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# NEW TECHNOLOGIES IN TRANSPORT IN THE FACE OF CHALLENGES OF ECONOMY 4.0

**Summary**. Nowadays, the dynamics of variability marked by technologisation and digitisation cannot be underestimated. New technologies identified with Economy 4.0 affect almost every dimension of the modern world. The level of competitiveness of modern economies is determined by the implementation and diffusion of innovations based on new technologies. Artificial Intelligence, the Internet of Things (IoT), the Internet of Everything (IoE), hyperconnectivity, cloud computing applications and services, Big Data Analytics (BDA), Big-Data-as-a-Service (BDaaS), automation and robotisation are just a few of the technologies that the authors found worth looking at in more detail with regard to transport. Digital transformation is also a new opportunity as well as a challenge for business. This paper indicates the metamorphosis that transport has undergone as a result of the injection of new technologies. The presented material has been collected in the course of the source research carried out using the idiographic method. A critical analysis of available documents and literature, as well as digital

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sources, has made it possible to identify the benefits of injecting new technologies in transport as an effect of adaptability to the digital age.

**Keywords:** transport, economy 4.0, new technology, innovations, Internet of Things

## 1. INTRODUCTION

Time is one of the most precious resources available to mankind. Everyone has the same amount of time. It is not possible to aggregate, divide, or transfer it. Time, apart from information, is a driving force for constant changes in humans, organisations and the environment. Thanks to time, the present fate of the world is shaped by the forces and achievements of technology, which only a few decades ago was just a matter of futurologists' deliberations. An efficient business system today means a symbiosis of technologies and information that form the basis of efficient supply chains binding organisations together through the provision of logistics services such as freight forwarding and transport. The effectiveness, reliability, efficiency and speed of transport depends now and will certainly depend in the future on innovative ICT solutions developed as a result of the passage of time and human thought.

Transport is a universal integrator of all economic processes and forms of social life. As far as historical roots are concerned, the circle and settled lifestyle are the beginnings of logistics identified with transport. The Middle Ages were the time of the first transport companies. The next step in development was the period from the 15th to18th century, when new types of ships, navigation devices and chamber locks were constructed. The industrial revolution marked the beginning of transport mechanisation and road construction. The following step in development was the appearance of the car. The beginning of the 20th century was the time when the first motorways, tunnels and sea channels were built. The beginning of the 20th century was also the time when man flew up in the air. The following years were a time of modernisation of technologies in logistics characterised by the pursuit of excellence, optimisation, orderliness, regularity and the desire to improve security.

The 21st century is the century of technicisation in logistics based on digitisation. Innovations combined with appropriate financing makes it possible to create the value of the organisation in the market and contribute to gaining a competitive advantage, which may become a source of success. The aim of this paper is to illustrate the impact of innovative technologies in transport transformations in the face of the challenges of the future. To achieve such a purpose, the authors had to specify areas of partial consideration. In accordance with the research procedure, a diagnosis was made of the components of the environment and their impact on the shape of the reality of Economy 4.0. The technologies gaining importance in the implementation of the processes of moving goods were pointed out and AI as a transmitter of an innovative approach to technology on human-environment relations was indicated.

## 2. THE CHALLENGES OF ECONOMY 4.0

The electronic economy, also known as the e-economy, digital economy or bit economy, is a method of doing business using modern information technologies and computer networks; it is an element of the interpenetration and combination of IT, telecommunications

technologies and knowledge. Reality is becoming computerised and nothing seems to be able to oppose this trend. Digital information is becoming the foundation for the second technological era. According to the Digital Yearbook "We Are Social" report, the number of people with access to the Internet in 2016 amounted to 3.42 billion, which means that almost half of the earth's population is networked. The pace of information generation is increasing, resulting in doubling the volume of the Internet as a result of data collection and processing.

Contemporary times are marked by the digital blood circulation of data, which makes the virtualisation of the world, apart from globalisation, a marker of the level of development of the economies of individual countries. A set of technical and technological solutions includes cloud data collection and computing, mobile technologies, an analysis of large data sets and social media in business. Billions of interconnected devices with enormous computing power transmit data and information embedded in them. Revolution 4.0 means that connected computers and machines equipped with software-assisted sensors enable the initiation of communication that is part of a system of human-machine interaction. Devices communicate with one another, cooperate with one another, support one another, or replace people in repetitive activities. According to M. Weiser's principle of "a good servant", intelligent objects should always be ready to perform their assigned tasks and functions on their own, providing maximum usability with minimum human attention absorption.

The next step in development is the Internet of Things (IoT), an ecosystem that connects the infrastructure of facilities, people, systems and information resources with intelligent services. Objects equipped with sensors like a living organism can feel and respond to external stimuli, process and store information collected, as well as transmit information in digital form to other objects or people connected to the network via appropriate communication protocols. Intelligent, easy-to-manage and secure infrastructure, scalable to support billions of devices. This intelligent network is designed to listen, learn and respond. It is designed to withstand global data centre traffic of 6 Bytes (Z, Zetta is $10^{21}$).

Another aspect of Economy 4.0 is robotisation. According to a report by the United Nations Conference on Trade and Development, around 2 million industrial robots are used worldwide. Nearly half of them are located in just three countries: Germany, Japan and the United States. In addition to the USA, China, Russia and Japan, Europe also has a solid position in this specific robot race. Under the European Commission's SPARC programme, the EU will invest 700 million Euro in industrial robotics research and a consortium of 180 European companies is expected to contribute an additional 2.1 billion Euro by 2020. According to estimates from Gartner's research institute, IoT will cover around 26 billion devices by 2020. The competitor Allied Business Intelligence (ABI), in turn, claims that this number will exceed 30 billion. Cisco, a technological giant, asserts that there will be 50 billion of these devices within this time frame. According to Nelson Research, it will be 100 billion, while Intel mentions about 200 billion and Intel Data Corporation (IDC) about 212 billion. This impending time for the next-generation robots means that living beings will coexist with machines capable of seeing, moving, responding to the surrounding environment and performing precise tasks.

## 3. TECHNOLOGIES IN APPLICATION - INTELLIGENT TRANSPORT

Transport as an activity involving the provision of services, whether in return for payment or free of charge, which results in the movement of persons and/or cargo from the point of consignment to the point of collection and the provision of ancillary services directly

linked to those services. It covers both movement from one place to another and all the operations necessary to achieve this objective, that is, cargo operations (loading, unloading, and handling) and handling operations, for example, fees. In order to provide a transport service, a number of elements are necessary, such as means of transport, transport infrastructure, people, and the established principles and rules for the provision of these services. Today's transport is particularly dependent on technology.

Effective management of a transport fleet relates to the elimination of so-called empty runs, which according to the TRANSPOREON Group currently accounts for 25% of road transport. Their elimination is possible on account of the existence of freight exchanges, especially mobile access to them. Mobile applications are willingly used, as shown by the data. In 2017, Mobile application users spent 900 trillion hours (quoted from Wtransnet, App Annie study). Using a smartphone, iPhone, tablet or iPad running Android, Windows or iOS operating systems, customers have access to these platforms. Through them, they can enter and search for offers of cargo or free cargo space on the SPOT market, conduct tenders, search and offer warehouse space, databases of companies, documents and instant messengers.

According to the report by IDC's (International Data Corporation) Worldwide Semiannual Internet of Things Spending Guide, the global Internet of Things market will grow by about 16.7% year on year. The global Internet of Things market will be worth as much as USD 1.5 trillion in 2020, and in 2024 this amount may oscillate around USD 3 trillion.

Transport management in today's world without proper support of modern technological solutions is extremely difficult. Of course, there are specialist software that makes planning and performing tasks easier. The solutions supporting the implementation of tasks include the Customer Relationship Management System (CRM), whose beginning dates back to the 1990s, when the American economy began to influence the economy around the world. Attention was paid to the individualisation of the customer approach, which increased their awareness and requirements for sellers. However, customer loyalty has decreased, and research shows that acquiring a new customer is up to 7 times more expensive than maintaining the old one. CRM is a customer-oriented integrated multi-access and open IT system designed to support marketing management, sales, service and technical support, that is, data about the seller-customer relationship and characterising the client in terms of its acquisition and maintenance in the long-term. In transport services, it means clear and easy to use tools that are delivered simultaneously to all company departments in the form of necessary information about the selected contractor.

Time is a determinant for transport services. It is important to find a suitable contact person in a simple and quick way to communicate with him/her. Of course, it is still possible to carry out transport and forwarding activities using a telephone, calendar and handwritten notes, however, the current economy counts time optimisation, costs and flexibility, which is why it is more beneficial to implement one tool that will facilitate customer relationship management. The following graphic from the Galactica Pegasus system allows one to easily search for the right customer/carrier that conducts business activities in the desired location. In addition, it allows one enter documents into the system in the form of files, including PDF, JPG, XLS, DOC, as a result of which, for example, contracts, licenses or insurance can be added to the card. One of the modules, the order module allows the registration of customer inquiries up to the carrier's order.

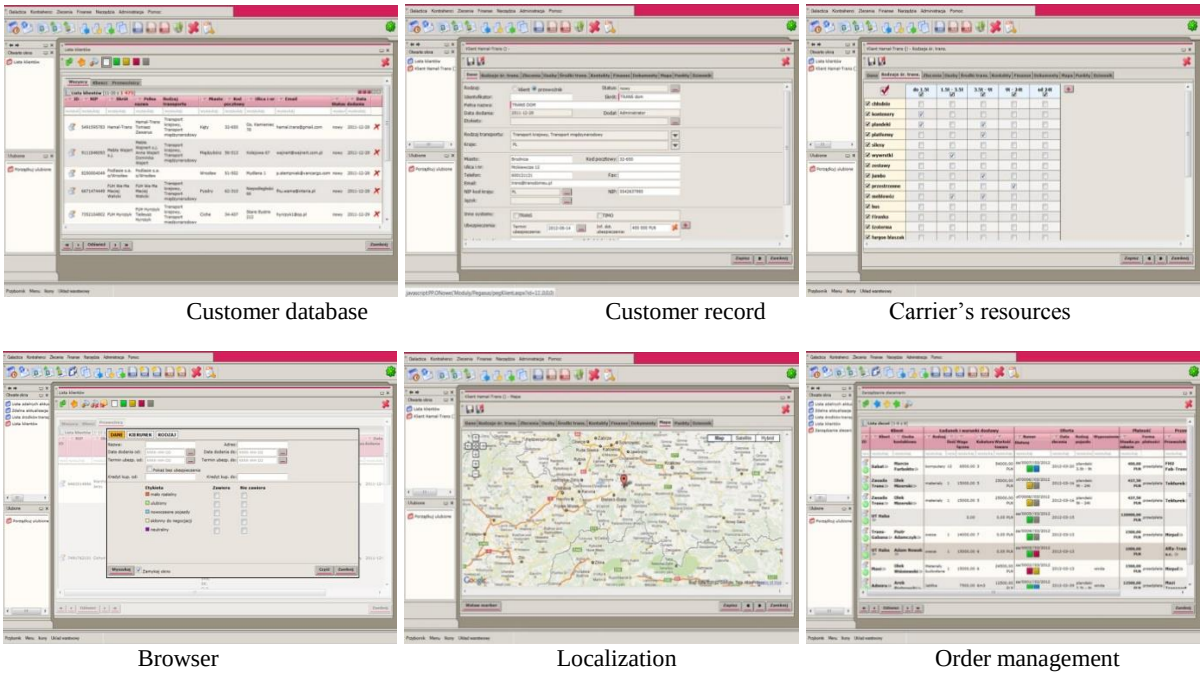


Fig. 1. Elements of Galactica Pegasus CRM

A module has been created for transport companies allowing for controlling operational activities (repairs, inspections, replacement of fluids, etc.), and at the same time reminding about upcoming dates, for example, technical inspection or the approaching end of the insurance policy. An additional feature of the system is the financial module that allows issuing accounting documents such as proforma VAT, VAT invoice, corrections or debit notes. This module can be integrated with the bank account, which is beneficial as information about transfers is automatically saved in it. Undoubtedly, CRM is a business strategy that actively builds preferences and favours for the organisation among its employees, agents and clients, resulting in stronger relationships and better results, and the management of transport and customer base centred on one tool, allows one to easily optimise tasks. In addition, CRM systems are complementary to comprehensive control of the situation in the enterprise and the external environment.

The YMS system (Yard Management System) comes out against the expectations of enterprises that are forced to manage the means of transport in the environment of their companies. The software, which has the task of managing the traffic around the warehouse has to optimise the use of available vehicles and plan their traffic, minimise the load on ramps, and thus avoid bottlenecks in the schedule of shipments and deliveries as well as direct contact with drivers (call to the destination of loading or unloading using SMS, e-mail or light board) and generally better customer service. In addition, the YMS system can be integrated with the weights at the entrance and exit, as a result of which the exact weight of the goods is calculated, also allows the registration of position, movements, states - supporting RFID technology and barcodes. When talking about YMS, it is worth noting that it is aimed at better use of the work of gates. In the software provided by Comarch, visible integration in a single system of geographically dispersed warehouse doors, customs warehouses, cold stores, ramps, etc. based on a planning table, where each gate has its own name, the range of working hours and implemented on its operations, significantly facilitates

fleet management. The company also provides an active red line in its application that shows delays in real-time ramp operations. The advantage of the application is that it is available through a web browser, which allows access from any device and place, 365 days a year, and even the driver himself can make an alert via his smartphone or tablet.

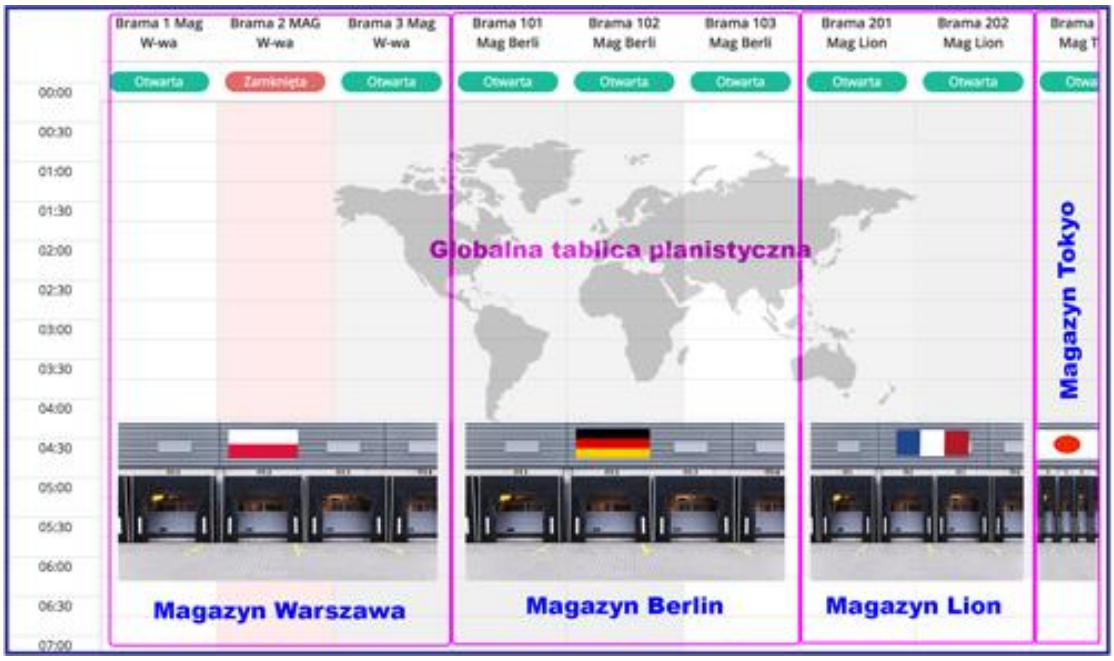


Fig. 2. Global planning dashboard of YMS system (Comarch)

Electronic transport exchanges operate in the form of interactive platforms that primarily connect forwarding, transport, production and service companies. In the TSL industry, the most important factors are time, costs, supply chain security and, at the same time, easy access to information. Hence, the possibility of direct access to the offer and cooperation with reliable business partners, at a time when the economic situation is subject to high fluctuations, is great facilitation for the continuity of work and optimising the operation of the company.

Growing consumption causes an increase in the demand for transport and forwarding services, and because it is road transport, due to its infrastructure, it is the only one able to make door to door deliveries possible. In today's electronic market, most of these services have been taken over by electronic transport exchanges. One of the main advantages is access to the electronic transport marketplaces 24 hours, 7 days a week, although continuous access is only a theoretical assumption, because users have predefined working hours and in practice, electronic transport exchanges operate on weekdays, 7-17?. Apart from these hours, it is hard to look for contact with anyone and it is difficult to obtain any information. The fact is, however, the ability to quickly reach customers, suppliers and, in general, entities forming the TSL environment, regardless of geographic or time zone. The platforms enable presenting in detail, the offer of cargo or the demand for a given type of cargo space.

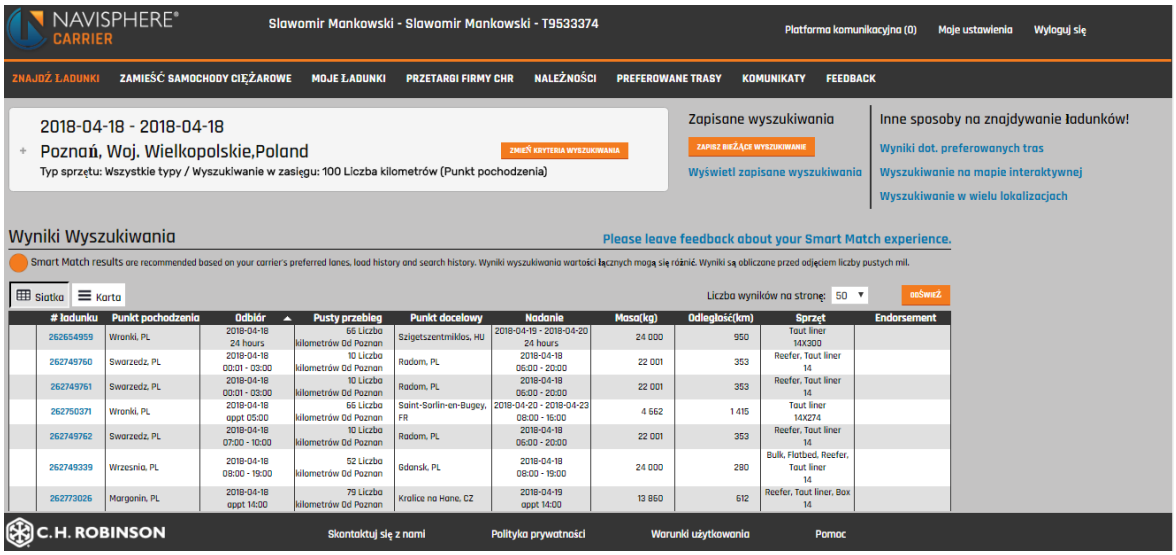


Fig. 3. Internal freight database provided by C.H. Robinson (sample)

## 4. MAN AND INTELLIGENT TRANSPORT

Functioning in a technologised world focused on knowledge, digitisation, the use of machinery and robotisation means a necessary coexistence of people and devices. There are many effects of such coexistence of worlds. One of them is the revolutionary change in the area of transport infrastructure, both in internal and external transport.

In the field of internal transport, an example of automation and robotisation commonly used in intralogistics is AGVs (Automated Guided Vehicles), vehicles with the capacity of 1.5 tonnes working in a continuous mode to support transport processes and improving the flow of resources in the warehouse. On the other hand, Kiva Systems robots are used by Amazon. In the USA, at the end of 2016, 45,000 such robots were in operation in 20 distribution centres, supporting employees in warehouse operations. A single robot over 40 cm high and weighing nearly 145 kg can transport shipments of up to 317 kg helping warehouse managers and improving the packaging and picking processes.

Another example is the Pick-by-vision system supporting the picking process by integrating the advantages of the Pick-by-Voice and Pick-by-Light methods, which in combination with the ERP system allows a warehouse worker equipped with special glasses with a display and a scanner put on the finger to move freely with a warehouse trolley to complete picking processes. Thanks to this solution, the process becomes intuitive, efficient and has fewer mistakes made.

Another solution that connects people with the world of machines in the implementation of logistics processes is the Toru robot. The device is equipped with a sensor system integrated with the WMS system makes it possible to intensify the picking processes by locating the goods, collecting the assortment inside and moving it to the packing point, where the next phase of the order fulfilment process can take place. This robot can operate 24 hours a day, 7 days a week, especially as additional support during sales peaks.

In the field of external transport, there are also many technological changes. Consequently, present-day cars will slowly become history. They are slowly and systematically been replaced by those with advanced technology, more and more often

connected to the Internet (smart connected products). Integration through the Web makes interactions between cars, cars and people and other components of the environment possible. In this system, the position of man is changing. From a direct user, man is becoming a supervisor.

In 1925, the American Wonder Chandler "self-driving car" for the first time drove through the streets of New York. Although it was not an autonomous car in the modern sense, it was a milestone in the transport revolution. Artificial Intelligence is the representation of the future, which has already become well established in the human world and is also represented in transport. Autonomous vehicles interpreting the situation on the road and making their own decisions according to the McKinsey Report will be available already in 2020 and will be fully rolled out in 2030. By revolutionising business models and supply chains, these cars are now available alongside drones, robots and remote-controlled ships and aircraft.

Much has changed since the first vehicle that can be considered an AV, the Van Mercedes, designed by the team of Ernst Dickmanns of the Bundeswehr University of Munich. Subsequent technological steps such as ABS, traction control, automatic parking and adaptive cruise control (autopilot function) have brought about an inevitable change in transport. Although the driver is still present behind the wheel of the car, autonomous technologies are already implemented in cars today, such as collision prevention systems, which, when detecting obstacles, decide to stop by themselves and systems allowing the vehicle to park itself, greatly facilitate the process of driving. Today, all major manufacturers offer cars equipped with such partial autonomous systems. In addition to the most recognised Tesla, they are also available in Mercedes, BMW, Porsche, Volvo, Toyota, Honda, Kia and Skoda.

Autonomous vehicles can operate through a combination of sensors, platforms, communication systems and road infrastructure support. Sensors (distance, sign recognition, line recognition sensors, etc.) allow machines to perceive the environment. With terrestrial systems (for example, *Vehicle to Infrastructure*) and satellite systems (*GPS, Galileo*) it is possible to retrieve information from sensors. Data exchange protocols (IEEE 802.11p, 4G LTE, Wi-Fi and Bluetooth) enable information transmission. On the other hand, computing and control platforms make it possible to process, interpret and control vehicles. The last component of the system is the road infrastructure monitoring and facilitating the exchange of information between vehicles.

A major step towards alienating the driver was taken in 2014 when Google showed for the first time a car that was devoid of typical attributes such as a steering wheel, pedals and a brake, which meant alienation of the driver. All major market players in both the sector with roots in the automotive industry and the sector of new technologies (Apple) are in favour of autonomous technologies. The spread of autonomous passenger and freight transport is becoming a reality. Autonomous buses, taxis and truck tractor transport are changing the optics of transport.

SAE International (formerly the Society of Automotive Engineers) in a document from 2016 which introduced a five-step classification of autonomous vehicles in accordance with the SAE J3016 standard. At level 0 there is no automation of driving. Decisions are made only by the driver. Level 1 indicates the driver's support. The car can automatically change its course and speed (adaptive cruise control, automatic parking). Level 2 features partial automation due to the combination of one or more driving assistance systems (independent acceleration, braking, steering control). The car is driven, however, by a human being. The next level 3 is conditional automation. Only in exceptional conditions does the driver

intervene in the process of moving the vehicle, and the rest is managed by the on-board computer. Level 4 means high automation. The on-board computer can take complete control of all aspects of driving (for example, motorways), even in difficult situations. Exceptionally, the driver can take control. The last level 5 is the highest level of advancement, that is, full automation. The computer controls all aspects of driving in all conditions. No interaction by the driver is needed here.

Currently, car manufacturers offer their customers cars mainly from the 2nd level of autonomy. Cars from levels 4 and 5 are now available in conceptual or prototype versions (for example, Audi Elaine and Aicon or Renault Symbioz). According to analysts working for the Boston Consulting Group, in 2025 the market value of such cars will reach 42 billion dollars. For this to be possible, it is necessary to establish legal regulations that consider the responsibility for accidents not only of drivers but also of control units.

The coexistence of people and the world of machines depends not only on technical possibilities, costs of technology implementation, legal regulations, but also on social acceptance and people's ability to coexist with technologies. According to the results of the PIAAC study on adult competencies conducted by the OECD, the most desirable skills will be text comprehension, mathematical reasoning and the use of information and communication technologies. The employee structure will be reconfigured. Many people will be forced to retrain. A unanimous idea is to follow the LLL (Long Life Learning) trend. The transformation of the education model will enable the acquisition of key competencies necessary in the new economic reality.

## 5. CONCLUSIONS

The level of technological advancement, directly influencing the implementation and diffusion of innovations, determines the level of competitiveness of the economy. New developments before their introductions had always evoke fear. After adaptation, they become a part of human existence without which it is impossible to imagine life. Although today we do not know how new technologies will affect the society of the future, many experts dealing with new technologies in the field of transport indicate that new technologies will support safety.

One thing is certain in the era of the ubiquitous use of the Internet and the digitisation of the business processes, the importance of modern ICT solutions in transport will undoubtedly grow. Remote transport management, autonomous vehicles as well as processes of robotisation, automation and the use of artificial intelligence methods in transport is not the future, it is the everyday life of transport companies. Furthermore, enterprises that do not acknowledge this trend will lose out because of the resultant lower business efficiency, while enterprises that skilfully use modern technical and technological solutions in transport management will gain the technological advantage and thus the competitive advantage in the demanding transport services market.

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