Challenges of digital transport transformation in Europe

Drago Ezgeta, Samir Čaušević, Mustafa Mehanović

Faculty of Traffic and Communications, University of Sarajevo Zmaja od Bosne br. 8, 71000 Sarajevo, Bosnia and Herzegovina

Abstract

Digitization of transport requires the transformation of the transport system from a physical to a cybernetic physical system. Digitization of transport includes the application of information and communication technologies and artificial intelligence in the transport system. This leads to the transformation of transport processes, but also to a change in the behavior of users and their views on transport and transport services. This creates the conditions for the development of new services and new solutions in the transport system that enable more efficient, economical, safer and more environmentally friendly transport.

***Keywords**: Digitalization, Transport, Cyber physical system*

1 Introduction

Digitization has already become a natural part of our daily lives. Digitization acts as a kind of "universal translator", making data from various sources workable for the computer and thus offers a number of possibilities that would otherwise be unthinkable. This includes conducting complex analyzes and simulations of objects, machines, processes, systems. In essence, "digitization" refers to the binary display of texts, images, sounds, movies and properties of physical objects in the form of successive sequences of 1 and 0. These sequences can be processed by modern computers at extremely high speeds - billions of commands per second. Digital technologies and services are transforming traditional concepts of mobility. Digital transport takes place in the transport sector, which is a large economic sector with a wide range of interconnected subsystems that ensure the mobility of people and goods. Means of transport and transport infrastructure are also being transformed by digital technologies.

Digitization offers new opportunities to connect mobility services via the Internet and smartphones. The availability, speed and use of the Internet are essential for the successful integration of digital business models into the business environment. Four areas of digital transformation can be identified: business processes, business models, business domain and cultural organizational transformation.

In the field of mobility, the following factors influence digital transformation :

- User requirements such as flexibility and connectivity

- Needs for accessibility through active demand for innovative solutions for effective mobility

- Growing awareness of the importance of environmental protection requires sustainable mobility solutions.

- The trend evolution of the sharing economy, on the one hand, and on the other hand, technological changes are redefining the field of mobility.

Mobility service providers will have to adapt more and more to the individual needs and specific requirements of users.

2 The role and importance of digitalization in the development of transport in Europe

Digital Transformation (DT) refers to the profound changes that are taking place in the economy and society as a result of the takeover and integration of digital technologies into every area of human life. Digital technologies have become the foundation of all modern innovative economic and social systems. In European documents commission digitization is treated as one of the main issues affecting all sectors of the economy globally. Digitization represents a

significant difference compared to previous waves of technological innovation that had an impact only on certain sectors. The effects of digital transformation on the economy and society will be much deeper due to their global, cross-sectoral nature. In addition to the direct transformation of economic sectors, digitalization is changing the whole society by affecting the way of life, communication and social interaction of the entire population. Consequences of digital transformation DT will affect almost all European policy. DT is expected to be a strategic policy area in the coming years [4].

In its draft multiannual budget for 2021-2027, the European Commission recognized the importance of digital technology for the future of Europe through increased investments in digital networks of EUR 12 billion. A new Digital Europe program has been announced that identifies artificial intelligence AI, cybersecurity and high-performance computing as key strategic areas for Europe. The development of artificial intelligence and AI technology is recognized as one of the most important drivers, increasingly transforming every aspect of society, and therefore deserves special focus in the wider scope of DT development, as stated in the European Artificial Intelligence Strategy. Digitization led to the fourth industrial revolution (Industry 4.0) [4].

3 Conceptual technical and regulatory framework of digital transport transformation

A common conceptual framework and a systematic approach are needed to implement the digital transformation of transport in the European Union, to monitor dynamics, trends and impacts in order to exploit its potentials and address future challenges. Digital transformation is rapidly shaping the complex techno-socio-economic relations of society and the economy (education, employment, markets, governance, etc.). The dynamics, interactions, models, actors and factors influencing digitalization and its profound impact on society and the economy need to be studied. EU policy makers, taking into account all these influences in the design and implementation of measures for successful digital transformation, have created a conceptual framework for the implementation of digitization.

The conceptual framework should therefore serve the following purpose [1]:

1.The DT framework should provide a holistic overview of the overall DT program in terms of actors, technologies, sectors, policies and core values.

2. Enable multidisciplinary analysis of DT based on relevant topics, areas and actors in a complementary way. The framework should help organize a multidisciplinary analysis of DT and position different contributions within the broader picture of DT.

3. The framework should demonstrate the need to study the interactions between digitalisation and the impact on society and the economy that policy makers need to take into account.

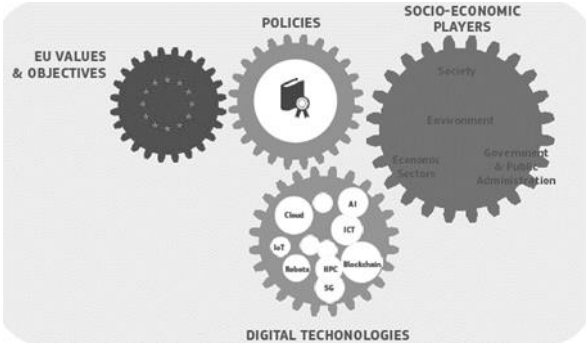

Fig. 1. Conceptual framework of the EU's digital transformation [1]

A simple but comprehensive conceptual framework for DT analysis is shown in Figure 1. The proposed framework has four main sets of interdependent and interconnected components:

- EU values and objectives
- EU policy
- Digital technologies
- Socio-economic factors

The EU's values and objectives form the starting point for digital transformation and include the following core values in the European Union: respect for human dignity and human rights, freedom, democracy, equality and the rule of law. These values officially unite all EU members. Non-EU countries may also share all or some of these values. These core values are an integral part of EU policy, such as the well-being of all citizens, environmental protection, growth and jobs, equity, privacy, etc. These values and objectives should be reference points in the analysis of DT. Sectoral policy areas, for

example, transport, energy, construction, digital public administration, health, agriculture, etc., which can be identified as "vertical" policy areas. "Horizontal" policy areas that affect all vertical sectors and are closely linked to digital technologies. Horizontal areas of EU policy include cyber security, personal data protection, intellectual property rights, telecommunications infrastructure, standardization and interoperability, research and development and innovation, labor, etc.

Digital infrastructure and digital technologies are the technical backbone and key drivers of DT. New digital technologies, networks and services are constantly evolving, and this set of components is certainly the most dynamic. The fourth set of components of the EU digital transformation framework includes factors that have an impact on socio-economic development.

4 Business and technological models of implementing digital transport transformation

Digital technologies, together with social media, make it possible to transform the traditional concept of mobility. New technologies and traffic trends add new levels of interaction with society and users and can have a significant impact on people's mobility and freight services. New business models are emerging that lead to innovative mobility services, including new online platforms for freight operations, car or bicycle sharing services, or smartphone apps that offer real-time analytics and traffic data. The vehicles themselves are also being transformed by digital technologies.

They benefit from new connected and cooperative services via trip computers and increased levels of automation that are becoming more accessible. The emergence of Connected and Automated Vehicles (CAVs) with advanced sensor and wireless communication capabilities could be the standard in passenger cars by 2050 [3]. Connected vehicles can help increase transport system efficiency and safety, improve traffic flows, optimize infrastructure and use public infrastructure. transport and encourage multimodal transport solutions.

In other modes of transport (air, rail and sea) connectivity and partial automation are present in various forms and have gained the trust of passengers and other stakeholders. In aviation, automation has changed the roles of pilots and air traffic controllers, providing support for strategic air traffic management and control. Automatic train operations are used in metro systems in Europe and around the world, and their further expansion on major railways is expected. In the field of maritime transport, the development of autonomous vessels is underway.

In parallel with the development of digital technologies, there is a paradigm shift in the field of road mobility services. The traditional ownership of fossil fuel cars has led to the development of a new mobility concept as a MaaS service, which represents a shift from personal-owned means of transport to mobility solutions with payment for on-demand transport services. The impact of the MaaS has been accelerated by social, economic and technological change. Sharing economics, big data and urbanization are additional drivers of MaaS development. However, widespread property-based car mobility remains motivated by the high value people give to perceived reliability and affordability of a transport service, not just its cost-effectiveness.

The digital transformation of transport can help develop AMOD (Autonomous Mobility on Demand) services that could complement public transport networks where they are too expensive (in sparsely populated suburbs, but also in urban areas outside rush hour / night). AMOD could have a synergistic impact on public transport as it saves money and resources and can support optimal system performance in other, key areas. DT has enabled a thorough redesign of old production processes and service delivery. DT provides a new approach to supply chain operations. New forms of sustainable freight delivery (bicycle delivery services) are emerging as viable alternatives to the last kilometers of goods delivery. Air drones are now being promoted and supported by a growing number of companies as a valid alternative to delivering the last kilometers in rural and suburban areas, with significant advances in legislation in this area. Electrification of transport with the help of DT can contribute to breaking the dependence on oil and reducing emissions of harmful substances. Digital technology and traffic management systems based on digital technologies are used to optimize and manage the operation of transport networks. Predicting the future development of

transport, whether it is new transport technologies, new approaches to mobility, changes in demand, etc., is a constant challenge. Many of today's traffic trends didn't even exist a few years ago.

Companies that offer transportation services that use online platforms to connect passengers and local drivers with their personal vehicles that did not exist before, now serve tens of millions of trips every day. It is clear from the above that the transition to a new era of transport systems with the help of DT in the transport sector has great potential. However, there are potential issues such as data collection and related challenges such as privacy and cyber security that need to be addressed through an appropriate policy framework, integrated with research and innovation activities and the development of standards.

5 The impact of digital transformation on cyber security in transport

5.1 Basic elements of cyber security in transport

The issue of digital transformation and cyber security are interrelated. The development of cyber security is associated with the development of the first computer systems and digital communication networks. The growing digitalisation of public administration, industry and society and their growing dependence on information and communication technologies (ICT) have profoundly transformed the environment and the importance of cybersecurity in recent years. While the Internet led to the development of a global cyberspace populated by rich and - at the time - revolutionary online services, it also exposed computers to a wider range of cybersecurity threats, which exploited the connectivity provided by the Internet. Two decades later, the escalating number of cybersecurity incidents and their impact have led to cybersecurity being at the top of the list of priorities of governments and businesses around the world today.

5.2 Challenges of cybersecurity in Europe

The upcoming challenges of digital transformation lie in maintaining the balance of increasing digital connectivity and reducing the risks posed by digital transformation. The ultimate goal of European policy should be to create a framework in which the effects of digital transformation are directed towards reducing risks and increasing cyber security. In a joint declaration on cybersecurity published in September 2017, the European Parliament and the European Commission presented a package of high-level measures to address these challenges and build strong cybersecurity in the EU.

These measures are grouped into three main areas [7]:

- Resilience: promote cyber security and enable effective responses to cyber attacks in the EU by building cyber resilience and strategic autonomy. New Network and Information Systems Security Directive ("NIS Directive") (European Parliament and Council, 2016) (focusing on the implementation of measures to respond to cyber security threats) and the Cyber Security Act (European Parliament and Council, 2019) with the definition of the European Cyber Security Certification Framework (which focuses on the definition of the cyber security certification process and standards for ICT products) are examples of initiatives aimed at this. In addition to these initiatives, the creation of a network of cybersecurity competence centers with the European Center for Cybersecurity Research and Competences has also been proposed. It aims to encourage the development and application of technologies in cyber security and to complement capacity-building efforts for previously identified initiatives at EU and national levels [7].

- Deterrence: With measures aimed at providing a more effective law enforcement response in deterring, detecting, monitoring and prosecuting perpetrators of cyber attacks. The Information Systems Attacks Directive (European Parliament and Council, 2013) was already a step forward in this direction by requiring Member States to strengthen national cybercrime laws. Public-private cooperation against cybercrime is key for public bodies to fight crime effectively.

- Defense: Strengthening international cooperation in the field of cyber security, with the recently adopted framework for a joint EU diplomatic response to malicious cyber activities, also called the EU Cyber Diplomacy Toolbox and the Rapid Response Draft (European Commission, 2071b).

Another key aspect is EU-NATO cooperation in fostering cooperation in cyber defense research and innovation.

The Cyber Security Act lists a number of measures to improve the response to cyber attacks and strengthen cyber security in the EU. A framework for European cybersecurity certificates for products, processes and services needs to be created. The initiative aims to increase the cybersecurity of ICT products, ranging from IoT devices to critical infrastructure, by creating EU-recognized cybersecurity certification schemes, promoting pre-market cybersecurity assessments and enabling end-users to improve their understanding. the levels of security they can expect in the products and services they use.

6 Conclusion

The process of digital transformation of transport will not be fast and will not be carried out without overcoming technological, regulatory and institutional challenges. Many technological, social and legislative barriers will need to be addressed. Standardization problems for immature technologies and legal aspects of third party liability (automated vehicle liability, drones, etc.) must be carefully addressed to avoid future pitfalls, accelerate technology diffusion and achieve future safety objectives. [8]Today, information is stored and transmitted almost exclusively in digital form. But data is not just something we consume, it is also something we produce, like a digitally controlled product. The amount of digital data is constantly increasing. Personal data, as well as data produced by machines, can be used to explain, improve or manage transport processes. This is also why digital data is a commodity to trade, making it one of the most valuable assets of the 21st century. Automated driving - a specific technological vision that can be achieved with the help of high-end digital technology - can truly become a reality only when possible without hesitation and permanently leave complete control to the car. This requires a huge amount of automated communication that would take place reliably and seamlessly, i.e. between controls and car sensors, between road users, as well as with infrastructure such as traffic management systems and location services. As in other domains, the challenge for regulators is to balance the need for technological progress and its many benefits with the protection of fundamental rights and the security of citizens. However, an additional aspect to consider is the possibility of the emergence of a digital divide driven by digital solutions, which can exacerbate the distinction between low and high income classes, young and old generations, urban and rural citizens. These growing divisions may be caused by differences in access to technologies that relate to affordability but also to the digital knowledge of different classes of citizens (including literacy, gender and age).

Security and safety are key issues when it comes to digitization. Designing products, systems and infrastructure in a way that will work continuously and without interruption in the interest of the people will become a central goal of technological development.

References

[1] Desruelle, P., Digital Transformation in Transport, Construction, Energy, Government and Public Administration, Sevilla, Spain, JRC, 2019. pp. 55-72

[2] Ezgeta, D., “Digitalization of transport” in Intelligent Transport Systems, Sarajevo, BiH, Faculty of Transport and Communications Sarajevo, 2018, pp. 200-208.

[3] Fernández-Macías, E., Automation, digitalisation and platforms: Implications for work and employment, Luxembourg, Luxemburg, Eurofound, 2018. pp. 9-11

[4] Noussan, M., Hafner, M, and Tagliapietra, S., “Digitalization Trends” in The Future of Transport Between Digitalization and Decarbonization, Cham, Switzerland, Sprnger, 2020, pp. 87-96

[5] Paksoy T., Koçhan, C.,Samar A.S., “Digital Transformation of Supply Chain Management” in Logistics 4.0, CRC Press, New York, 2021, pp. 338-342

[6] Parkinson, S., Ward, P., Wilson, K., & Miller, J., Cyber threats facing autonomous and connected vehicles: future challenges. IEEE Transactions on Intelligent Transportation Systems, 8, pp. 2898-2915, 11, 2017.

[7] Petit, J.&Shladover, S. E., Potential cyberattacks on automated vehicles. IEEE Transactions on

Intelligent Transportation Systems, 2 , pp. 546-556, 2, 2015.

[8] Sullivan, M., Kern, J., “Technologies Driving Digital Transformation" in The Digital Transformation of Logistics, New Jersey, US, IEEE Press, 2021, pp. 23-25