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THE CONCEPTS OF CONNECTED CAR AND INTERNET OF CARS AND THEIR IMPACT ON FUTURE PEOPLE MOBILITY

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Technological convergence has had a huge impact on development of automotive industry. Two main concepts related to mobile technology and the Internet of Things (IoT) in this industry are car connectivity and Internet of Cars (IoC). The article aims to present these two concepts with special emphasis on the characteristics of people mobility in future cities.

Keywords: automotive, logistics, information logistics, convergence, technological convergence, internet of things, internet of cars, connected car, car connectivity, mobility, public transport.

1. Introduction

The global economy, which is currently characterized by development of mobile and Internet technologies, is in large part composed of the services sector. A new paradigm appeared: information and communication technologies enable achievement of the economic and / or social objectives by use of cooperation methods (including sharing). ICT contribute to the acceleration of economic recovery and the creation of "sustainable digital future" [7].

This paper aims to achieve cognitive objective, which is to present the impact of technological developments in automotive industry (especially the concepts of car connectivity and Internet of Cars) on the development of new people mobility behaviour in cities. The author hypothesizes that technological convergence, present in currently-sold cars and cars of the future significantly contributes and will contribute to development of new patterns of mobility in cities. The main research method used in the study is analysis of secondary sources, including literature and branch studies made by experts in automotive industry.

The article is organized as follows. The first part concerns technological convergence phenomenon and its presence in everyday life of global society. The next one presents the main trends affecting the development of mobility of people in cities. The following chapter mentions the concepts of connected car and Internet of Cars as concepts representing technological convergence. The end of the article includes conclusions and further research guidelines.

2. Technological convergence

Megatrends are global phenomena that have been developing in the economy in 30-50 years and affect the strategies development of global corporations. They relate primarily to social issues that significantly determine changes in the structure and volume of demand. Among the most frequently described long-term trends in the global economy may be mentioned: digitization (increasing role of the Internet in shaping the business and social environment) and mobility (changes in the mobility of people and changes in the patterns of ownership). More and more practitioners and researchers investigate the phenomenon of Industry 4.0, which is characterized by, among others, more efficient use of resources and more flexible production of goods and services [5]. Disruptive technologies that will change the world in relation to the ubiquitous integration and convergence are e-mobility, autonomous vehicles and solar energy technologies.

Convergence is defined as the interoperability of new elements of reality, in particular interpenetration of telecommunication, multimedia and information technology [21]. It is also a phenomenon of becoming similar to each other by different technologies and equipment, which were originally performing a totally distinct roles, and now fulfill similar functions. Technological dimension of convergence is mainly based on digital communication, currently carried out by various media. Technological convergence also has other dimensions - allows to receive the same message or the same medium on various devices, desktop or mobile, at a time convenient for the customer (e.g. on demand videos). Therefore, not only the differences between different media are blurring, but also between devices enabling receiving data transfer. Convergence of media means that recipient of information can receive the same message many times, on many different media platforms and devices, which is called omnichannel transfer and results in creation of hyperspace also called hyper-reality. In the coming years, the convergence in the economy will result in [14]:

- growth of market domination of the Internet, which will become leading medium and a base for other media (mediatization of the Internet),
- increasing share of online communities in creation of successful businesses,
- increasing number of channels through which the sender of transfer reaches the recipient.

3. Trends in mobility in future cities

3.1. Future smart cities

According to data from the UN, population living in cities in 2050 is expected to reach 6.3 billion [24] - it will be almost twice more than in 2011. The number of mega cities is currently more than thirty and continues to grow. Growing cities in the coming four decades will absorb not only the whole world population growth, but also part of the existing rural population. Europe is one of the most urbanized continents in the world. Over 74% of the EU citizens live in urban areas, a proportion which is expected to grow to 80% by 2030 [6].

Smart cities are innovative areas supported by digital solutions. They are sustainable, digital or connected cities [11] providing high quality of life through use of intelligent transport systems (ITSs), green buildings and industrial control systems (ICSs). Key elements of these cities are information sharing systems[9] and use of new generation vehicles to improve mobility of habitants and guests with use of Internet of Things (IoT) concept[15]. Smart mobility means intelligent and safe transport with use of smart solutions and is connected with other "smart" categories – smart economy, smart environment, smart governance, smart living, smart society, smart city etc.

The most important challenge for future city will be mobility development according to sustainable development principles. This will include: energy-efficient and low-cost transportation systems, environment-friendly solutions (bicycles roads, pedestrian areas), dense network of suburban transport, many intermodal transportation hubs. Mobility infrastructure should be planned in long-term with taking into account future structure of urban society (e.g. aging society, fast-growing suburban areas etc.). In some regions, up to 80% of those working in the city, is living outside the city [24]. The rest of them also sometimes have to come to the city - they must bring their children to schools and commute to the city to use services like health, social or cultural services. Pointless is therefore planning urban mobility, without considering the mobility patterns of people living in suburban areas.

The main problem of cities is traffic congestion which will be reduced or eliminated in future smart cities. To solve these problems cities use park&ride

systems, pay zones or entrance prohibition in city centres and many others, but the most important motivator should be good public transportation system. Public transport should be more competitive to private car transport by providing available transport services, also between cities (a good solution can be high-speed train transport).

Today cities become network cities. They are growing fast, so locating a large number of people and businesses in a relatively small area creates significant management problems. Logistics of the city determines the further process of opening up cities to diffusion of innovation or functioning of cities in the network. In urban logistics all the activities should be taken into account that make up the living cycle of the city in an economic, social and cultural dimension.

A concept of Sustainable Urban Mobility Plans (SUMPs) appeared including transportation plans (SUTPs) for the future urban mobility. It takes into account current trends in mobility such as blurring contrast between individual and collective transport, needs for new mobility solutions, such as dynamic carsharing and ridesharing, collective taxis, peer-to-peer transport, hitchhiking, shared vehicles etc. [16]. That is why public and private transport should be redefined. Repositioning of urban transport systems will be possible only with use of ICT systems, for example social media, mobility platforms, Shared Mobility Centers offered in Business-to-Consumer (B2C), Business-to-Business (B2B), Business-to-Administration (B2A) and Consumer-to-Consumer (C2C) channels.

3.2. Automotive market changes related to mobility

There will be three main areas of change in the automotive industry: shifting markets and revenue pools, changes in mobility behavior and coopetition (cooperation mixed with competition) [23]. Mobility related conditions concern sharing economy, differences between urban and rural mobility, using autonomous and electric cars. City habitants will be more willing to buy electric, autonomous car and rent it when not using a car, for example in work hours, during nights and weekends. Sharing solutions will be popular model of ownership in cities, in contrast to rural areas, where traditional model of ownership will dominate. Generally 10% cars sold in 2030 will be shared vehicles and in 2050 – 30% (mostly in big cities) [23]. New services (MaaS – Mobility as a Service) will appear, as well as new mobility-driven business models. Automotive competitors will not only compete, but also cooperate in some areas like research and development or transportation and sales of products.

One of the areas of automotive development is the introduction of autonomous vehicles, which is forecasted to 2017, although most manufacturers declare the introduction of such cars to mass-market a few years later ("intelligent drive" concept) [22]. This includes semi-autonomous cars, because the fully-autonomous cars will be made available on the market in about 20 years. Their launching will trigger the biggest changes in the mobility of inhabitants of large cities, in which autonomous cars will dominate on roads in 35 years [4]. Systems based on autonomous vehicles have already been introduced on a small scale, e.g. in Singapore, Rotterdam, London.

Consequences that will arise from the spread of autonomous vehicles for urban mobility are:

- redistribution of routes, signs, lights, etc. - response to the same signals on the road will become uniform, the level of predictability of traffic participants behavior and also in adapting to the conditions on the road will increase,
- decrease in demand for professional drivers in the labor market - especially chauffeurs and taxi drivers, to a lesser extent on couriers and suppliers,
- reducing the visibility of social differences and improving the situation of people who cannot afford to have a car - poorer people will be able to use good and new cars without buying them.

The aforementioned MaaS exists mainly thanks to applications and Internet services offering car sharing and route optimization using different modes of transport. KPMG predicts that in the countries of the Triad (USA, Japan, Western Europe) 25% of the inhabitants of large cities in 2029 will use every day solutions for the optimization of routes within the city by using car rentals and the use of other means of transport [13]. Due to appearance of new services, new business models will be created, absorbed by OEM, IT enterprises, new market players and individual car owners. To the current business models will join the Mobility Service Provider and Basic Mobility Provider, offering a wide range of mobility services and accompanying services, e.g. insurance, mobile applications, catering services, entertainment, etc. [23].

3.3. Mobility changes in cities

In the age of ubiquitous networking and the Internet of Things mobility will be one of the main elements of human life, which can be seen also today, especially in large cities. First of all, a working model of urban residents will become more mobile. The growing demand for mobility and the differences between specific world regions in this respect (and between types of locality) were observed and predicted already by Schafer and Victor in 2000 [19]. In future cities differentiation of means of transport will be increasing (walking, cycling, air and others).

In this paper only one of the urban mobility modes was analyzed -terrestrial mobility and its relationship with the second dimension - virtual mobility, according to Kellerman's approach to mobility (see Table 1).

Dimensions that will affect the people’s choices will be the time and place. Mobile applications will enable ordering a car to a specific time from a particular user registered in the network - it can be an individual, a company or public transport service provider. People will be able to rent their car while not using it.

The car will become an additional source of income - also thanks to the trunk, which will become mobile parcel locker. A similar system has already been introduced in Ulm (Germany) and Shanghai (China) (car2go by Daimler) [13].

An interesting solution in urban transport is Flexible&Shared Use Mobility Centre concept proposed by Ambrosino et al. [4]. It presents intermodal transport systems as offering complementary services (B2C services, B2B services, real-time updates with use of mobile devices and applications, ITS services). The model is based mainly on virtual enterprises, service network, user groups and IT solutions [2].

Table 1. Chosen characteristics of terrestrial and virtual mobility

Feature	Terrestrial mobility	Virtual mobility
Ownership	infrastructure – mostly governmental vehicles – mostly private	infrastructure – mostly private vehicles – mostly private
Terminals	railway and bus stations, parking spaces	PCs, laptops, mobile devices (smartphones, smartwatches, tablets)
Channels	roads, rails	cables, wireless technologies: Bluetooth, Wi-fi etc.
Vehicles	yes (different kinds)	no
Availability	private – always, public – according to timetables	always
Impact on environment	very high and intensive	hardly noticeable
Choice	between public and private, between transport modes	between voice and written forms, between possible devices
Problems	low availability (e.g. changing modes in public transport) traffic congestion high cost of private transport	possible shortages or poor quality of internet connections make safety lower e.g. when using mobile devices while driving

Source: [12]

The main categories defining mobility in future cities will be: “shared”, “autonomous” and “electric” [18]. So future mobility should be characterized as mobility based on shared electric autonomous vehicles owned by different market actors (public or private). Mobility will be also connected with new generation of clients called “millennials” or “Y generation” presenting different approach to consumerism, using IT solutions, social media and ownership models as previous generations. Some of mentioned market actors will create so-called free-floating electric carsharing-fleets (an example is car2go)[8]. These solutions will be especially popular (based on private ownership) among elderly people (above 50 years old) [20]. It is expected that the percentage of urban population, who will use mobility solutions will reach in 2030 16-25% in the case of the Triad and Russia, and 6-15% in the case of China, India and Brazil [13].

4. Internet of Cars (Internet of Vehicles) and Connected Car

Now world is always connected. The use of smartphones by society gave rise to new needs for the purchase of mobile applications enabling the use of infotainment in vehicles, originally from practical reasons (checking the operability of routes, traffic jams, accidents, calculating routes, travel time, etc.). With time, they transformed to the needs of the entertainment, as passengers spend a lot of time in cars while commuting or at work (in case of professional drivers or sales representatives). At the same time, almost all car manufacturers began to install the equipment and applications linked with those on smartphones and tablets (dominating supplier in the early stage of development was Apple). However, over time, too many device-to-vehicle platforms were created and it was necessary to reduce the complexity in this area. Integration platforms for mobile applications were introduced linked to vehicles (eg. MySPIN offered by Bosch, capable of handling applications for Android and Apple's and integrated with Google Play and Apple App Store). Finally ready-made applications for automobiles began to be introduced, such as Apple's iOS in the Car.

Now these solutions are being developed. The share of electronic components in a car in 2030 should increase to 50%. Car is seen now as ultimate, final mobile device because of its telematics (telecommunications and informatics). BI Intelligence Report shows that connected car market is growing annually by 45% (2010-2015), 10 times more than the whole automotive sector. By 2020 75% of new sold cars will be connected [23]. The barriers of selling such cars now are: high price in comparison to not connected cars, still infant technology (although high level of development pace), low level of customer awareness.

Smart vehicles of the future will be able to communicate not only with navigation and broadcast satellites but also with passenger mobile devices, infrastructure elements and other smart vehicles, making them a crucial component of IoT and smart cities.

A connected car is a vehicle in which the user (driver and/or passengers) can access, download, consume, send and share information through vehicular communications systems, such as vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-broadband cloud (V2B, with monitoring data center), vehicle-to-human (V2H; with road users, pedestrians, bicycles), vehicle-to-sensor (V2S, with the sensors embedded in the environment).

New-generation vehicles are smart vehicles that represent technological convergence (the convergence of communications, infrastructure, computers and autonomy, resulting in new capabilities: sensing, navigation, sociability, context-awareness and communication). Based on that concept, smart vehicles are characterized by 5 features: self-driving, safety driving, social driving, electric vehicles and mobile applications.

There are two approaches to connected car hardware: [23]

- built-in – when hardware connectivity is installed in a vehicle (more expensive; user have to pay monthly fee for car producer, mostly it is 10-40 USD),
- brought-in – when car user plugs his/her device in a USB port in the car (less expensive – car user can use his/her library and applications installed on mobile device).

A car can be also connected to smart home and steer its activities while user is in the car. Still this area is in its infancy stage, but there are first solutions for connecting homes and vehicles, both with "built-in" and "brought-in" devices [10].

Although the infancy of car connectivity solutions, there are many existing mobility platforms providing possibilities for example for infrastructure search, infrastructure roaming, users communication, transportation service providers comparison etc. Most of the systems installed in cars allows control applications using voice technologies, also listening to mails, Facebook posts and dictating messages (for example Sync AppLink system).

Information systems installed in cars (In-vehicle Information Systems, IVIS) are divided into three categories (see Table 2):

- navigation systems,
- traffic and travel information systems,
- vehicle-to-vehicle and vehicle-to-infrastructure communication systems.

There are also other kinds of systems - Advanced Driver Assistance Systems, which help the driver to travel safely (see Table 3 and Table 4).

Table 2. Characteristics of IVIS systems

Kind of IVIS system	**Functions**	**Benefits**	**Possible barriers**
navigation systems	showing location showing of possible routes, their length (visual and voice) optionally showing traffic on the route (real-time traffic conditions) possible voice control possible remote controlplanning during the trip (mostly) or before	low costs dynamic routing turn-by-turn navigation automatic updates	overloading of functions overloading of steps to reach a goal to plan a routing
traffic and travel information systems	assist travellers in planning transport (private, public or mixed) pre-trip planning or on-route planning information about actual and future route characteristics (local, national, international) information about prices, fares, incidents, forecast, traffic, routes additional information: weather, hotels, restaurants, tourist points, other points	quick information about wanted object various object are stored in the database – complex information about a location/ city	driver distraction ocerloading of information about points in a city
vehicle-to-vehicle and vehicle-to-infrastructure communication systems	V2V: information about travel conditions, eg. fogs, icy roads, collisions, V2I: weather conditions, traffic jams, risky road parts	relevant information about routes is available for the driver safety on the road is higher	infancy of these solutions

In the last few years a concept of the Social Internet of Things (SIoT) appeared [3]. It is defined as a network of intelligent objects that have social interactions modeled on human networks. The Social Internet of Vehicles (SIoV) is an example of a SIoT where the objects are smart vehicles (mostly cars). The social connections can be made between vehicles, drivers and other users and between these two groups [1].

Table 3. Characteristics of ADAS – lateral and longitudinal control

Area	Solution/function	Description	Used tools, techniques
Lateral Control	Lane keeping and warning	correcting the track in case of deviation warning messages for the driver	connection to other systems like V2I
	Blind spot monitoring	information about overtaking vehicle or other objects like pedestrians	based on sensors installed in many car sides integrated with electronic rear view mirror
	Lane change and merge collision avoidance	control while changing lanes to avoid collisions	sensors in rear mirrors, one radar sensor – acoustic or visual information in case of danger
Longitudinal control	Intelligent Speed Adaptation (ISA)	control car speed external speed recommendation (based on V2I) or automated control system based on traffic information	static sensors measuring speed (located on infrastructure elements like traffic lights) control based on GPS control based on regional center transmitting data to vehicles in sightings
	Adaptive Cruise Control (ACC)	controlling safety distance on the road no reaction for stationary objects	automatic braking systems visual output with distance parameters
	ACC+ Curve Management	ACC enhanced by reducing the speed during approaching a curve	electronic devices connected to electronic maps (ADAS maps)
	Curve warning	warning if the driver is approaching the curve too fast	based on maps, weather conditions etc. – visual and acustic warning
	Collision warning and avoiding systems	warning messages and/or automatic braking intervention V2V communication about parameters	sensors measuring the distance and speed of analyzed objects – lasers and microwave radars front-end sensors rear-end transponders
	Intersection collision avoidance	information about potential intersection collision	cameras in the front of the car able to see other cars being 20-40 m away short range V2V communication system
	Stop&Go	keeping distance at speeds <70 km/h good for urban habitants (used in not-free flowing traffic) emergency braking traffic lights controlling can be semi-autonomous or fully	sensors in the front of vehicle V2I applications
	Obstacle detection	warning about collision of detected object (e.g. pedestrians) and predicted vehicle path	onboard sensors infrastructure-based sensors identification tags held by objects

Table 4. Characteristics of ADAS – other solutions

Area	Solution/function	Description	Used tools, techniques
Reversing aids/Parking aids		used at low speeds short-range obstacle detection and tracking	cameras visual system acoustic system
Vision enhancement		driving support systems in difficult conditions (while reduced visibility of the road)	ultraviolet light headlamps near infra-red illuminator far infrared sensor (making thermal maps) visual pictures presented to the driver
Driver monitoring	Driver standard monitoring	monitoring of driver's physiological status, eg. eye movements, heart rate warnings about impairments connected with eg. stress, alcohol abuse, inattention	different tools, including sensors
	Driver vigilance monitoring	detection, diagnostics and decision making or warning fusing data from several sources	different tools, including sensors
Pre-crash systems	standard	detecting unavoidable accident and activation of onboard vehicle restraint system	sensors, air bags, seat belts, other additional systems
	smart restraints	imposing and distributing the energy during a crash pre-crash detection maximum protection of passengers	accelerometers, proximity radar sensors, inner space monitoring tools: weight sensors, video detectors, prioritizing techniques, video sensors

Nitti et al. [17] describe a vehicular social network as social interactions among cars, which communicate autonomously to look for services and exchange information about traffic. Given that vehicles every year are more autonomous and these applications supporting social interactions among drivers and passengers are being developed, SIoV is possible network for the future. It will generate some new capabilities, opportunities, challenges, threats, barriers. It is obvious that SIoV will create new mobility possibilities, changes in mobility behaviors, patterns etc. mostly in cities, which will absorb new solutions very quickly. Nevertheless, despite the fact that this concept is very young, some products for SIoV are available on the market, for example RoadSpeak, NaviTweet, Caravan Track.

5. Conclusions

Technological convergence is ubiquitous and its course cannot be reversed, as well as technological innovation, in which automotive industry has always been a leader. Undoubtedly, these changes will create new opportunities for car users, and the needs in this field are largest in the cities, where congestion, lack of parking spaces and crowd can be observed. Therefore, cities need new solutions for mobility, in order to deal with the problem of growing number of residents, suburbs and rearrangement from the hierarchical to the network model.

Concepts of Internet of Cars and car connectivity contribute significantly to solve these problems, supported by the new model of shared, autonomous and environment-friendly electric vehicle. Communication between cars and their users will solve partially the problems of congestion, however, the responsibility of the authorities will remain a competitive public transport system in which implementation of both these concepts would be definitely beneficial. In addition, achievements of the automotive industry should be used in public transport system to implement also shared cars, as possible new means of transport, which could be used in accordance with the new car sharing, hitchhiking and ridesharing models.

The material collected in the article is the starting point for empirical research on development of new patterns of urban mobility, new business models, as well as development of methods and tools used in urban public transport.

REFERENCES

[1] Alam K.M., Saini M., El Saddik A.E. (2015) *Toward social internet of vehicles: Concept, architecture, and applications*, IEEE Access, Vol. 3, 343–357.

[2] Ambrosino G., Nelson J.D., Boero M., Pettinelli I. (2016) *Enabling intermodal urban transport through complementary services: From Flexible Mobility Services to the Shared Use Mobility Agency*, Research in Transportation Economics, 6 October 2016 (in press)

[3] Atzori L., Iera A., Morabito G., Nitti M. (2012) *The Social Internet of Things (SIoT)—When social networks meet the internet of things: Concept, architecture and network characterization*, Computer Networks, Vol. 56, 3594–3608.

[4] *Autonomes Fahren durch selbstfahrende Autos* (2016), https://www.bussgeldkatalog.org/autonomes-fahren/

[5] *Die digitale Transformation der Industrie. Analysen zur Studie* (2015), BDI, Roland Berger Strategy Consultants, http://bdi.eu/media/user_upload/Digitale_Transformation.pdf

[6] EEA (2013), *A closer look at urban transport e TERM 2013: Transport indicators tracking progress towards environmental targets in Europe*. EEA Report No. 11/2013. Copenhagen: EEA.

[7] *Europejska agenda cyfrowa: kluczowe inicjatywy, MEMO/10/200* (2010) http://europa.eu/rapid/press-release_MEMO-10-200_pl.htm

[8] Firnkorn J., Muller M. (2015) *Free-floating electric carsharing-fleets in smart cities: The dawning of a post-private car era in urban environments?* Environmental Science&Policy Vol. 45, 30-40

[9] Hollands R.G. (2008) *Will the real smart city please stand up? Intelligent, progressive or entrepreneurial?* City, Vol. 12, 303–320.

[10] Hong J., Shin J., Lee D. (2016) *Strategic management of next-generation connected life: Focusing on smart key and car–home connectivity*, Technological Forecasting & Social Change, Vol. 103, 11–20

[11] Ishida T. Isbister K. (2000) *Digital Cities: Technologies, Experiences, and Future Perspectives*. Number 1765. Springer Science & Business Media, Berlin, Germany.

[12] Kellerman A.(2011) *Mobility or mobilities: Terrestrial, virtual and aerial categories or entities?*, Journal of Transport Geography, No. 19, 729–737

[13] *KPMG's Global Automotive Executive Survey 2014 Strategies for a fast-evolving market* (2016) KPMG International Cooperative, kpmg.com/automotive,

[14] Lakomy M (2010) *Strategie mediów tradycyjnych w perspektywie konwergencji* , „Nowe Media", Wyd. UMK, Toruń, Poland, 85 – 97

[15] Maglaras L.A., Al-Bayatti A.H., He Y., Wagner I., Janicke H. (2016) *Social Internet of Vehicles for Smart Cities*, Journal of Sensor and Actuator Networks, Vol. 5, No. 3.; 1-6

[16] Nelson S.P. (2009) *Challenges and Technologies: The human friendly vehicle in 2030 and beyond*. Freescale Semiconductor, Inc. http://www.freescale.com/files/training_pdf/

[17] Nitti M., Girau R., Floris A, Atzori, L. (2014) *On adding the social dimension to the internet of vehicles:Friendship and middleware*. Proceedings of the 2014 IEEE International Black Sea Conference on Communications and Networking (BlackSeaCom), Odessa, Ukraine, 27–30 May 2014, 134–138.

[18] Phillips A. M., McGee R.A., Kristinsson J. G., Hai Y. (2013) *Smart, connected and electric. The future of the automobile.* Mechanical Engineering, Vol. 135, Issue 3, Special section, 4-9

[19] Röhrleef M., Deutsch V., Ackermann T. (2015) *Zukunftsszenarien autonomer Fahrzeuge. Chancen und Risiken für Verkehrsunternehmen*, Positionspapier/November 2015, Verband Deutscher Verkehrsunternehmen e. V. (VDV), Köln, Germany

[20] Sha W., Kwak D., Nath B., Iftode L. (2013) S*ocial vehicle navigation: Integrating shared driving experience into vehicle navigation*. Proceedings of the 14thWorkshop on Mobile Computing Systems and Applications, Jekyll Island, GA, USA.

[21] Szmelter A. (2015) *Communication in global supply chains in automotive industry*, Information Systems in Management, Vol. 4, No. 3, 205-218

[22] Szmelter A. (2015) *Wpływ konwergencji mediów na komunikację w korporacjach globalnych*, Kopecka-Piech K. (ed.) Zmiany medialne i komunikacyjne : media, wizerunek, biznes. Seria: Współczesne Transgresje, t. 2, Wydawnictwo Naukowe Katedra, Gdańsk, 131-166.

[23] Szmelter A., Woźniak H. (2016) *New mobility behaviors and their impact on the creation of new business models*, Toruń Business Review 2016, Vol. 15, No. 2, 71-83

[24] *The Connected Automobile Nears Critical Mass* (2015) Trends Magazine. Apr2015, Issue 144, 31-35.

[25] UN, *World Urbanization Prospects* (2014) https://esa.un.org/unpd/wup/Publications/Files/WUP2014-Highlights.pdf