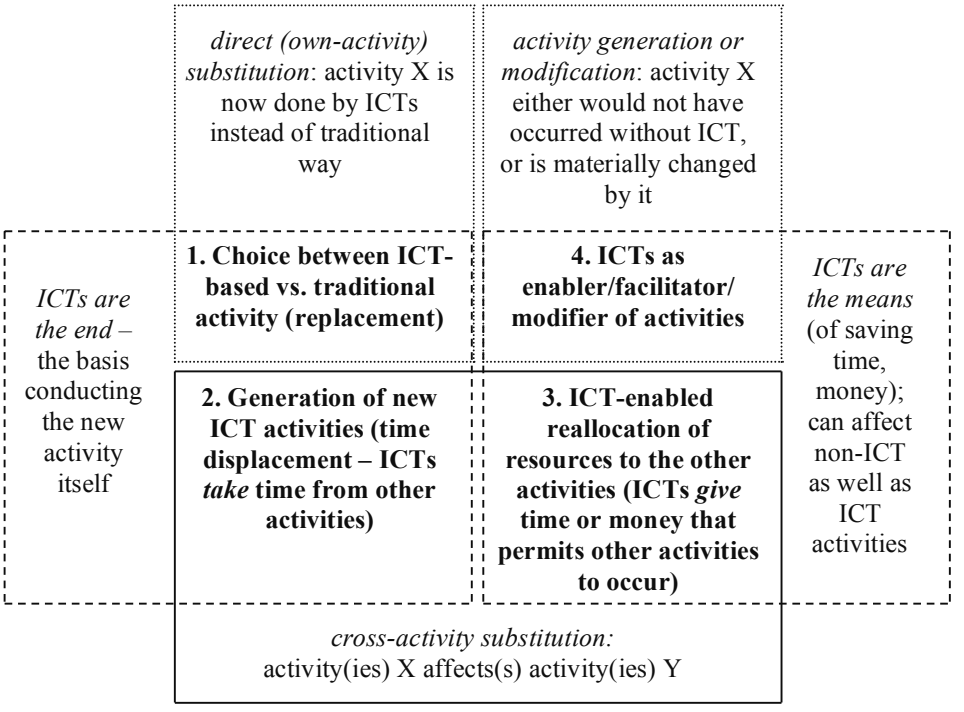

Fig. 1. Types of ICT impacts on activities (Mokhtarian, 2009)

Research has also been conducted to find out how the use of different types of ICT would influence the activities of people during the day, and whether such a change in behaviour may have consequences for transport (Alexander et al., 2011). In this research, attempts have been made to describe the extent in which ICT leads to fragmentation of activities in time and space, as well as the way in which those changes influence transport (in the view of changes in urban transport planning). The results indicate limit use of travel time for work related activities, with the provision that such results may be due to a short period of research, as well as the means of transport used by respondents. Further research is recommended regarding the influence of fragmentation of activities, especially concerning travelling by train and work. Further research with the purpose of determination of the factors related to ICT influence on fragmentation of activities and transport demonstrated that due to the diversity of ICT types and the possibilities of using them while travelling, the influence of individual technologies on fragmentation should be studied separately. Attention was also paid to the fact that, depending on the purpose of journey (work, shopping, recreation, others), the influence of ICT on fragmentation of activities will be different (Ben-Elia et al., 2014).

An attempt has been made to create a simplified model of the influence of technologies not directly related to transport on the demand for transport and the required consideration of that influence. This was done in order to

understand the mutual connections between social behaviours and transport (Hubers and Lyons, 2013). In order to evaluate the influence of a given technology upon transport demand, three basic questions needed to be answered:

1. Why and how do/did individuals use given technology?
2. In which way does/did the use of given technology influence other aspects of living/activities?
3. In what way does the collective use of technology and collective reaction to that technology influence social changes and cultures?

Unfortunately despite the apparent attractiveness of the presented model, the perspective of using ICTs and changes they evoke is too short to describe definitively – by means of it – their influence upon demand for transport.

3. ICT as one of the priorities of European Union

The development of ICTs and their use has been for a long time perceived by the EU as – on one hand – a substantial factor that influences economic growth and competitiveness, on the other – an area in which the EU loses in terms of the rate of development to other highly developed economies, such as the USA.

Strategies and policies, prepared at the EU level, join the issues related to the use of ICT with the development of information society in Europe. The most important documents prepared at the EU level are presented in Table 2.

Table 2. Development of information society and ICT in the EU – major documents (EUR-Lex).

Date of preparation	Document	Things postulated
	Early documents	
1993	White Paper: "Growth, Competitiveness, Employment. The Challenges and Way forward into the 21st century").	For the first time, the issues and scope of challenges and possibilities for Europe (resulting from ICT) have been dealt with.
1994	Document „Europe and global information society. Recommendations of the high-level group on the information society to the Corfu European Council" (Bangemann group)	It contained observations concerning changes taking place due to ICT.
1996	Green Paper: "Living & Working in the Information Society - People First".	It dealt with changes in the life of EU citizens resulting from ICT.
1999	Initiative "e-Europe – Information society for all"	It defined the aim of building information society, with indication of priority areas.
	Lisbon Strategy	
2000	Action Plan: "e-Europe 2002 - An Information Society for All"	Plan of action for the years 2000-2002 – it focused on the provision of fast and cheap access to Internet, as well as development of user skills
2001	Plan "e-Europe+2003" – Joint activities for implementation of Information Society in Europe"	Concerning activities of the countries which were to join the EU in 2004, in the ICT sphere.
2002	Action Plan: "e-Europe 2005 - An Information Society for All"	Plan of action for the years 2003-2005, it focused on the provision of access to new generation of ICT and e-services.
	Renewed Lison Strategy	
2005	Initiative "i2010 - Information Society and the media working towards growth and jobs"	Support of innovativeness to speed up growth and creation of new jobs, of better quality.
	Europe 2020	
2010	European Digital Agenda	The main aim is the development of common digital market.

All the programmes linked to the development of information society and – widely understood – use of ICT are in line with the general development strategies of the European Union. One should also point out to the prolonged planning periods – initially the documents were meant mainly for information and advisory purposes, but as time went on, they were given the role of guidelines and plans; their implementation is verified meticulously, and allows for their modification as needed. One can draw attention to the evolution regarding activities taken up: initially the EU initiatives focused on proper arrangement and keeping the legal framework up to date, especially in relation to telecommunication and radio frequencies; the promotion of widespread access to Internet followed later, both for individuals and public administration units, and education centres. Further on, attention has been paid to the necessity of developing certain skills, which would allow individuals/units to fully use the potential offered by ICT. At the same time, actions have been taken to help businesses to find their place in the new reality (with particular stress put on SMEs), comprising of promotion and assistance in implementation of ICT solutions, development and spreading of standards, unification of the legal framework concerning electronic transactions and settlements. At present, the activities within the framework of Digital Agenda, besides continuation of previous priorities, focus on the promotion of innovation activities and development of spending for research purposes in the territory of the EU member states. The areas in which activities have been carried out in specific EU initiatives concerning information society and ICT are presented in Table 3.

Table 3. Areas of activities assumed in specific documents concerning ICT (EUR-Lex).

Areas		e-Europe (1999)	e-Europe 2002	e-Europe 2005	i2010	Digital Agenda
Radio frequency		yes	yes	yes	no	no
Cheap access to Internet		yes	yes	yes	yes	yes
E-economy		yes	yes	yes	yes	yes
Internet for science		yes	yes	yes	no	no
Youths		yes	yes	yes	no	no
E-services	E-administration	yes	yes	yes	yes	yes
	E-health	yes	yes	yes	yes	yes
	Public transport	yes	yes	no	no	no
Intelligent Transport Systems		yes	yes	yes	yes	yes
Financing SMEs		yes	no	no	no	no
Promotion of ICT for SMEs		no	yes	yes	yes	yes
Needs of the handicapped/disabled		yes	yes	yes	yes	yes
Security in the net		no	yes	yes	yes	yes
Work and qualifications		no	yes	yes	yes	yes
E-content		no	yes	yes	yes	yes
Research and development		no	no	no	yes	yes
Private investments in ICT		no	no	no	yes	yes
Single digital market		no	no	no	no	yes
ICT for environmental protection		no	no	no	no	yes
International aspects		no	no	no	no	yes

As it may be deduced from the information presented in Table 3, the spheres of activities planned in specific EU documents concerning ICT and information society differed. Some of those activities have been continued throughout all the analyzed documents, some disappeared from the agenda and have been replaced with new ones. The weight of individual priorities/spheres changed as well, for example e-administration or on-line government may be a general sphere of activities or belong under other spheres, the same applied to the needs of the disabled or public transport (public transport concerning integrated e-ticketing systems has been transferred to public transport the sphere of transport policy). Changes occur in case of aims in specific ranges of activities as well, e.g. stress is shifted from cheap and universal access to Internet to the availability of broadband and mobile Internet. Some areas vanish from the

agenda because aims have been successfully reached – e.g. the sphere of Internet for science assumed connecting universities and research institutes to broadband and skeleton networks, which has been achieved. Certain areas appear in later documents only (e.g. single digital market or ICT for environment). This may result both from the absence of earlier need to consider such an area, or lack of technical possibilities, which would enable taking those areas into account and acting efficiently. Nonetheless, it should be stressed that certain areas, in particular those that have substantial importance for the main aims of the EU or concerning development and strategy (economic growth and competitiveness, improvement of life quality), invariably remain on the agenda. Among them, there are: cheap and universal access to Internet, e-economy, e-administration, intelligent transport, needs of disabled, and – to a lesser degree – work and qualifications, security, new content, and promotion of ICT use in SMEs. Of course, progress concerning quality has been made within individual areas, and the activities planned in (alternating) documents are different, e.g. in case of e-economy the activities contained in specific documents assumed, among others: reviewing, preparation and standardization of legal norms, establishing of standards and provision of interoperability of electronic payment settlement mechanisms (establishment of SEPA - Single Euro Payments Area).

In summary, one should stress that activities at the EU level, concerning information society, are complex and stimulating for both the supply and demand side, simultaneously. The wide range of activities conducted is not without the influence, both on transport and on the demand for transport services. Several influences may be distinguished:

- direct influences upon transport – multiplier technologies, having impact upon security and effectiveness of transport services provided, e.g. development of Intelligent Transport Systems, Galileo program, Intelligent Car Initiative,
- indirect influences upon transport – those which improve the overall functioning of enterprises at the European market, e.g. standardization of regulations concerning electronic signature, electronic transactions and settlements (SEPA - Single Euro Payments Area),
- direct influences upon demand for transport – easier functioning on the electronic market and conclusion of transactions results in changes concerning trade streams and direction, facilitated communication resulting from the use of ICT – which enables establishment of co-operation with foreign partners and extension of the existing markets,
- indirect influences upon demand for transport – social changes resulting from activities meant to enhance competencies and skills of citizens, as regards the use of ICT, e.g. increased trust in e-commerce, greater mobility.

The activities within Digital Agenda are subject of ongoing assessment, in the form of reports under Digital Agenda Scoreboard and the Digital Economy and Society Index, delivered every year. The recent assessment of activities indicates progress in reference to the previous years, yet it also indicates that individual member states reach different results and the progress made in individual spheres of activity also is different (it mainly applied to the development of electronic public services).

4. ICT use and transport demand in the European Union countries

Information technology would not have so much influence upon business activity these days, if not for the fact that it co-exists with communications technology. It was the Internet and possibility of communicating, not only between people, but also of receiving messages and transfer of data from the surroundings, that was decisive for such a big influence of ICT on the economy. Many researchers point out that the Internet became the heart of technological, economic, and social revolution, taking place right in front of our eyes (Lyons 2002). The research of Eurostat indicates that in 2014 more than 90% of enterprises and nearly 80% of households in the EU had broadband access to the Internet. Fig. 2 shows the percentage of households and enterprises in the EU 28 with broadband access, in the years 2004-2014. It can be noted that those amounts increased very dynamically over the last ten years. In case of households, the increase has been over five times over the period analyzed.

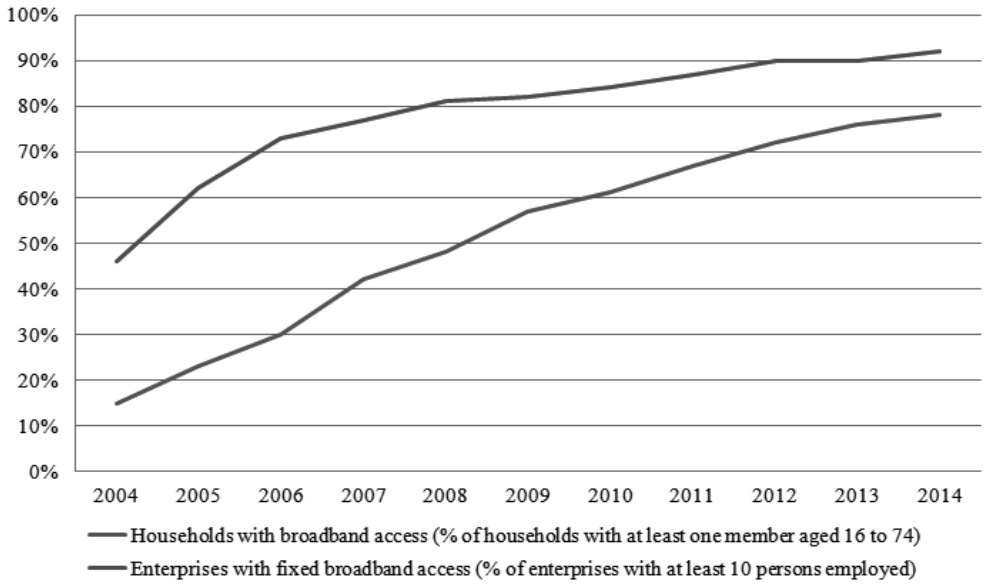

Fig. 2. Percentage of households and enterprises with access to the Internet in the EU28, 2004-2014 (Eurostat Database, 2015).

ICT technologies have been affecting consumer behaviour and trade in greater degree every year. Nearly half of the individuals in the European Union, in the age range of 16-74 years, have been using Internet for ordering goods and services. Table 4 presents Eurostat data concerning the percentage of individuals aged 16 to 74, using the Internet for shopping. For EU15 and the 13 new member states of the EU, average values have been calculated. E-commerce has been developing dynamically indeed in the new EU member states, which accessed the EU after 2004. Still, the percentage of people using Internet for shopping is in those countries half of the corresponding value of the EU15.

Table 4. Percentage of individuals aged 16 to 74 using the Internet for ordering goods and services in the European Union, 2004 and 2014, Eurostat Database (2015).

Group	2004	2014	Growth rates (2004=100)
EU 15	32%	67%	108
EU 28	**20%**	**50%**	**150**
New EU 13 members	5%	33%	610

The possibility of shopping remotely via Internet, as well as change in consumer behaviour that comes with it, are the factors which strongly influence markets. In recent years, for example, a dynamic development of online groceries could be observed; such shops offer direct home delivery. All the big supermarkets in Europe are already offering such services. In consequence, some out-of-town supermarkets have been transferred into distribution centres, which have specific areas of cities and conurbations in their area of operation. One can risk a statement that online shopping (e-shopping) limits shopping trips undertaken by car by individuals. However, can we really state unequivocally that e-shopping reduces the demand for transport in economy? The research conducted so far does not allow to draw such conclusions. The research conducted in the Netherlands by Weltevreden and Rotem-Mindali (2009) show that B2C e-commerce indeed influences the reduction of the number of travels and distance covered by consumers. On the other hand, Internet influence the dynamic development of new C2C e-commerce market, on which easy purchase and sale of second hand items is possible. As has been demonstrated by research, C2C e-commerce influences the increase of personal travels and distance travelled by consumers (Weltevreden and Rotem-Mindali, 2009).

Transport sector is the second largest sector in the European Union in terms of turnover in electronic trade. In 2014, about 22% of total turnover of enterprises in transportation and storage was the turnover in electronic trade. Table 5

shows the share of turnover from e-commerce in total enterprises turnover by economic activity in 28 EU countries in 2014. To illustrate the disproportions occurring within the European Union, besides data for the Euro area, Table 5 also contains data for two countries from the EU15 and from the new 13 member states, with the highest share in transportation and storage. Ireland is the decisive leader in e-commerce in the European Union.

Table 5. Share of turnover from e-commerce in total enterprises turnover (10 persons employed or more) by economic activity in 28 EU countries and euro area (19 countries) in 2014 (Eurostat Database, 2015).

Economic activity	**EU28**	Euro area	Ireland	UK	Czech Republic	Croatia
	percentage (%) of total turnover					
Accomodation, food and beverage service activities	**28**	26	88	39	31	35
Transportation and storage	**22**	20	81	37	30	23
Manufacturing	**19**	16	39	30	34	12
Information and communication	**18**	17	82	24	29	9
Wholesale and retail trade; repair of motor vehicles and motorcycles	**15**	14	52	19	24	16
Administrative and support service activities	**10**	8	26	12	17	13
Professional, scientific and technical activities	**4**	4	22	4	5	1
Real estate activities	**2**	1	7	3	12	10
Construction	**2**	1	1	4	3	4
All enterprises, without financial sector	**15**	14	52	20	29	13

ICT technologies are becoming a major tool for selling and integration of services; they are used by transport companies that provide passenger as well as freight transport. Electronic freight exchange platforms can serve as an example in freight transport, as they perform the function of virtual market for forwarding agents and providers of transport services (among the biggest and most popular providers in Europe is Teleroute – teleroute.com and TimoCom Truck&Cargo - timocom.com). On the other hand, in passenger transport, booking and ticketing systems developed worldwide, and passenger information systems may serve as examples. Systems of electronic tickets (e-tickets) are getting ever more commonly used in air transport, but also in rail transport and public urban transport (Kos-Łabędowicz, 2014). In the European Union, the process of integrating national high speed rail systems in a coherent, trans-European network depends upon the implementation of modern ICT tools in that branch of transport. It is one of the main priorities of common transport policy of the European Union (Kos and Urbanek, 2014).

Within the framework of Digital Agenda Scoreboard, the European Union, by means of The Digital Economy and Society Index (DESI) has been monitoring – for two years now – the competitiveness of economies of its member states, as regards the use of ICT. The DESI index is calculated as the weighted average of the five dimensions. Specific dimensions, in turn, are calculated on the basis of suitably weighted indicators of the use of ICT in the economy (European Commission, 2015b):

1. Connectivity (25%): Fixed Broadband, Mobile Broadband, Broadband speed and Affordability,
2. Human Capital (25%): Basic Skills and Usage, Advanced Skills and Development,
3. Use of Internet (15%): Content, Communication and Transactions,
4. Integration of Digital Technology (20%): Business digitization and eCommerce,
5. Digital Public Services (15%): eGovernment and eHealth.

Fig. 3 contains the DESI index data of 2015, compiled with the size of economies, measured by means of Gross Domestic Product (GDP) per capita for 2014.

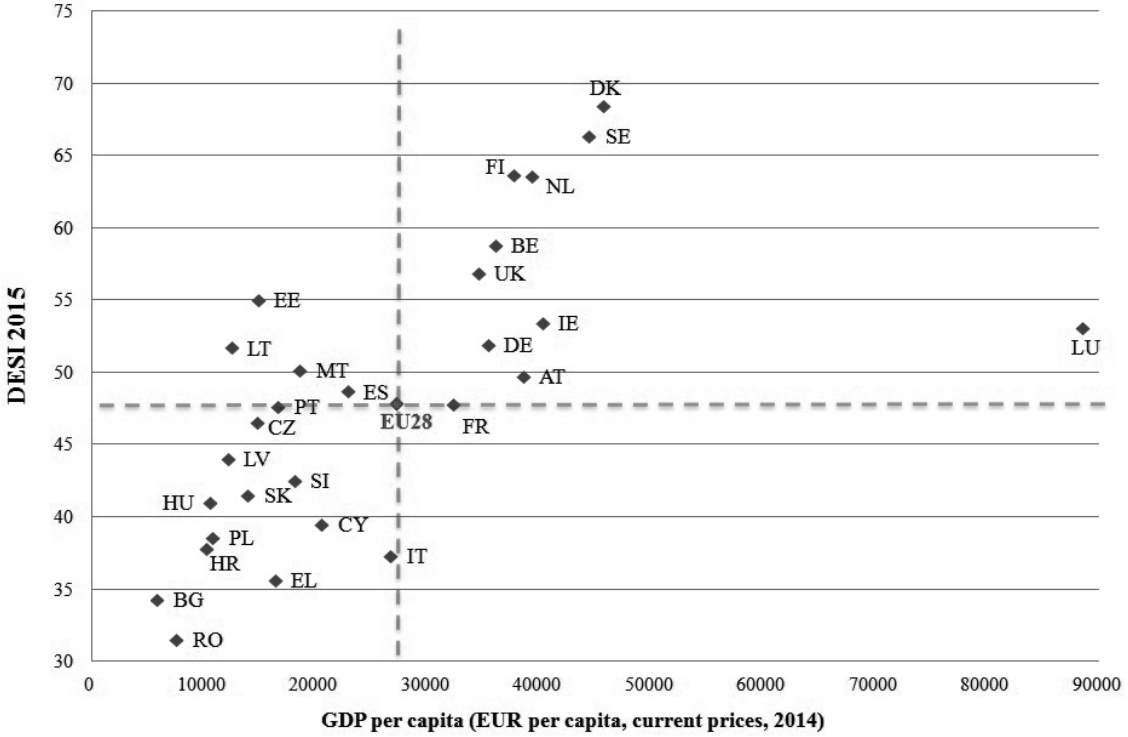

Fig. 3. The Digital Economy and Society Index (DESI) in 2015 and GDP per capita in 2014 (EUR per capita, current prices) in EU 28 member states (European Commission, 2015; Eurostat Database, 2015).

Most of the 13 new EU member states are located in the lower left quarter of the graph of the GDP per capita and DESI index; those results are below the European average. According to DESI 2015 Denmark, Sweden, Finland and the Netherlands have the most advanced digital economies in the EU. Among the most advanced countries, there are two from the Central and Eastern Europe, namely Estonia and Lithuania. The EU countries which are least advanced in the application of ICT in the economy are: Romania, Bulgaria, Greece, and Italy.

The DESI index, as a synthetic measure of ICT adoption in national economies, may be useful when trying to answer the question concerning the influence of ICT upon demand for transport, from the point of view of national economy. The demand for transport - both passenger and freight - keeps growing. Table 6 highlights the growth of transport and GDP in EU28 between 1995 and 2013.

Table 6. Transport and GDP growth in EU28 (European Commission, 2015a)

Indicator	1995	2013	Growth rates (%) 1995=100	Average annual growth rate (% per annum)
GDP [mln EUR] (chain-linked volumes, at 2000 exchange rates)	9 090 176	12 182 447	134.0	1.6%
Freight transport [tkm]	2 846	3 481	122.3	1.0%
Passenger transport [pkm]	5 368	6 465	120.4	1.1%

The dependence between economic growth, measured by GDP, and the growth of freight and passenger transport has always been really strong. The idea of decoupling of transport growth and GDP growth started to be one of the priorities for common transport policy of the European Union in 2001, when the European Commission's White Paper, entitled "European Transport Policy for 2010: time to decide" was published. It is interesting that in the most economically developed countries of the EU, that is the EU15, a reduction of the volume of transport relative to GDP could be noticed, beginning in 2007 (Fig. 4). Meanwhile, in the 12 new EU member states that value has been increasing steadily. When changes in passenger transport are analyzed in a similar way, it becomes apparent that both in the "old" EU15 and in the 12 new EU member states, the volume of passenger transport relative to GDP has been going down, yet the dynamics of its reduction is much greater for the 12 new EU member states.

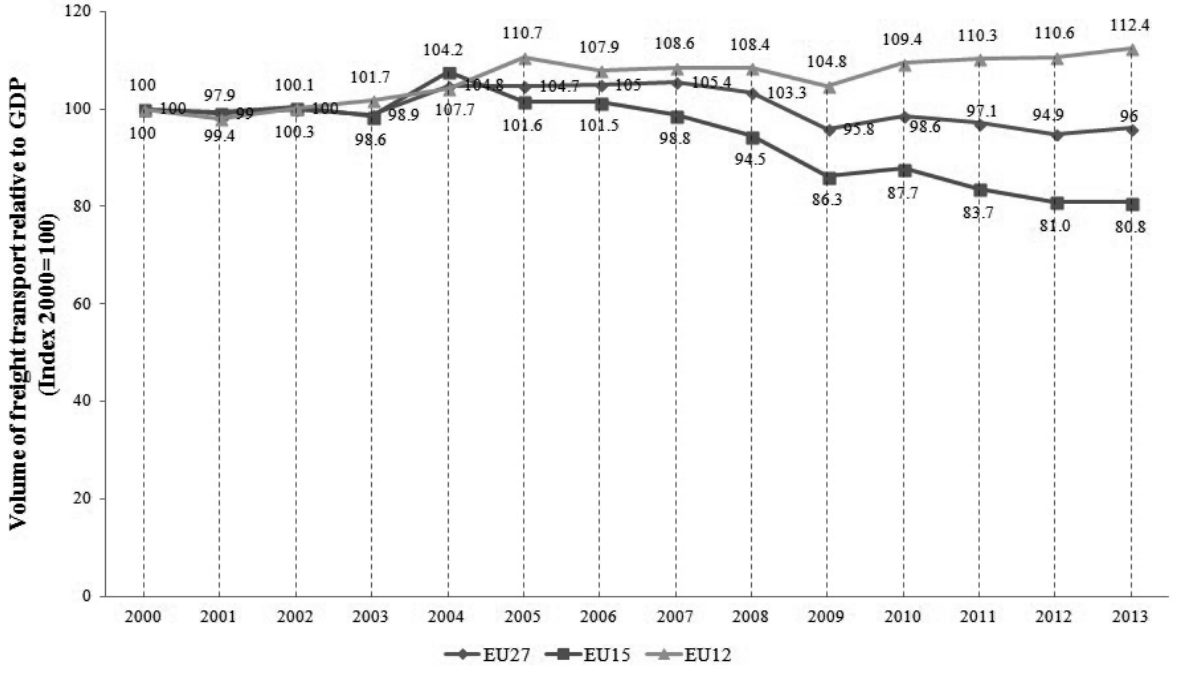

Fig. 4. Volume of freight transport relative to GDP in EU27 in the years 2000-2013 (Eurostat Database, 2015)

The aim of the common transport Policy of the European Union, concerning the split of strict correlations between economic growth and freight transport growth has only been reached in the EU member states with the highest level of wealth. Those are modern, highly developed knowledge-based economies. The countries that joined the European Union after 2004 have very dynamically developing economies, driven by development of international trade, and benefitting from lower costs of service provision (especially concerning salaries). The cause of more dynamic drop of the volume of passenger transport relative to GDP in the 12 new EU member states is probably the fact that GDP per capita in those countries has been growing much faster than the mobility of citizens. However, a clear answer to that question requires detailed analysis and further studies.

The analysis of the DESI index values for individual European Union member states and the volume of transport relative to GDP does not permit a clear answer to the question of how much the application of ICT in the economies of those countries contributed to reduction of the dependence of an economy upon transport. Still, it is a fact that in most cases in the countries with high level of the DESI index, it was possible to reach the aim of decoupling the strict correlation between economic growth and transport growth. The analysis made in this paper should thus be a contribution to further extended studies.

Conclusion

The development of Information and Communications Technologies and their increasingly common application in all branches of the economy gradually transfers the way of conducting business activities, shaping the relations between participants of markets anew, and changing the rules that govern functioning of those markets. The issues related to the implications of increasing dependence of societies upon ICT and the Internet are increasingly more often the subject of studies, not only in economy, but also in sociology and psychology. The multidisciplinary character and complexity of those topics are the reasons why science has just started to better understand the consequences of that process.

As regards the studies of the influence of ICT upon the demand for transport, there were many considerable studies, which provided a considerable input to the current state of the art. The research conducted so far allow, first of all to:

- identify the technologies applied in the sector of freight and passenger transport, and assess their influence upon the efficiency of conducted activities,
- identify mutual relations between ICT and transport,
- identify the directions in which those technologies influence the demand for transport, regarding both the influence on change in transport behaviour, and changes in transport companies.

In the literature of the subject, a more thorough analysis of the problem one that would take the influence of ICT upon transport in macroeconomic scale - that is in the scale of the entire economy - into account, is still absent. Moreover, the studies based upon the analysis of empirical data that allow drawing direct conclusions from economic reality are rare. It is a very difficult task, mainly due to the many dimensions and aspects that problem has.

In this paper, a thorough analysis of statistical data for European Union has been made; EU – within the economic policy conducted – has been stimulating the development of ICT and application of ICT in various sectors of the economy for many years. Information and Communications Technologies are, particularly in the sector of transport, an important tool for economic integration and development of common market. The analysis conducted permits drawing the following conclusions:

- The demand for transport, measured by the volume of freight (tkm) and passenger transport (pkm) has continued to increase, yet in the wealthiest EU member states, which became knowledge-based economies, the share of freight transport in GDP has been dropping since 2007. In the developing economies of new member states, a dynamic increase of freight transport share in GDP can be noticed.
- The role of ICT in economies of EU member states has been incessantly increasing, and transport is one of the sectors, in which profits from e-commerce are the highest.
- The European Union is pretty diversified as regards the use of ICT. The differences do not include merely the division into the so-called old member states, the so-called EU15, and new member states - EU13, which accessed the EU after 2004. Differences also occur within those two groups of countries. Among the EU15, Italy and Greece are the two countries demonstrating the lowest level of ICT use, as measured by means of DESI index, whereas among the new member states, EU13, the top values of the DESI index are scored by Estonia, Lithuania and Malta.

To what extend the decoupling of transport growth and GDP growth in the European Union is the result of increasing use of ICT in the economy cannot be stated clearly. Nevertheless, it should be stated that in most of the cases in highly developed and high digitized economies the share of transport in GDP dropped significantly. Assessing the influence of ICT on decoupling poses an extremely difficult research task, which is worth taking on, though, as it would give the assumptions for forecasts of future global trends.

It is also worth noting that in the research conducted so far, transport users have been treated as a whole, making uniform assumptions as their behaviour, not taking into account the differences between generations. The generation that grew in the times of universal access to Internet (those born after 1995 are sometimes labeled Z generation), which in a few years from now will have real influence upon the demand for transport, and may completely revolutionize the views that existed so far. A need thus arises to make a forecast concerning the influence of a the new, completely

different, generation upon the changes in transport behaviour and purchasing behaviour of contemporary societies, which as a result will affect changes in global economy.

The preliminary sighting studies carried out do not allow to make conclusions for transport and economic policies. However, in the context of the active policy concerning ICT, conducted by the European Union for many years, those studies provoke a question concerning the influence such a policy had upon the changes, which took place in economies and transport sector, versus the same changes happening independently, with innovativeness of entities and strife to increase competitiveness as their driving forces.

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