Udvari B. – Voszka É. (eds) 2019: Proceedings of the 3rd Central European PhD Workshop on Economic Policy and Crisis Management. University of Szeged, Doctoral School in Economics, Szeged, pp. 138–154.

A Policy Perspective on the Future of Mobility and Regional Competitiveness

Bence Zuti

The presence of developed regional transport and telecommunication infrastructure is considered a factor that can directly or indirectly contribute to regional competitiveness, especially in the age of digitalization. Through this phenomenon, we embrace a world that is becoming more connected and complex than ever. With the new technological innovations and solutions becoming available, more advanced levels of mobility can be achieved: concepts of smart urban mobility and autonomous transportation systems are becoming a reality. These rapid changes require swift action both from the perspectives of society and economy. This action includes the re-examination of our currently effective policies, with the use of a multidisciplinary mindset considering the perspectives of policymakers, manufacturers, and consumers as well.

The goal of the paper is twofold: First, to explore why the concept of regional competitiveness is more relevant in the digital age and second, to explore how EU policies are nudging towards the future spread of self-driving cars; potential enhancers of regional competitiveness.

Keywords: regional competitiveness, digitalization, regional mobility, EU policy

1. Introduction

As the transition to the next stage of globalization and the phenomenon of digitalization continues, we are experiencing worldwide changes that affect our economies and the foundations of society itself. As a result of globalization, we are able to exchange knowledge and participate in value creation on a global scale. Data and information are the fuel in the engine we commonly refer to as digitalization. With novel technological solutions, we can reach more people at a much lower cost. This results in higher data flows and the accessibility of data, knowledge and ideas is increasing (Brynjolfsson–McAfee 2012, Manyika et al. 2016, EC 2017a).

There is also a notable transition in how global processes and flows of society and economy work and contribute to our everyday lives. As we aim towards the establishment of knowledge- and innovation-based societies, the emphasis on physical goods is declining relatively. Tangible flows of physical goods remain significant as well, but intangible flows like the generation and analysis of knowledge, data, and information are becoming far more crucial, as these inputs can boost economies exponentially (Leonhard 2016, Magruk 2016, Schwab 2017). Networks are becoming more intensely complex, and meanwhile connections between academia, industry, governments, environment and society are denser than ever (Dujin et al. 2014, Lee–Vivarelli 2006, Schwab 2017).

We are living in an environment with an abundance of smart devices and people who are constantly online and connected to the Internet. We can definitely state that our presence as an individual or as an organization has both physical and digital aspects and components (Manyika et al. 2016, Schwab 2017, Yoon 2017).

This incremental increase of complexity and density is due to the fact that through digitalization, emerging economies and even individuals can be notable contributors to global economic flows (Manyika et al. 2016, WEF 2017). Building on this idea, the role of a national economy is decreasing relative to sub-national aspects of the economy and society, as the region or city gains more emphasis (Lengyel 2010).

Digitalization brings us opportunities and great challenges as well in an environment characterized by radical change. It is contradictory but true that the challenges emerging due to the spread of technology can be only solved by applying novel solutions provided by technology itself (Room et al. 2018, WEF 2017). Currently it seems that there is no turning back from digitalization. The digital environment that supports the global economy and society in general is constantly evolving, and it acts as the main trigger of innovation, transformation and disruption (OECD 2017, Piccinini et al. 2016, WEF 2016a).

There is also a need for change in our mindsets, as digitalization requires a truly multidisciplinary approach. Academia, the government and also businesses need to take part in this mindset change, so we can increase our digital literacy and digital capabilities, harness digital assets, mitigate digital risks (Dean et al. 2012, GSMA 2017).

Digitalization can be seen as a catalyst of creative destruction, as is affects all industries and directly alters every single aspect of our everyday lives, from social, economic and environmental aspects as well. One significant and radical innovation in the era of digitalization are self-driving cars. Through this, the way we think about mobility and the core concept of transportation needs to be reconsidered.

Self-driving cars promise to be efficient and integral parts of our society and the global economy. According to existing preliminary studies, the introduction of this new method of transport will enable savings of billions of dollars by significantly decreasing the cost of labor, fuel, time, reducing congestion and the number of accidents (Lukovics et al. 2018, Montgomery 2018, WEF–BCG 2018, Groshen et al. 2018, CGPS 2017).

Self-driving cars not only affect regional competitiveness but are also affected by policies as well, hence it is necessary to explore both sides to reach a full understanding of the topic. Due to the significant differences in how societies perceive self-driving cars, conditions for the use or testing of these vehicles could vary from region to region (Lukovics et al. 2018).

The pace of change in the digital world is fast, and those who delay, stand to lose their competitive edge. This is why in this significantly digitally-driven environment it is first required that we re-evaluate how regional competitiveness is interpreted. The next chapter will focus on the fundamentals, core ideas and a possible recontextualization of competitiveness.

2. The Relevance of Competitiveness in the 21st Century

The logical arc of regional competitiveness naturally evolved in the previous decades and with digitalization it is necessary to rethink how we interpret this key concept of economics. Rivalry and broadly interpreted competition has always been a part of human society. The most fundamental categorization of this rivalry can be expressed as follows (Lengyel 2010, p. 100, Batey–Friedrich 2000, p. 4):

- Rivalry among living organisms for food, a place to live and the assurance of biological reproduction
- Social groups (e. g. communities, political parties, religions) compete with each other for authority
- Economic units also compete in order to acquire economic increment.

Indeed, the word competition, from a purely economic perspective can be only interpreted assuming the latter category (Lengyel 2010). The competition among economic units can be further divided into three subcategories (Lengyel 2010, p. 100, Siebert 2000, p. 3):

- The most talented individuals compete to get hired by the best companies
- Firms compete for resources, market share and profit
- Territorial units (e. g. cities, regions, nations) compete with each other in order to provide high levels of wellbeing for those who live there.

The interpretations of regional competitiveness can be grouped into two main categories (Huggins et al 2014a, Huggins et al 2014b). Through the interpretation of the first group, competitiveness cannot be defined in the case of territorial units, it can be recognized only in the case of enterprises (Polenske 2004, Dicken 2003, Krugman 1998, Krugman 1994). For those who agree with this statement, competitiveness is only discussed on a microeconomic level (Lengyel 2010). Through the interpretation of the second group, competitiveness is a valid definition related to territorial units as well (Porter 2008, Dahlman 2007, Chesire 2003, Camagni 2002, Malecki 2002, Lengyel–Rechnitzer 2004, Markusen 1996, Porter 1996). The popularity of the latter concept has risen thanks to the fact that by globalization, nations, regions, cities also compete on a global level for resources, capital or talent, as enterprises do. This latter group claims that competitiveness can be interpreted on micro- and macroeconomic levels as well (Lengyel 2010, Martin 2003).

Capello (2009) states that economic activity is present in a diverse way in space, as the necessary resources are scattered unevenly throughout the globe. Some resources are available, some are non-existent based on their geographical location, hence some regions can harness the advantages, while others may experience disadvantages due to the availability and scarcity of factors. This imbalance affects the economic potential of a territorial unit, the levels of attainable well-being and also the fundamental mechanisms of economic systems. From yet another aspect, the presence and exogenous (e. g. presence of companies that attract workforce, local practical implementation of innovative solutions, installation and accessibility of infrastructures) and endogenous (e. g. processes supporting innovation, the ability to adapt, the potential for knowledge creation, the professional preparedness of experts) elements that are able to catalyse the economic activities carried out in a region (Capello 2009). According to Capello (2009) the potential for economic development also relies on factors like human capital, social fixed capital and accessibility. Camagni (2009) builds on this concept and highlights the significance of territorial capital, which regions and cities should address as well when it comes to enhancing competitiveness. From this perspective, territorial capital can be built up by the following elements (Camagni 2009, p. 123):

- Public goods and resources
- Intermediate, mixed-rivalry tangible goods

- Private fixed capital and toll goods
- Social capital
- Relational capital
- Human capital
- Agglomeration economies, connectivity and receptivity
- Cooperation networks
- Relational private services.

In an era of digitalization, especially the endogenous elements of a region can become more valuable, in the case of knowledge-based societies and smart economies. The researches that relate closely to competitiveness cover a broad spectrum, and in terms of defining competitiveness, the scale is also wide, as there are numerous ways to define competitiveness. The standard definition is the following: "*competitiveness is defined as the ability of a region to generate, while being exposed to external competition, relatively high income and employment levels. In other words, for a region to be competitive, it is important to ensure both quality and quantity of jobs*" (EC 1999, p. 75). We can find other definitions as well, like "*regional competitiveness is the ability of a region to offer an attractive and sustainable environment for firms and residents to live and work*" (Annoni et al. 2017, p. 2). The WEF (2016b, p. 4) defines competitiveness in the following way: "*competitiveness as the set of institutions, policies, and factors that determine the level of productivity of an economy, which in turn sets the level of prosperity that the country can achieve*". The definitions cited above focus on four key elements, which are productivity, high levels of income, employment, the presence of attractive economic and social environment. These elements have much deeper context; however, it is crucial to emphasize a key point, namely that competitiveness is made up from a set of deeply interconnected dimensions of hard and soft factors (Huggins et al. 2014a, Huggins et al. 2014b, Lengyel–Rechnitzer 2013).

In connection with research related to competitiveness, we have reached a significant milestone. As it is clear that digitalization has a growing effect on economies and societies, it was only a matter of time for competitiveness as a concept to be explored from a digital point of view. The IMD embedded competitiveness in a digital context and came up with a definition of digital competitiveness, described as follows (IMD 2017, p. 19): "*digital competitiveness is defined as the capacity of an economy to adopt and explore digital technologies leading to the transformation in government practices, business models and society in general. In this way, firms increase the opportunities to strengthen future value creation*".

Table 1 represents the three main components, overall 9 sub-components and indicators that make up digital competitiveness (IMD 2017, p. 21). This re-evaluation focuses on the significance of adaptation in a world of constant change. Also, it addresses the significance of the ability to harness the potential in digital technologies. Compared to the traditional definitions, we can see that this digital competitiveness definition builds upon the original key elements like productivity, income and a supportive environment, with digital technologies acting as the foundations of potential economic and social development. The drivers of competitiveness become success factors inserted in a digital framework, hence there is a shift in the basic point of view. As a further expansion of the traditional competitiveness definitions, digital competitiveness also lists indicators that

can be directly tied to concepts like gender equality, internationalization or even legal aspects.

Table 1 Overall Structure of Digital Competitiveness

Knowledge		
Talent	Training and education	Scientific concentration
Educational assessments, International experience, Foreign highly-skilled personnel, Management of cities, Digital/Technological skills, Net flow of international students.	Employee training, Total public expenditure on education, Pupil-teacher ratio in tertiary education, Graduates in Sciences, Women with degrees.	Total expenditure on R&D (%), Total R&D personnel per capita, Female researchers, Scientific and technical employment, High-tech patent grants.
Technology		
Regulatory framework	Capital	Technological framework
Starting a business, Enforcing contracts, Immigration laws, Technological regulation, Scientific research legislation, Intellectual property rights.	IT & media stock market capitalization, Funding for technological development, Banking and financial services, Investment risk, Venture capital, Investment in telecommunications.	Communications technology, Mobile broadband subscribers, Wireless broadband, Internet users, Internet bandwidth speed, High-tech exports (%).
Future readiness		
Adaptive attitudes	Business agility	IT integration
E-Participation, Internet retailing, Tablet possession, Smartphone possession, Attitudes toward globalization.	Opportunities and threats, Innovative firms, Agility of companies, Use of big data services, Knowledge transfer.	E-Government, Public-private partnerships, Cyber security, Software piracy.

Source: own construction based on IMD (2017, p. 21)

The knowledge component can be divided into three sub-components, which are: talent, training and education, and scientific concentration. Digital transformation greatly builds on the availability of knowledge and how it is implemented in practical solutions. Proper education and digital literacy also affect how endeavors towards digital transformation are accomplished. Scientific concentration describes the structures and investment levels present that enable the creation and dissemination of knowledge (IMD 2017).

The technology component is made up of the following three sub-components: regulatory framework, capital, and technological framework. A well-established legal environment, the presence of supportive institutions can all act as drivers of innovative change. Capital flows and the quality of technology-related physical infrastructures can all account for the spread of digital technologies (IMD 2017).

The future readiness component comprises three sub-components, namely: adaptive attitudes, business agility, and IT concentration. The future readiness component explores, the opinions, attitudes and behaviors that relate to digitalization and also measures resilience and how well digital solutions are used (IMD 2017).

If we thoroughly examine the indicators and components of digital competitiveness, we can identify that most of them can be directly or indirectly related to self-driving cars, as one of the novelties of the digital age. It is also an accepted concept that regional transport systems and advanced mobility solutions can contribute to the effective operation of regions and cities (Camagni 2009, Capello 2009, Kiel et al 2014, Lengyel 2010). As mobility and transport solutions contribute to the flow of human and physical capital, they influence the level of competitiveness (EC 2017b). In the next chapter, the opportunities and challenges of future mobility will be in focus from the perspective of digitalization.

By exploring the fundamentals and the development of regional competitiveness it is clear that mobility is a key enhancing factor in this framework. The next chapter focuses specifically on how mobility can influence regional competitiveness.

3. Mobility in the Digital Age

The transportation and logistics sectors face radical changes ahead as a result of the spread of digital technologies. Smart and autonomous solutions are being researched and developed in order to maximize the potential in the automotive industry (Foulser 2017, Thorpe–Motwani 2017). The subject is important, as mobility is a foundational part of both rural and urban territorial units, and it is an enabler of access to resources and destinations (Piccinini et al. 2016). The main challenges that the deployment of smart and autonomous mobility solutions need to address are the following (Benevolo et al. 2016, p. 15–16, Lang et al. 2016, Lang et al. 2017, Piccinini et al. 2016, UN 2016):

- reducing pollution,
- reducing traffic congestion,
- increasing road and personal safety,
- reducing noise pollution,
- availability of public city space,
- increasing access,
- improving transfer speed,
- offering better, safer and more reliable services,
- secure collection and management of data,
- reducing transfer costs.

Tackling these potential challenges will have great benefits for society and individuals as well. One of the potential solutions to tackling the above challenges lies in autonomous vehicles. These vehicles are agile assets that are able to collect data on their physical and digital surroundings via sensor technology and connectivity solutions, furthermore based on the level of automatization, some vehicles will be capable of engaging in transport as an integral and secure element of mobility without any human intervention (ITF 2015, SMMT 2017a, SMMT 2017b, Yeomans 2014). The US-based Society of Automotive Engineers (SAE) defines six separate levels of automation (Table 2).

The list starts with no automation, where the human driver is responsible for all aspects of driving tasks. The highest level of automation means that the vehicle is fully capable of operating all driving tasks without any human action necessary. In its most valid meaning, autonomous cars are vehicles in possession of Level 5 autonomy based on the SAE classification.

Table 2 Levels of Automation defined by SAE International

Level	Name	Definition
Human driver monitors the driving environment		
0	No Automation	The full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems.
1	Driver Assistance	The driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver performs all remaining aspects of the dynamic driving task
2	Partial Automation	The driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver performs all remaining aspects of the dynamic driving task.
Automated driving system monitors the driving environment		
3	Conditional Automation	The driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene.
4	High Automation	The driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene
5	Full Automation	The full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver.

Source: own construction based on SAE (2014, p. 2)

The support of efficient and accessible transportation infrastructures is crucial in order to maintain a vital economy and society (Lang et al. 2017). As stated by Litman (2017), the overall goal is the potential increase of accessibility in mainly urban areas. Accessibility can be explained as "*the ease of reaching goods, services, activities and destinations, which together are called opportunities. It can be defined as the potential for interaction and exchange*" (Litman 2017, p. 6).

Jeekel (2017) highlights that mobility is a multidimensional concept built up by three core elements. Firstly, vehicle technology solutions are at the center of travel and transportation. Secondly, intelligent communication systems are responsible for the seamless and real-time flow of data which is analyzed and utilized in traffic situations effectively. Thirdly, business models provide the framework of mobility. The efficiency and success of the business model is dependent on the dominant consumer behaviors of a given territorial unit.

The existing transportation paradigm is shifting from the individual ownership and possession of products towards considering mobility as a service (MaaS) (Foulser 2017, Goodall et al. 2017). The MaaS paradigm identifies three key stakeholders (Foulser 2017, p. 8):

- Customers: They are integral and essential in transport systems and are mainly driven by user experience.

- Mobility services providers and operators: They are the companies or authorities who operate and maintain services. Companies tend to put emphasis on their financial returns, while authorities focus on the establishment of cost-efficient and widely accessible solutions.
- Authorities: They are actors who are empowered to intervene in the transportation system though legal actions and have regulatory supervision.

As the new era of mobility rapidly approaches, similar haste is necessary in the revision and redesign of policies so that the regulatory frameworks remain fully viable in a more and more digital economy and society.

Besides the identified advantages of the introduction of self-driving cars, Lukovics et al. (2018) identified a number of risks that can be directly connected to this radical innovation. Due to this, regulations are also undergoing change and also determine the main approach towards self-driving cars.

The next chapter focuses on the initiatives driven by the EU which aim at the reformation of regulatory frameworks to enhance the positive effects of digitalization.

4. Policy Perspectives related to Autonomous Vehicle Technologies and Digitalization in the EU

There is growing interest in investing in technologies related to autonomous vehicles. This solution in mobility can bring a radical change from an economic and social perspective as well. While the ongoing research progresses in quick fashion, the related policies also need to be redesigned and updated within a short timeframe. Policymakers, regulators and experts in the related industries need to take a future-oriented, proactive and practical approach so the effective policies can act as enablers of new technology (Raposo et al. 2017, ETSC 2016, Frisoni et al. 2016, Yeomans 2014).

As a result of the introduction of autonomous vehicles, the future of driving and mobility overall is expected be notably different from what we know today. The appearance of these self-driving vehicles will bring a revolutionary change in how we relocate ourselves, and policies should also need to change and develop in order to minimize the effect of unfavorable risks, and to maximize the potential inherent in this technology. The regulatory frameworks will also need to be revised (Raposo et al. 2017).

There are a number of currently existing and applicable legal regulations in the EU that can be connected with driving (Raposo et al. 2017, p. 7–8):

- Geneva Convention on Road Traffic 1949
- Vienna Convention on international road traffic 1968
- Directive 2006/126/EC on driving license
- Directive 2003/59/EC on training and initial qualifications of professional drivers
- Directive 2009/103/EC on motor insurance
- Directive 85/374/EEC on product liability
- Directive 2007/46/EC on vehicle approval
- Directive 2014/45/EU on roadworthiness
- ITS Directive 2010/40/EU
- Directive 95/46/EC on data protection
- Directive 2002/58/EC on privacy in electronic communications

- Directive 2008/96/EC on infrastructure safety management
- UN Regulation No. 116 on anti-theft devices
- UN Regulation No. 79 for steering equipment
- UN Regulation No. 131 laying down the technical requirements for the approval of Advanced Emergency Braking Systems (AEBS) fitted on trucks and coaches
- Declaration of Amsterdam
- C-ITS communication.

From the above listed regulations, the most significant from the perspective of autonomous cars are the Declaration of Amsterdam and the C-ITS communications. Also related to autonomous cars, the C-ART, and from the perspective of the whole digital economy and society, the GDPR initiatives should be addressed.

4.1 Declaration of Amsterdam

The Declaration of Amsterdam instantly acknowledges that the changes coming in the next decades to the automotive industry and mobility will be more radical than the changes happening in the last century. The aim is to enhance the economic potential of the EU by improving traffic flows, road safety, environmental performance (zero-emissions mobility) and efficiency in the transportation sector overall. Besides the economic benefits, the document highlights potential benefits that can be harnessed by society as well. Here the goal is to enhance social inclusion, develop accessible mobility services both in rural and urban regions and spread the concept of mobility as a service (MaaS) (DoA 2016). The Declaration of Amsterdam envisions five key shared objectives (DoA 2016, p. 5):

- The establishment of a coherent European framework that supports the deployment of interoperable connected and automated driving, with a projected completion by 2019,
- Collect innovations and developments in the broadest available perspective so connected and automated vehicle technology can reach their full potential and there is also a focus on mitigation of identified risks,
- The adaptation of a cross-border, experience-focused approach that supports the dissemination of knowledge in the topic,
- The support of innovation activities related to connected and autonomous technologies, while strengthening the position of EU industry;
- The establishment of frameworks that assure data flows are handled in a secure way.

The five shared objectives above are supported by a joint agenda which emphasizes that stakeholders within the EU have a crucial role in promoting the initiatives related to the future deployment of autonomous vehicles. The presence of a transparent legal framework, proper data protection, engagement in international projects, raising customer awareness and the deployment of convenient infrastructure are all matters that need to be addressed in the joint agenda. Besides the potential advantages, the economic and social challenges also need to be identified on the broadest spectrum (e. g. security, ethics, data usage, liability, legal aspects) possible (DoA 2016).

4.2 C-ITS

The report is a summary on the deployment of Cooperative Intelligent Transport Systems (C-ITS), which supports cooperative, connected and automated mobility throughout the EU (C-ITS 2017).

The document lists four main recommendations from a legal and organizational perspective that would promote visions of a new phase in mobility (C-ITS 2017, p. 10):

- It is necessary to build a legal and technical framework in the EU that acts as a foundational structure when it comes to the deployment of self-driving cars in the EU.
- The EU needs to take proactive and future-oriented actions, so the deployment of autonomous vehicles can occur in a relatively short timeframe. This mindset is necessary in a fast-paced digital environment and in a world characterized by radical changes. It is crucial that all new services and solutions related to mobility have backwards compatibility. This means new technology is compatible with already existing technology, frameworks or infrastructures.
- The first set of standards and profiles related to future mobility technologies need to be defined by the second half of 2018.
- Common definitions that will be utilized in future work and autonomous vehicle projects should be clearly determined, mainly in the areas of compliance assessment, privacy and data protection and security.

If we compare the C-ITS recommendations with the shared objectives of the Declaration of Amsterdam, we can highlight a few similarities. Both documents emphasize the need of a firm and unified legal and technical framework to be created in a short timeframe. Furthermore, both promote the need for investments and R&D&I activities related to autonomous vehicles. Finally, questions and measures regarding privacy and data security have a central role.

4.3 C-ART

The C-ART (Coordinated Automated Road Transport) document acknowledges the potentially radical changes lying ahead of us due to future deployment of autonomous vehicles in the EU. In the case of this deployment being completed, it will have huge economic and social impacts and a great number of challenges will need to be addressed. The study explores future-oriented approaches so autonomous vehicles can be deployed to their fullest potential, EU-wide (Raposo et al. 2017). The authors of the C-ART document identify three pillars that require attention when it comes to the introduction of autonomous vehicle in practice: technology, legislation and users (Raposo et al. 2017).

Building on this idea, seven fields are emphasized, where the EU will need to take firm action in order to answer the open questions, address the challenges presented, so the potential of autonomous technology can be maximized (Raposo et al. 2017, p. 95–96):

- Technology-related open questions (e.g. What operational issues may arise? Would the deployment of autonomous vehicles be feasible and sustainable by car manufacturers?
- Infrastructure-related open questions (e.g. Should related infrastructure be able to monitor and control traffic as well?)
- Human-factors-related open questions (e.g. How will the mix of autonomous and non-autonomous vehicles in traffic be managed? What is the opinion of the public on autonomous vehicle technology? Will the operation of autonomous vehicles require some sort of training?)
- Data-related open questions (What data is required for the smooth operation of autonomous vehicles? How will data flows be managed?)
- Ethics-related open questions (What ethical dilemmas may arise related to autonomous vehicles?)
- Insurance and liability-related open questions (Who is accountable for potential damage?)
- Political and legal open questions (Who is accountable when an accident happens?)

It is obvious that these are crucial questions and challenges that need to be answered so that the potential risks in autonomous technology can be minimized.

4.4 GDPR

On 25 May 2018 the EU's General Data Protection Regulation (GDPR) will go live, replacing the currently effective Data Protection Directive (Directive 95/46/EC). The new GDPR framework is a redesign of how data will be handled EU-wide. The GDPR was adopted in April 2016 and the aim of the regulation is to strengthen individual personal data protection rights within the EU (EC 2018). The GDPR is unambiguously a risk and data management framework designed for the age of technology and digitalization (Room et al. 2018). Though this regulation does not address autonomous vehicle technology relations directly, the document will be the foundation of the manner in which data is handled in the digital economy EU-wide.

Why is it necessary to introduce a new framework aimed towards strengthening data protection of individuals, companies and organizations? It is necessary due to the fact that data is becoming a truly valuable asset in the digital economy (Bughin et al. 2016, EC 2018, Rose et al. 2013). From a company perspective, a general set of transparent rules will be introduced so personal data is stored in a secure and authentic way. From an individual's perspective, they will be more empowered to control how personal and private data is handled by institutions (EC 2018).

As summarized by the GDPR communication, the core elements of the new data protection framework are the following (EC 2018, p. 2–4):

- A harmonized legal framework leading to a uniform application of rules to the benefit of the EU digital single market: The design of the framework and the establishment of data protection laws are fundamental steps, as in economies and societies strongly driven by digitalization the assurance of personal data protection is a crucial safety element (Room et al. 2018),

- A level-playing field for all companies operating in the EU market: Companies based in or outside the EU fall under the same regulations, in case the goods offered, or services provided relate to an EU individual. Concerned entities will need to reevaluate how they use technology and data (EC 2018, Room et al. 2018),
- The principles of data protection by design and by default creating incentives for innovative solutions,
- Stronger individuals' rights: Individuals will be assured of their rights related to information, like the 'right of access', the 'right to rectification', the 'right to erasure', the 'right to restriction of processing', the 'right to data portability' or the 'right to object'. With these rights effective, individuals will be able to connect with and categorize their personal data, or enable data deletion as well (EC 2018, Room et al. 2018),
- More control over personal data for individuals,
- Stronger protection against data breaches,
- The Regulation gives all data protection authorities the power to impose fines on controllers and processors: Related fines can reach EUR 20 million or 4% of the worldwide annual turnover in case of companies (EC 2018),
- More flexibility for controllers and processors processing personal data due to unambiguous provisions on responsibility (the accountability principle)
- More clarity on the obligations of processors and the responsibility of controllers when selecting a processor,
- A modern governance system to ensure that the rules are enforced more consistently and strongly,
- The protection of the personal data guaranteed by the Regulation travels with the data outside the EU ensuring a high level of protection: Currently, companies are taking the appropriate technical and organizational actions that are necessary for the appropriate implementation of the GDPR initiative. Addressing the risks that emerge related to personal data security are necessary for smooth operations from a data flow perspective (Room et al. 2018).

The proper application of the framework will be carried out by the so-called European Data Protection Board. This institution will ensure the regulations are understood throughout the EU in a unified way. The collation of experience related to the GDPR will commence in 2019 and a report will be published in 2020 as a review of the framework (EC 2018).

The document puts emphasis on the individual and organizational benefits that the new rules provide, however there are an enormous number of challenges that need to be tackled, hence the forthcoming years will surely keep complexities in store for individuals, companies, policymakers and regulators EU-wide.

Analyzing the referenced EU policies, we can clearly see that from the perspective of the EU the introduction of intelligent transportation systems and self-driving cars is a priority, and that policies currently both encourage the research and

development activities related to this technology, but also raise awareness and attract attention to the tackling of the upcoming challenges.

5. Conclusion

The changes that are driven by digitalization require focused attention. Industries and societies are becoming more complex and innovative processes, novel technological solutions require a multidisciplinary mindset. Developed regional transport and ICT infrastructure contribute to the quality of mobility in certain regions. With the solutions enabled by digitalization, even more advanced levels of mobility become available with R&D&I projects revolving around smart urban mobility and autonomous vehicles. Research has taken great strides and it is imperative that we ensure that our policies are appropriately updated and redesigned, so they are aligned with the changing environment. The goal of the paper was to provide key points of consideration for policymakers in the planning of regulations, legal frameworks related to smart mobility and digitalization itself. There is a vast number of challenges that need to be solved and this can be only achieved with a broad, future-oriented mindset and open discussions among policymakers and experts, while considering both the potential advantages and risks that reside in technological solutions.

Acknowledgments
Supported by the ÚNKP-17-3 New National Excellence Program of the Ministry of Human Capacities.

References

Annoni, P. – Dijkstra, L. – Gargano, N. (2017): The EU Regional Competitiveness Index 2016. Working Paper 02/2017. Brussels: European Commission.

Batey, P. – Friedrich, P. (2000): Aspects of Regional Competition. In Batey, P. – Friedrich, P. (eds.): *Regional Competition*. *Advances in Spatial Science.* Springer, Berlin, Heidelberg, 3–33.

Benevolo, C. – Dameri, R. P. – D'Auria, B. (2016): Smart Mobility in Smart City. In Torre, T. – Braccini, A. M. – Spinelli, R. (eds.): *Empowering Organizations*. Cham: Springer International Publishing, 13–28.

Brynjolfsson, E. – McAfee, A. (2012): *Race Against the Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity and Irreversibly Transforming Employment and the Economy*. MIT Center for Digital Business, MIT Sloan School of Management, Cambridge, MA.

Bughin, J. – Hazan, E. – Labaye, E. – Manyika, J. – Dahlström, P. – Ramaswamy, S. – Cochin de Billy, C. (2016): *Digital Europe: Pushing the Frontier, Capturing the Benefits*. New York: McKinsey Global Institute.

C-ITS (2017): *Cooperative Intelligent Transport Systems towards Cooperative, Connected and Automated Mobility*. Brussels: European Commission.

Camagni, R. (2002): On the Concept of Territorial Competitiveness: Sound or Misleading? *Urban Studies*, 13, 2395–2411.

Camagni, R. (2009): Territorial Capital and Regional Development. In Capello, R. – Nijkamp, P. (eds): *Handbook of Regional Growth and Development Theories*. Cheltenham: Edward Elgar, 118–132

Capello, R. (2009): Space, Growth and Development. In Capello, R. – Nijkamp, P. (eds): *Handbook of Regional Growth and Development Theories*. Cheltenham: Edward Elgar, 33–52.

CGPS (2017): *Stick Shift: Autonomous Vehicles, Driving Jobs, and the Future of Work.* Center for Global Policy Solutions, Washington, DC.

Chesire, P. C. (2003): Territorial Competition: Lessons for (Innovation) Policy. In Bröcker, J. – Dohse, D. – Soltwedel, R. (eds.): *Innovation Clusters and Interregional Competition.* Berlin: Springer, 331–346.

Dahlman, C. (2007). *Technology, globalization and international competitiveness: Challenges for developing Countries*. New York: Department of Economic and Social Affairs of United Nations.

Dean, D. – DiGrande, S. – Field, D. – Zwillenberg, P. (2012): The Digital Manifesto. How Companies and Countries Can Win in the Digital Economy. The Boston Consulting Group.

Dicken, P. (2003): *Global Shift. Reshaping the Global Economic Map in the 21st Century*. London: SAGE Publications.

DoA (2016): *Cooperation in the Field of Connected and Automated Driving*. Declaration of Amsterdam.

Dujin, A. – Geissler, C. – Horstkötter, D. (2014) (eds.): *Industry 4.0. The New Industrial Revolution. How Europe Will Succeed.* Munich: Roland Berger Strategy Consultants.

EC (1999): *Sixth Periodic Report on the Social and Economic Situation and Development of Regions in the European Union*. Luxembourg: European Commission.

EC (2017a): *Reflection Paper on Harnessing Globalization*. Brussels: European Commission.

EC (2017b): *European Urban Mobility. Policy Context*. Brussels: European Commission.

EC (2018): *Communication from the Commission to the European Parliament and the Council. Stronger protection, new opportunities - Commission guidance on the direct application of the General Data Protection Regulation as of 25 May 2018*. Brussels: European Commission.

ETSC (2016): *Prioritising the Safety Potential of Automated Driving in Europe*. Brussels: European Transport Safety Council.

Foulser, B. (2017): *Reimagine Places: Mobility as a Service*. KPMG UK.

Frisoni, R. – Dall'Oglio, A. – Nelson, C. – Long, J. – Vollath, C. – Ranghetti, D. – McMinimy, S. (2016): *Research for TRAN Committee – Self-piloted Cars: The Future of Road Transport?* Brussels: European Parliament.

Goodall, W. – Fishman, T. D. – Bornstein, J. – Bonthron, B. (2017): *The Rise of Mobility as a Service. Reshaping How Urbanites Get Around.* Deloitte Review, 20, 111–130.

Groshen, E. L. – Helper, S. – MacDuffie, J. P. – Carson, C. (2018): *Preparing U.S. Workers and Employers for an Autonomous Vehicle Future.* Study Prepared for Securing America's Future Energy. Washington, DC.

GSMA (2017): *Embracing the Digital Revolution. Policies for Building the Digital Economy*. GSM Association, London, UK.

Huggins, R. – Izushi, H. – Prokop, D. – Thompson, P. (2014a): *The Global Competitiveness of Regions*. London: Routledge.

Huggins, R. – Izushi, H. – Prokop, D. – Thompson, P. (2014b): Regional competitiveness, economic growth and stages of development. *Proceedings of Rijeka School of Economics*, 32, 255–283.

IMD (2017): *IMD World Digital Competitiveness Ranking 2017*. Lausanne: International Institute for Management Development World Competitiveness Center.

ITF (2015): *Automated and Autonomous Driving: Regulation under Uncertainty*. International Transport Forum Policy Papers, No. 7. Paris: OECD Publishing.

Jeekel, H. (2017): Social Sustainability and Smart Mobility: Exploring the Relationship. *Transportation Research Procedia*, 25, 4296–4310.

Kiel, J. – Smith, R. – Ubbels, B. (2014): The Impact of Transport Investments on Competitiveness. *Transportation Research Procedia*, 1, 77–88.

Krugman, P. (1994): Competitiveness: A Dangerous Obsession. *Foreign Affairs*, 2, 28–44.

Krugman, P. (1998): *Pop Internationalism*. Cambridge: MIT Press.

Lang, N. – Rüssmann, M. – Chua, J. – Doubara, X. (2017): Making Autonomous Vehicles a Reality. The Boston Consulting Group.

Lang, N. – Rüssmann, M. – Mei-Pochtler, A. – Dauner, T. – Komiya, S. – Mosquet, X. – Doubara, X. (2016): *Self-Driving Vehicles, Robo-Taxis, and the Urban Mobility Revolution.* The Boston Consulting Group.

Lee, E. – Vivarelli, M. (2006): *The Social Impact of Globalization in the Developing Countries. Discussion Paper No. 1925*. Bonn: Institute for the Study of Labor.

Lengyel, I. (2010): *Regionális gazdaságfejlesztés. Versenyképesség, klaszterek és alulról szerveződő stratégiák*. Budapest: Akadémiai Kiadó.

Lengyel I. – Rechnitzer J. (2004): *Regionális gazdaságtan*. Budapest and Pécs: Dialóg Campus.

Lengyel I – Rechnitzer J. (2013): Drivers of Competitiveness in the Central European Countries. *Transition Studies Review*, 20, 421–435.

Leonhard, G. (2016): *Technology vs. Humanity. The Coming Clash Between Man and Machine*. San Bernardino: Fast Future Publishing.

Litman, T. (2017): *Evaluating Accessibility for Transport Planning. Measuring People's Ability to Reach Desired Goods and Activities*. Victoria: Victoria Transport Policy Institute.

Lukovics M. – Udvari B. – Zuti B. – Kézy B. (2018): Az önvezető autók és a felelősségteljes innováció. *Közgazdasági Szemle*, 65, 949–974.

Magruk, A. (2016): Uncertainty in the Sphere of the Industry 4.0 – Potential Areas to Research. *Business, Management and Education*, 14, 275–291.

Malecki, E. J. (2002): Hard and Soft Networks for Urban Competitiveness. *Urban Studies*, 5–6, 929–945.

Manyika, J. – Lund, S. – Bughin, J. – Woetzel, J. – Stamenov, K. – Dhingra, D. (2016): *Digital Globalization: The New Era of Global Flows*. New York: McKinsey Global Institute.

Markusen, A. (1996): Sticky Places in Slippery Spaces: A Typology of Industrial Districts. Economic Geography, 72, 293–313.

Martin, R. (2003): *A Study on the Factors of Regional Competitiveness. A Draft Final Report for the European Commission Directorate-General for Regional Policy*. Cambridge: Cambridge Econometrics.

Montgomery, W. D. (2018): *Public and Private Benefits of Autonomous Vehicles.* Study Prepared for Securing America's Future Energy. Washington, DC.

OECD (2017): *Making Globalization Work: Better Lives for All.* Paris: OECD Publishing.

Piccinini, E. – Flores, C. K. – Vieira, D. – Kolbe, L. M. (2016): The Future of Personal Urban Mobility – Towards Digital Transformation. In Nissen,V. – Stelzer D. –Straßburger, S. and Fischer, D. (eds.): *Multikonferenz Wirtschaftsinformatik (MKWI) 2016*. Ilmenau: Technische Universität Ilmenau, 55–66.

Polenske, K. R. (2004): Competition, Collaboration and Cooperation: An Uneasy Triangle in Networks of Firms and Regions. Regional Studies, 9, 1029–1043.

Porter, M. E. (1996): Competitive Advantage, Agglomeration Economies and Regional Policy. *International Regional Science Review*, 1–2, 85–94.

Porter, M. E. (2008): *On Competition. Updated and Expanded Edition*. Cambridge: Harvard Business School Press.

Raposo, M. A. – Ciuffo, B. – Makridis, M. – Thiel, C. (2017): *The r-evolution of driving: from Connected Vehicles to Coordinated Automated Road Transport (C-ART). Part I: Framework for a safe & efficient Coordinated Automated Road Transport (C-ART) system.* JRC Science for Policy Report. Brussels: European Commission.

Room, S. – Almond, P. – Clark, K. (2018): *Technology's Role in Data Protection – The Missing Link in GDPR Transformation*. PwC Publications.

Rose, J. – Barton, C. – Souza, R. – Platt, J. (2013): *The Trust Advantage. How to Win with Big Data*. The Boston Consulting Group.

SAE (2014): *Automated Driving*. *SAE INTERNATIONAL STANDARD J3016*. Warrendale: Society of Automotive Engineers.

Schwab, K. (2017): *The Fourth Industrial Revolution*. New York: The Crown Publishing Group.

Siebert, H. (2000): *The Paradigm of Locational Competition. Discussion Paper 367*. Kiel: University of Kiel.

SMMT (2017a): *Connected and Autonomous Vehicles. Revolutionising Mobility in Society*. London: The Society of Motor Manufacturers and Traders.

SMMT (2017b): *Connected and Autonomous Vehicles. Position Paper*. London: The Society of Motor Manufacturers and Traders.

Thorpe, J. – Motwani, E. (2017): *Nudging People into Autonomous Vehicles*. PwC Australia.

UN (2016): *Smart Cities and Infrastructure*. Report of the Secretary-General. Geneva: United Nations Economic and Social Council.

WEF (2016a): *Digital Transformation of Industries: Digital Consumption.* Geneva: World Economic Forum.

WEF (2016b): *The Global Competitiveness Report 2016-2017. Insight Report*. Geneva: World Economic Forum.

WEF (2017): *Digital Policy Playbook 2017. Approaches to National Digital Governance.* Geneva: World Economic Forum.

WEF – BCG (2018): *Reshaping Urban Mobility with Autonomous Vehicles. Lessons from the City of Boston.* World Economic Forum and The Boston Consulting Group.

Yeomans, G. (2014): Autono*mous Vehicles. Handing Over Control: Opportunities and Risks for Insurance*. London: Lloyd's.

Yoon, D. (2017): What We Need to Prepare for the Fourth Industrial Revolution. *Healthcare Informatics Research*, 23, 75–76.