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26th - 27th May 2022, Sarajevo, Bosnia and Herzegovina

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"Digital transformation and sustainable development in postal and logistics systems"

Organized by:
University of Sarajevo, Faculty of Traffic and Communications
Institute of Traffic and Communications

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Conference Proceedings

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Conference Proceedings of First International Conference on Advances in Traffic and Communication Technologies(ATCT) – "Digital transformation and sustainable development in postal and logistics systems"

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FOREWORD

The First International Conference on Advances in Traffic and Communication Technologies – ATCT 2022 was organized by the University of Sarajevo - Faculty of Traffic and Communications and the Institute of Traffic and Communications Sarajevo in cooperation with the Bosnia and Herzegovina Ministry of Communications and Transport. The thematic focus and working subtitle of the conference was "Digital Transformation and Sustainable Development in Postal and Logistics Systems". The Conference was held in Sarajevo, Bosnia, and Herzegovina. Sarajevo is the capital city of Bosnia and Herzegovina. Located in the heart of south-east Europe and the Balkans, Sarajevo is the leading political and social center in Bosnia and Herzegovina and a prominent cultural center in the Balkans. The Faculty of Traffic and Communications of the University of Sarajevo has a long tradition of organizing conferences in various fields of traffic and communications. This International Conference with the working subtitle “Digital transformation and sustainable development in postal and logistics systems" connected the professional, experts, and innovative community from Bosnia and Herzegovina, the region, and Europe who are interested in the required digital solutions in order to develop their innovative projects, products, and services. The conference was also hosted by eminent international experts in the field of digital transformation of postal and logistics systems as keynote speakers. The first International Conference had the pleasure to be opened by three prestigious Key Note Speakers: Marjan Osvald - Deputy Director-General of the Universal Postal Union, PhD., Nikola Trubint - Vice Chairman of CERP - European Committee for postal regulation and PhD., Nino Ćorić - Chair of the Council of the Agency for Postal Traffic of Bosnia and Herzegovina. The completely refereed papers presented at the conference were documented in these proceedings. Reviewers from scientific committees, external reviewers, and editorial board members reviewed all of the submitted papers in the proceedings. Organizations of the conference extend their gratitude to all businesses and institutions who assisted in the planning of the conference. Also thanks to all authors and participants for their contributions to these proceedings, as well as the members of the International Academic Scientific Committee who helped with the review process.

Prof. dr. Amel Kosovac

Dean of Faculty of Traffic and Communications,
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Some aspects of digital transformation in postal sector

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Abstract

The fast growth in the use of technology in every sphere of people's private and business life is an evidence of the digital acceleration process. This process affected also all companies and sectors. Today, electronic communications affect all business of postal operators. Postal operators are an integral part of the overall e-commerce experience, as the delivery services are a critical element of the e-commerce customer experience. Operators offer a wide range of services to meet the needs of all customers, embracing online and mobile technologies to provide competitive and convenient postal services. It is all part of the operator's digital transformation process. The process of digital transformation of postal operators is a broad topic and in this paper only a part of possible aspects of consideration is given. Some of the challenges and opportunities related to digitalization of postal operators are presented. Also, the Integrated Index for Postal Development has been singled out, as well as the issue of sustainability of last mile delivery in conditions of digital transformation.

Keywords: *Digitalization, Postal sector, Postal operator,* I*ndex of postal development, COVID-19*

1 Introduction

Digitalization has impacted the development of postal markets across the world. Digital transformation of companies and correspondence is having an impact on the core business activity of postal operators. In that sense, digitalization has changed the role of the postal sector as letter volumes decline and parcel volumes grow. Whereas letter volume decline has shaped the postal market and continues to drive changes, the advances in information and communications technologies create new opportunities and demands for the postal market. The combination of letter volume decline and growth in parcel volumes has important operational and economic implications for postal networks. In response, postal operators have diversified into a broad range of new service areas. Hence, the digital transformation has become a strategic priority for postal operators.

Postal services are at a turning point: they need to adapt in order to remain relevant, competing with digitally native companies in different areas of their product portfolio. To be able to compete effectively, postal operators need to speed up the digitization of their products. This means that postal operators have not yet fully digitized, need to do so urgently or risk being excluded as digital service providers for e-government, e-commerce, and e-finance services.

Although digitization is not a new phenomenon, the challenges and opportunities that are associated are constantly changing. Before the emergence of COVID-19, the challenges posed to digital transformation were essentially focused on the fourth industrial revolution, associated with the concepts of Industry 4.0, Internet of Things (IoT) and Web 4.0, as discussed in [1] and [2]. The challenges involved both the disruption of concepts and technologies, as well as the speed of this digital transformation. In the era of COVID-19, the challenges were exposed and it is fundamental to involve the entire organization and stakeholders in this process.

Furthermore, the pace with which this change occurred was tremendous. Organizations had to do this regardless of their previous positioning and experience in digital transformation processes. Inevitably, organizations are moving along the path of digital transformation. However, a key question is whether they are prepared for this change. Studies [3] and [4] indicate that companies, even those that are most

advanced in the digital transformation of their activities and workflows, are not yet fully prepared to face the challenges of the digital transformation. Digitization requires a restructuring of processes, turning the company more agile, investing in more organic structures, reinforcing standardization and automation in order to optimize the response capacity to customers.

COVID-19 has brought difficult and uncertain times and accelerated the inevitable processes of digital transformation. At this stage it is important to start thinking about the post COVID-19 world and, above all, to explore how we can leverage and transform these challenges into new opportunities, both in business and internal organization.

Challenges and perspectives of postal operator's digital transformation are main objectives in this paper. The paper gives a partial overview of possible directions of digital transformation, with an overview of the current index of postal development by regions and countries. In this process of transformation, postal operators must keep in mind sustainability of last mile delivery and this is also discussed in this paper.

2 Phases in the process of digitalization of postal sector

Electronic substitution of traditional postal services is accelerating as both costumers and businesses adopt electronic processes across multiple domains. Now customers are attracted to greater convenience, faster service and lower cost [5]. In the conditions of digital economy postal services need to modernize their role to accommodate for the digital age. Postal operators should offer new products and services that reflect the evolving mandate to bind the nation together in a new world where people are increasingly communicating digitally.

In the conditions of digital economy, it is important to understand how the sector has evolved historically. There are four main phases in the process of digitalization of postal sector, as we can see in [6]. In early 90`s the efforts of postal operators were mainly focused on rationalizing and automating sorting centers. This is the first phase. The second phase was the phase of creation of new revenue-generating digital services. Most postal operators started to offer trust-based services like certified electronic communications, online identity verification, secure electronic mailboxes, online payment, government services platforms, etc. In the third phase, the broadband penetration of Internet and information and communication technologies is increased (early 2000s) and changed the core postal business. The objective of postal operators was to expand customer access to postal services and to create new services at the intersection of physical and digital. Some of the so called core-enhancing digital postal services are support to e-commerce, e-finance and payment solutions and other support services. The last phase is the phase of digital transformation. Digital transformation is not about any particular function. It is a fundamental organizational change that comes from advances in technology, process, culture and business model. It is about converting an organization wholesale into an information enterprise where connectivity, cloud and
analytics can enable faster innovation and more informed decision-making.

The drivers of digital transformation in postal sector are summarized at Figure 1. Some of them, such as broadband Internet, mobile and social networks are long-term trends that started at the turn of the century. Others, such as the Internet of Things or Big Data embody a new phase that will increasingly impact postal strategies in the coming years [7].

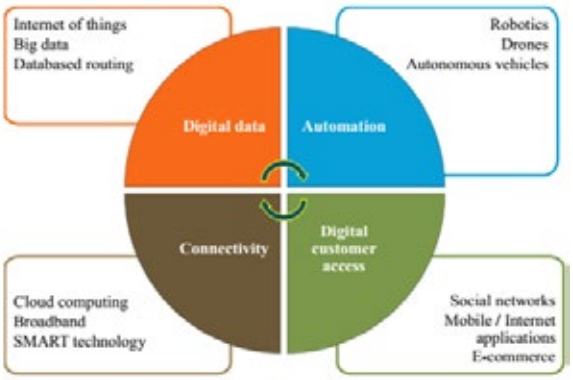

Fig. 1. Drivers of digital transformation in postal sector, Source: [6]

2.1 Transformation from physical to digital with important trust

It is a fact that the postal industry is being disrupted by technological developments. Digital means of communication are replacing paper-

based ones and decreasing the demand for physical letters. In other words, this is a call to action to increase the pace of digital transformation within the postal and express industry. The postal infrastructure forms the backbone of a government's communications with its citizens. In some EU countries, governments themselves have driven the development in a digital direction, pushing new digital services which enable them to communicate in a secure and trusted way with their own citizens. But there are many countries waiting to take the next digital steps, such as digital mail.

Amongst the different factors influencing usage, trust in government is increasingly important. An advancing digital economy and society impact the routines of people and this can only work if people trust the organization that is accountable for that change. One possible explanation is that citizens might only be willing to share personal data online when they trust their government to provide high quality and therefore secure online service.

There is still a lot of ground to be won, even amongst the frontrunners in e-government. According to the EU's eGovernment Benchmark Report 2019, the way forward in e-government services is building digital public services that people trust and will therefore use as it makes their interaction with government easier, as discussed in [6].

With emerging technologies and business models, even the biggest, most established enterprises are trying their best to modernise to keep up with the times. Such is the case with the postal industry. To survive, it has to adapt. Modernising the postal service industry is the first step in embracing digital transformation. The associated benefits include increased profits and the possibility to save on labor costs, while positively influencing the climate by cutting down on usage of paper and gas.

2.2 The some examples of postal digitalization

Secure, flexible, and inexpensive communication between citizens and public authorities, e.g. through a digital postbox of smart post offices, are some of the many advantages of increased digital communication. These are just some of the examples of the power of digitalization.

Digital postbox services are a secure delivery channel where consumers can view, manage and organize their digital communications from multiple providers in a single location, through a single login. Through this channel, consumers can receive and respond to various transactional communications, while also securely manage other business relationships, such as paying bills, uploading and storing documents, and receiving important notices and reminders [8].

A secure digital postbox is much safer than sending physical communications via the ordinary postal system – because it is much easier to steal information from a physical postbox. Among other benefits of having a digital postbox is savings on internal and postage costs while simultaneously reducing your environmental impact.

In some geographical regions, it may be difficult to find the exact mailing address of an intended recipient, or many intended recipients may live at the same address. However, with safe digital post, the sender has a guarantee that each of the documents sent will be received by the right person.

In an increasingly connected world people want to improve control and efficiency. A smart post office puts together all the best bits about a physical location and the productivity of digital technology. They utilizes physical and digital features. Puts together multiple channels such as payment, public transport, networking into one platform for ease of use and prioritizes a personalised experience for the costumer. These smart post offices use real-time and location-based information to update the customer, offers 24/7 digital solutions, employ a digital postbox that creates an encrypted and secure digital mail ecosystem that eradicates spam and unwanted messages, evidently in [9].

Post offices are not completely abandoning old systems in place. Some of them are favoring a hybrid approach as a way to become a "smarter" post office. In this scheme, citizens can still opt to receive posts in the mail but the majority of them have converted to receiving important and sensitive documents such as letters from the bank using a more secure digital postbox.

3 Integrated Index for Postal Development

In 2020, the pandemic's impact on the world economy, global trade and cross-border supply chains was inevitable. Since the pandemic was declared, postal operators around the world have had to deal with intermittent air traffic, labour supply shortages and increased operational costs, as concluded in [10]. Unlike many other businesses, they have also had to continue operating during most lockdowns, providing services deemed essential by authorities while at the same time attempting to meet a surging demand for the delivery of online shopping transactions.

However, despite its essential nature, the sector had already been facing tremendous challenges before the pandemic. Postal operators were struggling to make their revenues grow at the same rate as the wider real economy, while postal services in many developing countries were increasingly falling behind when compared to the performance in wealthier nations. In this context, measuring postal development remains paramount and the Universal Postal Union's Integrated Index for Postal Development (2IPD) constitutes a key tool to help policymakers, regulators and operators steer the course of the sector in an environment of accelerated transformation [10].

One major symptom of the COVID-19 crisis is perceptible in the area of delivery times, which reflect the reliability of postal services. When the pandemic first struck in 2020, both speed and predictability dropped dramatically, with 13% lengthier delivery times on average and a 9% increase in the coefficient of variation of the same with respect to 2019.

In 2021, delivery times appear to have reverted to pre-crisis levels; but more time will be needed before declaring a "return to normal". Moreover, even if the deterioration of reliability through the crisis is eventually overcome, the issue of gaps in postal development is likely to remain high on the agenda of policymakers, regulators and operators in the years to come.

The 2IPD is a comparative indicator of postal development around the world. It is a composite index that summarizes information about the performance of postal operators in 168 countries. As such, the 2IPD is a unique tool for analyzing the state of the postal sector [10].

The 2IPD is built on four pillars (which are in turn sustained by a variety of sub-indicators), stated in [10]:

– Reliability reflects performance in terms of speed and predictability of delivery, across all the key segments of physical postal services (letter post, parcel post and express);

– Reach synthesizes global connectivity by evaluating the breadth and depth of the postal operators' international network. These are measured by the number of partner networks and the volumes of international exchanges, respectively, across all the key segments of physical postal services;

– Relevance measures the intensity of demand for the full portfolio of postal services relative to the best performers in each category of postal activity, also taking into account elements such as the number of international transactions and the number of post offices;

– Resilience indicates the level of diversification of revenue streams, as well as the capacity to innovate and deliver inclusive postal services.

The input is then integrated into an algorithm, which yields a general score between 0 and 100 for each assessed country. Given the statistical distribution of the 2IPD scores, it is possible to categorize countries in four main categories, according to [10]:

– Postal champions: A score above 55 shows that a country's postal development is among the top 20% in the world, a performance which can be considered very good to outstanding. This group of countries can be denoted as having a well-balanced performance across all pillars of postal development;

– Good performers: A score between 30 and 55 shows an upper-intermediate level of performance. These countries are consistent performers and belong to the top 50%;

– Potential performers: A score between 15 and 30 shows a performance that is lower than the median, with countries usually performing only partially well, with some development potential. Most countries in this group exhibit glaring weaknesses in one or more areas of postal development;

– Least developed operators: A score below 15 shows that a country's postal development is very low. These countries are facing major

challenges in several of the key pillars of postal development.

The 2021 2IPD ranking covers 168 countries with a global average score of 33 versus 36 in 2020. Once again, Switzerland secured the top spot, slightly distancing itself from Germany (2nd, 93) and Austria (3rd, 91), with Japan (4th, 90) and France (5th, 88.4) completing the top five, as we can see in [10].

As in all past editions of the ranking, the group of industrialized countries (ICs) has recorded the highest average score at 68.25, followed by Eastern Europe and the CIS (49.82), Asia Pacific (28.63), the Arab region (25.62), Latin America and the Caribbean (18.74), and Africa (17.85) [10].

Following closely behind the group of ICs, countries in Eastern Europe and the CIS also benefit from a high average score (49.8, Figure 2) [10].

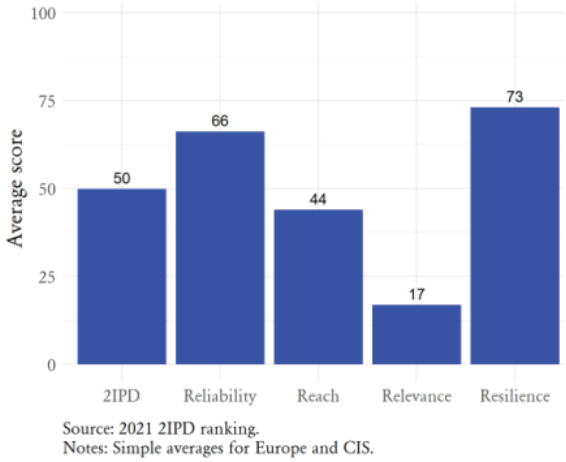

Fig. 2. 2IPD performance in Eastern Europe and the CIS, Source: [10]

4 The sustainable last mile delivery

During the pandemic of COVID-19 the lastmile delivery it got greener. With many people stuck at home, e-commerce sales skyrocketed. When supply chains started moving again, the ecosystem adapted fast, as people purchased more and different products online. Out of sheer necessity, new consumer behaviours and retailers' responses to them changed last mile delivery's carbon footprint, making it more sustainable. But these sustainability gains are only the beginning of a whole new opportunity for collaboration. One that could produce a remarkably more sustainable last mile. But only with action and smart investment.

The carbon footprint of the last mile has long been an environmental and societal challenge. The sustainability gains that came from the pandemic were unintentional. Yet they happened at an ideal time. Now it's time to get intentional and make the last mile more efficient, less expensive and more eco-friendly. The imperative to act is clear.

Last mile delivery accounts for 53% of the total cost of shipping and 41% of total supply chain costs. With no interventions, we can expect a 32% jump in carbon emissions from urban delivery traffic by 2030 [11]. Consumers need convenience, speed and sustainability at the right price. Lasting change will require bold moves such as incentivising greener choices among consumers and businesses, rethinking asset use, and harnessing data and analytics. The whole last mile ecosystem, post and parcel organisations, retailers, delivery companies, governments and consumers is at a tipping point. Go one way, and it can create a truly sustainable last mile faster, cheaper and greener. Go the other way, and things worsen unchecked. No single entity can solve this problem alone. It will take all ecosystem players working together in ways they never have before.

4.1 The potential of local fulfilment

The acceleration of local or market-based fulfilment is one stand-out impact of the pandemic. Amazon is a pioneer here. The company's ability to meet its Prime delivery promises has always hinged on its innovative local fulfilment strategy. In March 2020, the e-commerce giant doubled down on its local delivery strategy, investing in a network of new micro-fulfilment centres located even closer to its customers that stock "need it today" items. The goal was to offer more speed and convenience with a lower carbon footprint, stated in [11].

To respond to Amazon's delivery speed and cost, brick-and-mortar retailers had already been developing capabilities for omnichannel fulfilment using their stores or other local inventory options. The pandemic radically accelerated fulfil-from-store investments by about three to five years, permanently altering supply chains where inventory is placed closer to

customers than ever before. Retailers accelerated these investments as they scrambled to adapt. But these investments won't be rolled back post-pandemic. Now, many more items will come from market-based inventory, which creates an opportunity for new experiences around local fulfilment for consumers and exciting potential for post and parcel and logistics organisations to create a more sustainable last mile.

The last mile supply chain made possible by local fulfilment centers could lower last-mile emissions between 17 and 26% by 2025. Using local fulfillment for even half of ecommerce orders between 2020 and 2025 could lead to significant impacts [11]. The scheme of system of local fulfilment is shown in Figure 3.

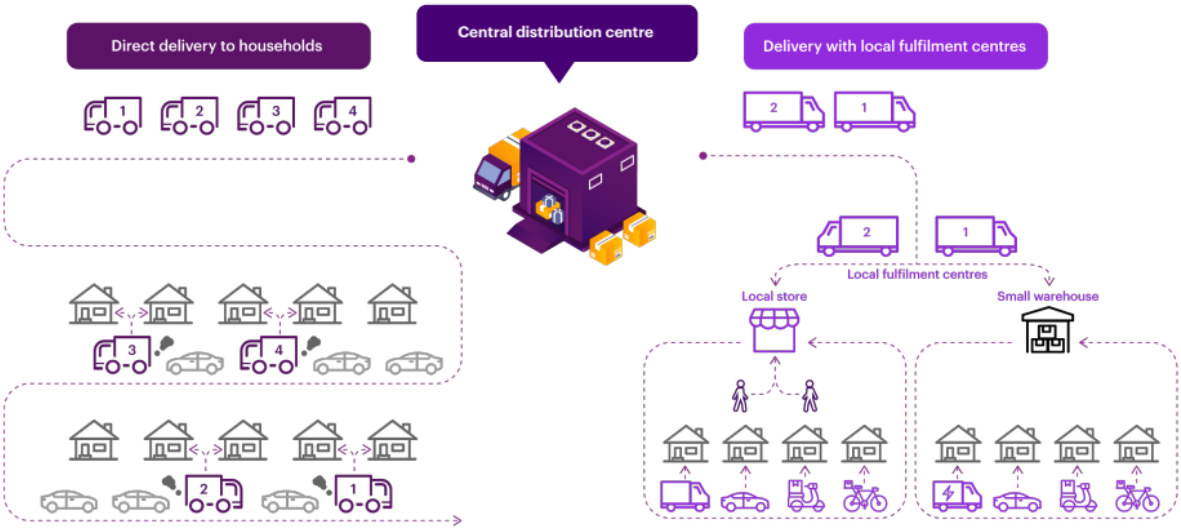

Fig. 3. Local fulfilment, Source: [11]

The last mile is not going to get greener with more investments in traditional processing and distribution infrastructure and delivery fleets. This is about thinking outside the box to deliver the box. It's critical to work across the ecosystem to understand the unseen costs of last mile delivery and pursue change. This means investing smartly in innovative technologies and balancing highland low-impact opportunities. Three fundamentals are key to any plan and success involves coordinated investment and creative even unconventional ecosystem cooperation. These fundamentals are: incentivise greener choices, rethink asset use, harness data and analytics [11].

1. Incentivise greener choices

Making purchases online can be as easy as clicking a button and finding the package at front door an hour later. It's so easy that people don't think about how the shipping option they select, the size of their basket or where, when and how their order is fulfilled impacts the environment. The root issue here is lack of buyer awareness. It's why the last mile ecosystem must make consumers more aware of the environmental impact of delivery options and be more transparent by offering greener delivery choices at checkout. Many people would choose these greener options, 43% of consumers are more likely to choose retailers that offer more sustainable delivery options [11]. There are also options to incentivise consumers to pick up parcels at local fulfilment centres by offering value-add experiences or discounts.

Cainiao Smart Logistics Network, which is Alibaba Group's logistics unit is locating 30,000 new postal stations in convenient spots across 100 cities in China. The posts support easy, contactless mailing and parcel collection, have services for consumers to track their packages in real time, and use autonomous vehicles to bring parcels to the door step.

Incentivising greener choices doesn't just extend to consumers. City and national governments and planners must weigh the trade-offs they can make to incentivise delivery companies to invest in greener fleets, enable the circular economy and develop greener route management practices. Delivery companies are already investing in electric vehicles. Cities can incentivise further action by investing in electric vehicle charging infrastructure, making them convenient for delivery companies. They can also offer GOV (green occupancy vehicle)

driving lanes, express parking, ticketing and toll exemptions, or carbon credits for green vehicles.

2. Rethink asset use

Assets have a fixed role in the traditional last mile. Warehouses and fulfilment centres store the inventory. Delivery fleets run the routes. Every delivery organisation invests in its own infrastructure, technology, people and vehicles. But as the context of the last mile changes more volume, more velocity and new consumer expectations. It's time to stop building redundant networks and start repurposing assets with sustainability as a priority.

Delivery companies can also enhance cooperation and move to share assets in new ways. Providing access to each other's networks can eliminate costly redundancies and reduce emissions. The United States Postal Services (USPS) is already doing this through its Parcel Select® Service. Other delivery companies, including USPS competitors, can use this ground delivery service to get sorted packages to their final stop at less cost.

Delivery companies and post and parcel organisations can embrace greener practices more economically by sharing delivery infrastructure, including fulfilment and open locker and PickUp DropOff networks that support interoperability. At the same time, cities and regulators can encourage asset sharing. One way to do this is by creating points at the outskirts of cities where deliveries are concentrated for all carriers.

3. Harness data and analytics

Deep customer insight enables delivery companies to pursue more proactive delivery approaches that are kinder to the environment. Take anticipatory shipping, for example. Delivery companies use customer and geolocation data to ensure a package is delivered the first time. By using geolocation to see that a customer isn't home, the delivery company can automatically leave the package in an alternative location per the recipient's known preference. This eliminates exceptions that add cost and extra trips that increase the carbon footprint, as concluded in [11].

With more data delivery companies can make routes more efficient, accounting for traffic and other real-time conditions. They can personalise service level commitments, using longer timelines to accommodate greener routes. They can assess local traffic and weather patterns in real time. They can integrate route planning with the availability of smart charging stations. All of these data inputs can optimise routes with extraordinary precision, maximizing drop density and reducing complexity and downtime. Cross-ecosystem data sharing via the cloud is key to making it happen.

5 Conclusion

The postal operators are facing unavoidable digital business transformation in the era of the digital economy, Industry 4.0 and innovations. The main trend in postal sector is the increasing competition from electronic substitutes. The continued growth of e-commerce is fueling growth in parcels in postal networks both domestically and internationally as well as in the networks of the integrators and increasing number of private postal operators.

The changes in the postal market require that the postal operators have to develop their postal networks into different directions. Many of the postal operators have replaced their traditional post offices by outsourcing and franchising of post offices to third parties, and leveraging their post office infrastructure to enter new markets, e.g., financial services, insurance services, or high value retailing.

The digitalization has changed the role of the postal sector. There are four main phases in the process of digitalization of postal sector: postal automation, phases of revenue-generating digital services, phase of core-enhancing digital postal services, digital transformation. Also, there are four main drivers of digital transformation in postal sector: automation, digital customer access, connectivity and digital data.

All these drivers of digital transformation of companies and correspondence is having an impact on the core business activity of postal operators. The volumes of letters have been decreasing, particularly in the last couple of years. This leads to loss of revenue. At the same time digital innovations, e-commerce, data collection, and digital identity have been the core of postal operators' efforts to propose new services and adapt their organizational culture and strategy to the needs of the digital economy. All these efforts require a different postal infrastructure as well as different skills and patterns of employment for postal operators.

The impact of digitalization is not new, but the digital economy is entering a new phase that presents new challenges and opportunities. Digital tools are changing how postal operators are structured and how they communicate, and sell. This has triggered the digital transformation of the postal industry in many aspects.

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ESG management - the main factors of sustainable business in the postal logistics sector

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Abstract

Sustainability, along with globalization, e-commerce, and digitalization, is one of the main trends in business development, and is based on three main factors**: Environment** - the "Green" business; **Social** - Socially responsible business; **Governance** - Corporate management **(ESG).** ESG, with its guidelines, transforms the business into "smart" business for a sustainable future. In other words, it is a series of activities carried out by the companies, to achieve sustainable results for the welfare of the environment and the community in general. The implementation of the ESG management system, represents an organization of the company's business aimed at opening the new growth potentials, increasing competitiveness, contributing to the economy, employees and the customers. Given the significant impact postal service providers have on the environment and society in general, the paper analyzes the trends in the implementation of the ESG management system. It also contributes to the identification of the major activities carried out in the green business segment to contribute the carbon neutrality by 2050.

Keywords: *Carbon neutrality; Postal service providers; ESG, Environment Social Governance*

1 Introduction

Climate change is one of the key issues of the modern policies and strategic planning. To address key climate change issues, the European Union (EU) has adopted a European Green Deal [1]. The European Green Plan covers all economic sectors, in particular the transport, energy, agriculture, maintenance, building construction and industries such as production of steel, cement, textile, and chemicals, containing a framework plan to stop the climate change. Environmental issues are a key guideline for both the postal and delivery sectors. Postal service providers are therefore under pressure to reduce the environmental impact of their business, including, the level of greenhouse gas emissions.

The European Commission's Directorate for the Environment [2], identifies transport as a key area for environmental action. Transport accounts for almost a quarter of Europe's greenhouse gas emissions and is a major cause of air pollution in the cities. Road transport accounts for 70% of all emissions from the transport sector. Although postal and delivery service providers are likely to account for only a part of transport emissions, various policies and regulatory measures will probably maintain a pressure on postal service providers to reduce their carbon footprint in this area.

With the adoption of the European Climate Law Regulation [3], the EU's policy ambition to achieve climate neutrality by 2050 has become a legal obligation. By passing this law, the EU and its Member states have committed themselves to reducing the net greenhouse gas emissions in the EU, for at least 55% by 2030, compared to the 1990 levels. This objective is legally binding and is based on an impact assessment carried out by the European Commission. To become a society and economy with zero net emissions by 2050, our mobility sector needs to become more sustainable and smarter. It is estimated that emissions from the transport sector will have to be reduced by 90% by 2050, for the EU to achieve climate neutrality.

2 Current legal framework of the postal logistics sector

Neither the Postal Services Directive (PSD) [4] nor the Cross-Border parcel Regulation [5]

have any specific provisions on environmental sustainability. However, Article 5 of the PSD, deals with essential requirements that could cover sustainability issues. The term essential requirements is defined in Article 2 (19) of the PSD as:

general non-economic reasons which can induce a Member State to impose conditions on the supply of postal services. These reasons are the confidentiality of correspondence, security of the network as regards the transport of dangerous goods… and where justified, data protection, environmental protection, and regional planning.

Some regulators have stated that environmental protection is implemented in general national laws, but not necessarily in sector-specific regulations.

In addition, sustainable development is mentioned in Article 7 of the (Universal Postal Union) UPU Convention [6]:

Member countries and/or their designated operators shall adopt and implement a proactive sustainable development strategy focusing on environmental, social, and economic action at all levels of postal operations and promote sustainable development awareness.

Nine postal regulators that have been surveyed by (European Regulators Group for Postal Services) ERGP [7], stated that the UPU convention has been implemented in their national law postal services law.

Generally, and perhaps due to the lack of specific sustainability references in the postal legal framework, most of postal regulators stated that they have only limited experience with the sustainability issues of the delivery sector.

It should also be noted that the UPU during its 2021 Congress, adopted a resolution aimed at taking greater action and further cooperation in the mutual fight against climate change [8].

With the resolution, UPU made a commitment to investigate the setting of possible emission reduction targets for the postal sector and to introduce the carbon-neutral cross-border services. The resolution also boosted the exchange of knowledge on emission reduction strategies and climate adaptation of postal service providers.

An additional regulatory obligation arises from the Regulation (EU) 2020/852 [9], on establishing a framework to facilitate sustainable investments, introducing a general framework to determine whether an economic activity can be considered environmentally sustainable to determine the extent to which the investment is environmentally sustainable. The regulation defines six environmental objectives: climate change mitigation, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, and protection of biodiversity and ecosystem restoration.

3 The environment impact of the postal logistics sector

Postal and other delivery networks consume energy and water while producing excess waste. All these activities have an impact on the environment. Besides that, rapidly growing parcel volumes now require significantly more logistics and transportation capacity. As a result, postal and delivery service providers are facing the challenge of reducing the environmental impact of their business. To monitor the impact of the postal sector on climate change, in 2016 UPU launched the Online Solution for Carbon Analysis and Reporting (OSCAR) project [10]. This project provides a procedure for reporting of emissions from postal service providers and monitoring their performance in reducing such emissions. In parallel, the International Postal Corporation (IPC) in cooperation with 20 EU postal service providers and building on its previous Environmental Measurement and Monitoring system [11] (EMMS), in 2019 launched its Sustainability Measurement and Management System [12] (SMMS).

Many organizations, including postal service providers, are adopting the Greenhouse Gas Protocol (GHGP) standards for measuring and managing the greenhouse gas emissions. In particular, the GHGP [13] approach, divides the emissions into three scopes:

scope 1: direct emissions produced by the organization, ie from sources owned and controlled by the organization;

scope 2: indirect emissions from purchased energy consumption; and

scope 3: indirect emissions from the upstream and downstream organization activities, ie the

value chain emissions that the organization does not generate directly, e.g. from purchased goods and services

The SMMS also has a broader sustainability program, aligned with the UN's global sustainable development goals, most relevant to the postal sector, including learning and development, economic growth, responsible consumption, and production, aligned with appropriate climate actions. The latest SMMS report [14] presented the results of work for 2021 and measured the progress in each of the focus areas. The report indicates that the result of greenhouse gas emissions:

- for 2020, in scope 1 and scope 2, amounted to a total of 5.6 MT $C0_2$ and a common target for 2030 was set at 2.9 MT CO_2;
- for 2020, the energy used from renewable sources accounted for 33% of the total energy used, and the target of 75% for 2030 was set;
- it plans to increase the number of electric vehicles, from a 16% of the total fleet in 2020 with an increase of 25% of the total fleet in 2030.

The IPC further analyzed the data collected from postal service providers through SMMS, by comparing CO_2 emissions in relation to item volumes, ie their effect on the delivery of letters and parcels. The results at the level of the IPC member group are shown in Table 1.

Table 1: Delivery-related CO_2 emissions overview, Source: [14]

Delivery efficiency	2013	2014	2015	2016	2017	2018	2019	2020
Letter mail (grams Co_2 per item	35.6	36.1	36.5	36.4	35.7	36.3	37.6	40.8
Parcel (grams Co_2 per item	540.9	501.3	487.8	478.3	466.3	474.1	508.7	513.8

The measurement shows that CO_2 emissions per letter items are increasing, which is partly due to a decrease in their number (the average number of items per deliverer is decreasing) and in 2020 it has been determined on average, of 40.8 g CO_2 per letter item and 513.8 g per parcel. This represents an increase of 8% in grams of CO_2 per letter-post items and an increase of 1% for parcels, compared to 2019. However, if we look at the results throughout the period, from 2013, this is equivalent to an increase of 15% for letter-post items, but an average decrease of 5% per parcel. The decrease of 5% per parcel, is a consequence of alternative ways of parcel delivery introduction, but also of the increase in the average number of parcels per vehicle and per deliverer.

There are multiple ways to compare the postal service providers in terms of CO_2 emissions intensity, ie the volume of their carbon emissions in relation to a common business metric. For the postal sector, the most appropriate business metric for comparison, would probably be transferred postal items, but since not all countries publish detailed information on volumes, another metric that could be used is revenue (Figure 1).

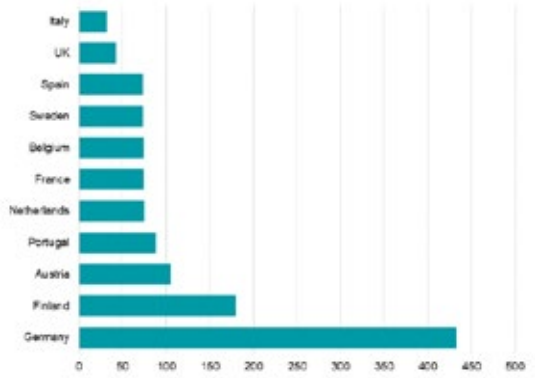

Fig. 1. Carbon intensity levels (CO_{2e} per €) among postal service providers, Source: [15]

Figure 1 shows the relation between providers total emissions and revenue (t CO_{2e} per 1M €).

4 Activites of postal services providers

Despite not being present in the national regulatory framework, most universal postal service providers (USPs) have already adopted and implemented a proactive sustainable development strategy with clear environmental objectives (Figure 2) [16].

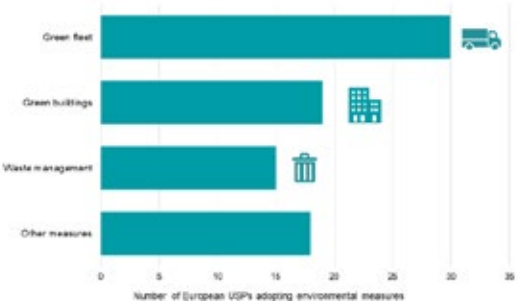

Fig. 2. USPs adopted environmental measures (Cullen International), Source: [16]

The USPs have replaced parts of their fleet with electric vehicles, some using renewable energy to supply energy to at least some real estate portfolio, while others have planned to

include waste management and other general environmental protection measures.

Table 2: % share of vehicles on alternative fuels, Source: [14]

	2012	2019	2020
Total vehicles	524 000	591 000	601 000
Total alternative-fuel vehicles	65 000	131 000	134 000
% of alternative fuel vehicles	12,4%	22,2%	22,3%

Table 2 shows the share of alternative fuel vehicles within the IPC SMMS member's fleet. According to the study Assessment and analysis of the impact of transport and delivery of e-commerce parcels on air pollution and CO_2 emissions, possible factors on the impact of reducing greenhouse gas emissions are shown in Table 3.

Table 3: Impact of trends on GHG emission reductions, Source: [17]

Category	Case study	Impact (default)	Impact (alternative)
Urban solutions: bundling	Increased density of pick-up points	-61%	positive
	White label city logistics hubs	-34%	marginal
Urban solutions: last mile reorganisation	Micro-hubs with delivery to consumer's home	-70%	marginal
	Micro-hubs with delivery to retail store	-63%	marginal
Rural solutions	Pick-up points at social hubs with fixed delivery dates	-73%	positive
	Virtual shopping as a new shopping concept	-70%	positive
Consumer decisions	Flexible consumer (office delivery and acceptance of delayed delivery)	-40%	positive
	Green consumer (choosing EU goods and self pick-up by e-bike)	-25%	very positive
Long distance legs	Modal shift from air to rail and sourcing more goods from EU	-28%	very positive
	Modal shift from air to rail	-1%	extremely positive

For each of the proposed assumptions, the impact of greenhouse gas emissions in relation to current trends was assessed, as well as an estimate of the reduction of greenhouse gas emissions by 2030, if the delivery processes to e-commerce users were carried out in accordance with the proposed alternatives.

For each of the assumptions, an assessment of its impact has been made, depending on:

- choice of means of transport
- distance travelled,
- number of stops
- package load per vehicle.

The most significant impact in the implemented assumptions can be achieved by the decisions of users who choose more flexible delivery and are ready to pick up their item on their own, in one place, using e-vehicles or walking. However, a much greater impact can be achieved by the mode of items transport over long distances (cross-border delivery), in a way that the railway is used as much as possible, instead of air transport. The research showed that if transport of goods over long distances, would transfer from air to rail, according to current trends, would have an impact of reducing CO_2 by only 1% by 2030. More significant impact could be achieved by an interventions in this area, which would enable the reduction of the emissions in this segment of the supply chain by about 98%. This indicates that the length of transport has less impact on greenhouse gas emissions compared to the mode of transport (the choice of means of transport). This option is also related to the flexibility of users, who would need to accept a slightly longer delivery times of international postal items.

5 Croatian post strategy – growing green and sustainable

The Croatian Post in the Pošta2022 Development Strategy [18], intensively conducts digital business transformation, which is closely related to increasing energy efficiency and reducing greenhouse gas emissions through three key business segments, shown on Figure 3.

Fig. 3. Main factors of sustainable business, Source: [19]

The reduction and the elimination of greenhouse gas emissions in the Croatian Post is focused on national and international goals, which are based on: the Paris Agreement, the EU Green Deal, and the National Development Strategy of the Republic of Croatia. Therefore, in April 2021, the Sustainability Management Strategy Growing Green and Sustainable [20] has been adopted, which includes segments shown on Figure 3.

5.1 Green business

The main goals of the Croatian Post green business are:

- Reduction of energy consumption and GHG emissions
- Expansion of the electric vehicles fleet
- Environmental protection through systematic waste management

- Encouraging the users to use alternative delivery channels such as parcel lockers

According to the stated goals, the current main sustainability projects are implemented are related to the continued procurement of electric vehicles and increasing the energy efficiency.

5.2 Corporate social responsibility

Corporate social responsibility is one of the development philosophies highlighted in the Pošta2022 Strategy, and corporate social responsibility is an integral part of Croatian Post's business.

- Humanitarian work
- Workers
- Scholarships and internships
- Community support
- Environmental Protection

6 Corporate management

HP - Croatian Post Inc applies:

- The Codex of corporate management with trade companies of the Government of the Republic of Croatia
- The Codex of corporate management of HP-Croatian Post Inc with the aim of improving the high standards of corporate governance and transparency of the company's business

Fig. 4. The Croatian Post's main goals of sustainable development, Source: [19]

To achieve the adopted Strategy, there are more than 200 electric vehicles in the Croatian Post fleet, of which 40 of them are electric four-wheelers and almost 30 are electric mopeds; three charging stations for electric vehicles were organized: Velika Gorica, Zadar and Osijek - the basis for further expansion of the electric vehicles fleet. Also, parcel lockers have been installed throughout the whole territory of the Republic of Croatia as a new delivery channel, which increases the percentage of delivery in the first attempt. With this kind of the organization of delivery, the mileage that vehicles cover while delivering has been reduced, which significantly reduces the emission of harmful gases.

It can be concluded that the main goals of Croatian Post sustainable development are:

1. ECONOMY – 500 million HRK per year contribution to the economy, more than 95% of the items delivered within three days and more than 85% of the items delivered within one day.
2. ENVIRONMENT – the reduction of CO_2 emissions by 300.000 kilograms per year, 10% share of e-vehicles in the total delivery fleet, 6 locations for installation of solar panels, development of e-charging stations network.
3. SOCIETY – keeping the number of post offices at more than 700, development of a network of parcel lockers at 300 locations in the Republic of Croatia, more than 500 children ensured through the Vaša pošta Foundation.

7 Conclusion

ESG management, as the main factor of sustainable business in the postal logistics sector, represents the future in defining the development strategies of postal and delivery service providers. A key element in defining development strategies is the balance between ESG management and financially sustainable management. Investing in the economy that will maintain jobs and create new workplaces, investing in society that will use the reduction of the GHG emission to ensure a healthier environment as well as the socially responsible businesses, are the key tasks of postal service providers and primarily the national postal service providers who are the key players in the market of the postal logistics sector. Mutual coherence of all market stakeholders (service providers, users, as well as the state/regulators) is the only way to achieve the goal of reducing the GHG emissions by 55% by 2030, ie to achieve the goal of climate neutrality without emissions by 2050.

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Implementation of modern information solution for greater efficiency of intermodal transport through Port of Bar Case Study – NAVIS

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Abstract

Digitalization of logistical processes is an unstoppable process. The shipping companies are imposing new trends on ports that they must follow. On the other hand, the efficiency of shipping goods is one of the basic prerequisites for the competitiveness of a port. In both cases, the port must have an information system developed that will successfully connect the shipping companies to the logistics community in the hinterland. The subject of this paper is the potential implementation of such solution in Montenegro, the US software solution NAVIS. The aim of the paper is to explain the current state and present the benefits that intermodal traffic through the Port of Bar would have by implementing an information solution like this. The methods used in the paper are analyzing data obtained from the official websites of the NAVIS, the experience of ports that use the subject solution as well as analysis of existing processes that take place through the Port of Bar in intermodal transport. The results of the paper will present its hypothesis, the greater efficiency of logistical processes in Montenegro and primarily the Port of Bar which will contribute to a better competitive position of Port of Bar in intermodal transport.

***Keywords**: Information solution, NAVIS, Intermodal transport, Port of Bar*

1 Introduction

A port needs to be seen as a transshipment hub catering for the needs of multiple transport modes that engages many different actors; private and public. With digitalization now entering the maritime and transport sector at an ever increasing pace, attention is now being paid to ensuring that the different modes of transport are much better connected to overcome the coordination and synchronization challenges that arise from port visits. In the emerging digital landscape, the different parties engaged along the transport chain need to take action to improve their coordination and synchronization by sharing the information upon which they have a mutual dependency. An increasing number of maritime and port authorities are now engaged in empowering digital collaboration among the actors in sea transport, and especially in relation to port operations [1]. Today, Small and Medium-Sized Ports (SMSPs), are jeopardized due to increasing pressure on them. The reason for it is lower integration into both horizontal value chains and vertical supply chains, thus, suffering from less freight volumes, missing smart specialization, low cognitive, organizational, or institutional proximity to and between macro-regional, national, EU, and international actors, outdated infrastructure, lack of investments and new business models accompanied by missing hands-on strategic foresight. The Adriatic Sea Region has 67 ports in five countries, of which nine are categorized as Core Ports, while the rest (58) are SMSPs.

Digital transformation in seaports implies huge potentials and opportunities to improve productivity and efficiency in logistics as well as to increase competitiveness [2]. In recent years, major ports around the world have been implementing new technologies to realize “Smart Ports,” in order to enhance international competitiveness, reduce environmental impact, and improve the workplace environment. In addition to the automation and labor-saving measures that have been actively pursued so far, smart ports are nowadays expected to benefit from the Internet of Things (IoT), Artificial Intelligence (AI), and Big Data 1 , as well as more focused initiatives, in specific the Physical

Internet (PI), based on the development of high-speed communication infrastructures, such as the fifth generation mobile communication system (5G). The robust use of the numerous digital technologies, such as the ones above-mentioned, offers substantial business innovation opportunities and requires numerous organizational adjustments [3]. Digitalization is expected to play a major role in improving efficiency in container shipping, said Soren Toft, CEO of Mediterranean shipping company, on IAPH World Ports Conference [4]. On official web site of Maersk line is written, "We all buy goods, track deliveries and pay online. Shipping with Maersk is no different "[5]. The digitalization of the economy is going to revolutionize our business. Today, our customers want more transparency, more speed, more immediacy, more interaction and more visibility. This requires a serious rethinking of how to approach shipping, and this is what we have started to do, said Rodolphe Saade, Chairman and CEO of CMA CGM [6]. Hapag-Lloyd has committed to making new investments in digitalization and automation over the next five years, as it unveiled details of its new 'Strategy 2023' corporate plan [7]. The container shipping industry is characterized by fierce competition. One way for shipping companies to gain a competitive advantage is to be one step ahead of competition in the digital transformation of their services and processes. Ports are under pressure to keep up with the shipping companies' demands, inter alia, in the digitization process. Some ports themselves are unable to meet the high expectations of the shipping companies and as a result we see the shipping companies becoming the owners and co-owners of more and more terminals around the world.

2 Research problem

On the territory of the once unique the Port of Bar, today there are two port operators, Port of Adria AD and Luka Bar AD. Container traffic takes place via Port of Adria AD container terminal. Unlike the operator Luka Bar AD, which has its own PCS (port community system), which does not have the ability to exchange EDI messages with shipping companies, Port of Adria AD has a modern information system that has the ability to exchange EDI messages with shipping companies in all container handlings while currently developing a system that will allow EDI messages to be exchanged in the area of invoicing services. However, although the Port of Adria AD information system is at a satisfactory level, the problem is that all the entities involved in the movement of goods via the Port of Bar territory ,are not connected to a single information system. The documentation structure is accompanied by a contractual documentation and information link between certain parts of the Port of Bar: Service manufacturers, freight forwarders, transporters, warehouses, electronic information centre, port operators, dockers, customs administration and other... one of the serious practical problems is the circulation of documents between different subjects, i. e. errors in numbers and procedures. This problem significantly increases the additional costs. It increases the retention time in certain places, sometimes even leading to the termination of contracts and / or client's confidence. This is why various electronic data processing systems are applied in the Port of Bar, operating on the principle of interconnection of all entities and elements of the integrated supply chain [8]. Within the Port of Bar, there are several basic container operations: unloading, transshipment and loading, control, disposal of cargo, storage and saving, transport, stripping and stuffing, repair and servicing. From the moment the container arrives at the Port of Bar to its loading on a means of transport (train, truck, vessel), several operations are taking place. Unloading the container is followed by a check of its accuracy. The containers are being loaded onto one of the said means of transport or being stripped. Empty containers are first put away and later stuffed with other goods, load onto one of the means of transport and shipped to a specific destination [9]. The flow of information within the port itself, has been well resolved. However, communication with customs brokers, customs administration, transporters, shipping companies representatives, etc. continues to be carried out with a lot of paper documentation which slows down processes and leads to inefficient time use, with higher costs and less competitiveness of the port. After the consignee of the goods sends the documents to his customs broker in Bar, the customs broker with the bill of lading goes to the shipping companies' representative to retrieve the document "Bez Zapreke", the container is free to be taken over from the port. Based on data from "Bez Zapreke", the customs broker

prepares the disposition order to port. The customs broker returns to his office where he prepares it. Since the port asks for the dispositions to be stamped and signed by the shipping agent and the customs administration, the customs broker must get back to the shipping agent's representative to sign and stamp the disposition order. The customs broker then goes to the customs administration to verify the port's disposition and goes to the container terminal. After receiving the dispositions order properly stamped and signed by shipping agents and customs administration, the port worker starts the activities of the work organization according to the subject disposition. Meanwhile, the customs broker returns to his office to prepare a customs declaration where he will enter the number of the truck after the port confirms that it will load that truck. While the port organizes the loading of the container onto the transport vehicle, the customs broker with the customs declaration prepared goes to the customs administration office and surrender a set of papers. In the meantime, he goes to the container terminal to make sure everything goes according to plan regarding the loading of his truck and returns in front of the customs administration office. After the truck comes from the container terminal in front of the customs administration office, the customs broker goes to the container terminal to get an exit from the port, i.e. a confirmation that the truck, after customs administration finish his part of job, can leave the port. After customs files a declaration, gets a way out document of the container terminal for the truck, handing over it to the driver. The customs broker goes to his office to copy the customs-filed documents to archive it for own purpose and the original handing over to the driver. Once the complete process has been completed, the truck can leave the Luke Bar Free Customs Zone. In addition to wasting a lot of time to dispatch one container, there is a lot of walk around the town of Bar. Sometimes, a few dozen kilometers. It costs. Vehicle depreciation, paper documentation, crowds forming outside the offices of shipping agents, customs, container terminals... are some of the problems that make the cargo flow through the Port of Bar significantly less efficient than in competing regional port which have installed NAVIS-Terminal Operating System. Figure 1 gives an operational view from the moment the owner surrenders the documentation to its customs broker until the moment the means of transport leaves the Port of Bar.

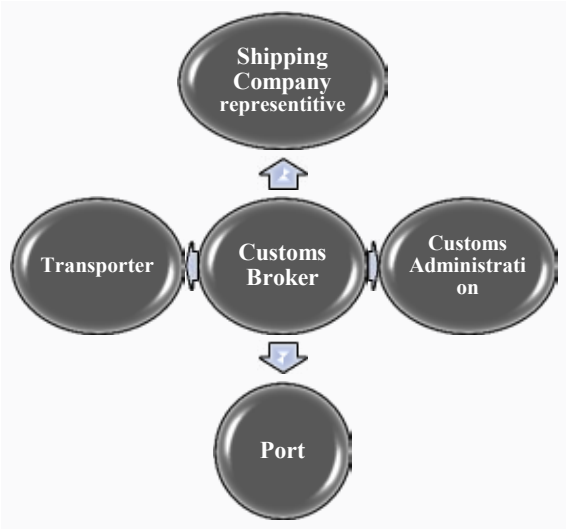

Fig. 1. The present manner of communication of logistics stakeholders in the town of Bar (Source: Authors)

3 NAVIS – Terminal Operating System

NAVIS is a provider of operational technologies and services that unlock greater performance and efficiency for the world's leading organizations across the cargo supply chain. NAVIS combines industry best practices with innovative technology and world-class services, to enable its customers, regardless of cargo type, to maximize performance and reduce risk. Through its holistic approach to operational optimization, NAVIS customers benefit from improved visibility, velocity and measurable business results. Whether tracking cargo through a terminal, improving vessel safety and cargo capacity, optimizing rail network planning and asset utilization, automating equipment operations, or managing multiple terminals through an integrated, centralized solution, NAVIS helps streamline operations. With more than 340 customers in over 80 countries, NAVIS is the global standard for terminal operating systems (TOS). N4 has been implemented at more sites than any other TOS provider, and no other TOS can match NAVIS' unique capability to optimize the planning and management of container and equipment moves at a terminal. NAVIS N4 scales with business to optimize utilization of IT infrastructure and eliminate unnecessary, upfront capital expenditures. The

flexible N4 architecture allows terminals to create clusters of database and application servers, allowing TOS to grow to meet demand. The NAVIS Smart technology also allows terminal operators to unleash and monetize the vast abundance of data being collected in and around their terminals - including water side and inland - to optimize planning, visibility and asset utilization for all players in their eco-system. All terminals, regardless of the operational type, have to maximize use of their limited resources. N4 optimization solutions help terminal operators automate decision making and elevate productivity across a range of critical operational and business processes. N4 optimization modules take a holistic approach to streamlining operations to ensure that land, labor and equipment are used in the most productive fashion [10]. Most of competition of the Port of Bar and other regional ports uses NAVIS. All cargo and vessel in Rijeka processing is done through Terminal Operating System (TOS) NAVIS implemented on 29.01.2012. It also includes internal processes as well as interaction processes with 3rd parties needed in order to provide smooth and clear container flow through terminal. Main interaction parties are the shipping lines (local agents and vessel planners), freight forwarders and rail operators/dispatchers [11]. **DP World Constanta,** located in the western Black Sea, in Romania, announced that it is migrating to NAVIS' **N4 port operations system. Constanta South Container Terminal (CSCT)** has operated with NAVIS systems for 16 years and with a current annual capacity of 1.2 million TEUs and an average of 26 movements per hour. "The ability to absorb new and innovative thinking, and see it through, is what sets world-class companies out of the ordinary," said **Chuck Schneider, Director of Customer Service at NAVIS.** It focuses on innovating and optimizing its assets so that it can offer smarter solutions that enable commerce to meet the needs of its clients and advance global commerce in a reliable, efficient, effective and responsible manner. N4 represents an opportunity for DP World to fully exploit their experience and capabilities as trade facilitators and help drive economic growth in Romania. As the next step ahead, Terminal Container Ravenna TCR started an innovative digital project, introducing NAVIS N4 as the terminal operating system (TOS), DSP DATAVIEW as its Business Intelligence System in order to increase efficiency and productivity and SEVEN by SIS as the customs management system [12]. Terminal Intermodale Venezia (TIV), part of Hili Company, has gone live with NAVIS N4 TOS. On Sunday 23rd June 2019 the first container was discharged from MSC GIOVANNA using N4[13]. Alket Malo, CFO of Durres Port Authority, said, "The implementation of N4 SaaS is a significant advancement for Container Terminal of Port of Durres and one that we firmly believe will lead to improved efficiency across our operations, a more seamless exchange of information with key stakeholders and a broadened portfolio of services that we can offer our customers. Beyond that, the additional layer of security afforded to us through cloud operations, along with increased visibility, transparency, and traceability of our operational processes, will be key to expediting law enforcement activities within the port**.** Capt. Jan Nowak, Director of ACT Burgas, said: "With the implementation of N4, our terminal achieved a major milestone on our way to becoming a twenty-first century container terminal, operating to worldwide industry standards. Together with the investments we have made in the yard and handling equipment in recent months, this constitutes a significant step forward, but not the end, of our modernization plan. The new operating platform provided by NAVIS opens a range of new opportunities for all port stakeholders and will help us to become the main gateway terminal for Bulgaria, and perhaps, a transshipment terminal for the Black Sea region," . N4 provides ACT Burgas with a proven platform for the management of its container operations, as well as supports the implementation of standard processes and EDI at the terminal [14].

4 Benefits of possible implementation NAVIS in Port of Bar

Although the possibilities of NAVIS are greater and it is possible to achieve a greater interaction than presented in this paper, the focus has just been placed on the weak points concerning the intermodal activities that are taking place today through the Port of Bar. In this sense, the NAVIS system would provide all logistics stakeholders with a common information environment that would be visible to all and that would be accessible to all from their

offices as regards their part of the work. In a conversation with representatives of logistics companies in Rijeka, which use the NAVIS system, it is clear that customs brokers do not need to leave the office, but do all the data exchange and processing via the computer. There is no need to create queues in front of the shipping companies' offices waiting to be issued with the document "Bez Zapreke" and the signing/stamping of the ports' disposition orders, which creates discomfort for both. There's no need for traffic jams. Also, in front of the customs administration office and terminal there's no unnecessary waste of time and paperwork. All interaction takes place through the common platform NAVIS. The concrete benefits are time and money savings which is reflected in practice in the fact that the customs brokerage service for one container in Rijeka is EUR 15 / container while in the Port of Bar the average price of the same service is EUR 40 / container. Due to the unnecessary waste of time, logistics entities in the town of Bar are not able to devote themselves to the production of added value services and all this together contributes to making the Port of Bar less competitive than Rijeka and other ports that use the NAVIS system. Figure 2 presents a solution for how the interaction with the NAVIS system should look in the Port of Bar.

Fig. 2. The proposed manner of communication of logistics stakeholders in the town of Bar (Source: Authors)

5 Conclusion

It is argued at the beginning of this paper the importance of Digitalization of logistical processes that an unstoppable process. All the ports of the world must adapt to the needs of shipping companies. The requirements for digitizing the process are one of them. The efficiency of shipping goods is one of the basic prerequisites for the competitiveness of a port. The research raises an important question on how using NAVIS may increase the cargo flow through the Port of Bar. The regional ports of Durres, Rijeka, Burgas and Constanta, which are the direct competition to the Port of Bar, have already installed the NAVIS system, which is one of the reasons that gives them much better business results than Luka Bar has. Using the methods of analysis and comparison, it is concluded that due to not efficiently connection between logistics stakeholders in Bar, a lot of time and resources is being wasted what make processes of dispatching cargo less efficiency and more expensive. The hypothesis of this paper is confirmed that in the case of NAVIS Terminal Operations System implementation in Bar, the logistics route via Bar port would be more efficiency and cheaper. Additionally, it would bring more time to logistics stakeholders in Montenegro for the new value added services what would bring new value and better competitive position in the region. All of the stakeholders in Bar should keep in mind the importance this topic and work towards realization.

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Critical communication capacity

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Abstract

The need for the communication capacity (postal and telecommunications) increases daily during major incidents (pandemics and wars). The main aim of the paper is seeking an answer to the question "Was the structural and functional separation of telecommunications and the postal service necessary in the 20th century" The main elements of the network and service mergers in the future are also discussed in the paper.

***Keywords**: Postal, Telecommunications, Services, Pandemic*

1 Introduction

The need for communication grows worldwide in the times of major economic, health and security crises.

Social networks are booming, government services are being digitalized, distance learning is taking place, e-commerce is reaching unimaginable proportions, and postal and telecommunication services are using the maximum capacity of the existing infrastructure. What demand will be for communication capacities is beyond imagination.

The picture of the world has definitely changed. Independent communication networks are not enough, but the synergy of different communication infrastructures, networks and channels that will meet user needs for electronic and physical communication has to be considered.

This new communication chain will be as strong as the weakest link in it, and all the participants in it will have to contribute to an increase in the communication ability through the growth of the capacity of the existing and a new infrastructure. For example, the operators of public electronic communication networks have the right to request that another operator's or third party's electronic communication infrastructure should be shared when it is necessary for a competitive, economical and efficient performance of electronic communication activities, and universal postal service operators (UPS) are obliged to provide the access public postal network (PPN) to other operators on the market in order to perform the UPS.

The pandemic has taught us that user demands have changed. Many users have begun to use electronic communications so as to provide services in the trade, distribution, health or education sector. E-commerce has flourished even in rural areas.

In the world today, a small number of telecommunication and postal companies provide universal services, and almost all of them have the last-mile problem. Postal companies are reducing the number of their PPN units and the number of the UPS employees looking for new ways of delivery (delivery in the post office instead of a last-mile delivery) and telecommunication companies are using interoperability in order to solve the unprofitable last-mile problem.

Universal services are not expected to be profitable, and the approach used in many countries significantly reduces the communication capacity needed in the times of a crisis, war, and long emergencies.

The very process of the structural and organizational separation of the Post and Telecommunications has significantly reduced the strength of both communication systems in situations of emergency.

After the XX Washington UPU Congress in 1989, both sectors set out to meet user needs for

new sophisticated services in search of a profit and the liberalization of services and networks.

Although there is a satisfactory offer of postal, courier and electronic communication services in urban areas today, there have yet been gaps between supply and demand in the conditions of the Covid 19, the so-called "lockdown" pandemic. All this has been even more pronounced in rural areas.

The research study shows that there is the need for the convergence of postal and telecommunication networks and services in the field of universal postal and telecommunication services [1].

2 The Critical Communication Capacity and the PT Network

The aspects of the convergence of the postal and telecommunication networks can be described according to [1] in (Table 1).

Table 1. The aspects of the converging physical and electronic messaging services [1]

	Post	**Telecommunications**	**Trend towards convergence**
Consumer need	Reliable written communication over long distances	Written communication over long distances	Yes, consumer ask for fast and reliable access to messages
Product / Technology	Letter mail and parcels	DSL, wireless	Yes, substitution by electronic messaging
Frequency of service	One per day (5 to 6 days per week)	Continuous	Driver for convergence-
Speed	Low Trend: lower (fewer deliveries per week)	High Trend: differentiated (net non-neutrality)	Driver for convergence
Coverage	Nationwide	Nationwide	-
Reliability	Reliable	Less reliable	Yes, by digital IDs provided by postal operators
Confidentiality, integrity	High	Rather low	Yes, people trust in brands of postal operators
Price	High Trend: higher	Low Trend: lower	Driver for convergence
Accessibility	Postal retail outlets or post box criteria based on distance	All residences and business offices on request	Driver for convergence
Scenario for USO reform	Reform in delivery models and frequency	Electronic convergence (fix and mobile infrastructure) or technology neutrality Increased minimum speed	Yes, by hybrid services

2.1 The public postal network (PPN)

Designated (national or public) postal operators have long borne the burden of the universal service obligation (USO), according to which they are obliged to deliver at a uniform price to every home and business in the country although the costs of such delivery to remote areas may often be much greater than the uniform price itself. This burden has become heavier over the past thirty years, and for the three reasons. Firstly, the privatization revolution of the 1980s confronted the incumbents with competition from new players not burdened with the USO. These entrants often had a lower cost base and were able to fix lower prices, thereby eroding the margins having formerly been achieved by incumbents in a more profitable urban market. Still subject to the USO, many incumbents saw margins fall below the cost of capital and many went into a loss. Secondly, the internet revolution (dating from the early 1990s) has transformed the economics of postal services around the world. It has reduced demand for letter mail because emails are a cheaper and quicker means of communication, thereby reducing revenue. On the other hand, it has boosted demand for parcel items as online shopping has taken a growing share of the retail market, all to the detriment of the high street and the shopping mall. An industry struggling to adapt to these seismic changes was further hit by the Great Recession in 2007, the recession being the worst in the postwar era. Some countries recorded a 4% decline in the real output at the low point of the crisis and the subsequent recovery was anemic due to past standards, leaving the economic activity subdued for a decade or even more. The impact on postal volumes which track the GDP growth very closely was huge. The Great Recession ushered in a new era of falling letter volumes. These three factors – the internet revolution, the privatization revolution and the Great Recession – have affected incumbent postal operators everywhere. The threat scale broadly differs from one country to another, depending on the regulatory environment in the jurisdiction and the intensity of the competition from new entrants, how badly their economy/economies was/were affected by the Great Recession and how rapidly they responded to falling demand for letters by switching to the fast-growing parcel market [2].

These problems were solved in several ways, namely by:

- putting up the UPS prices,
- reducing the delivery frequency, and
- reducing the minimum number of postal units.

These variations are not readily explained by the obvious factors such as the size of the land mass served, the population density or the number of the letters or parcels delivered per capita [3].

2.2 Public telecommunication network (PTN)

The telecommunications sector originated from the postal sector. Historically, the first communication systems were actually postal systems. With the development of technology, an accelerated data transfer, the telecommunications sector has developed within the postal sector. The liberalization and privatization of public operators have led to a loss of the synergies between these two sectors. At the same time, a universal service was much needed in both sectors. However, both universal services most frequently developed independently, slowly and with great difficulty in the last mile.

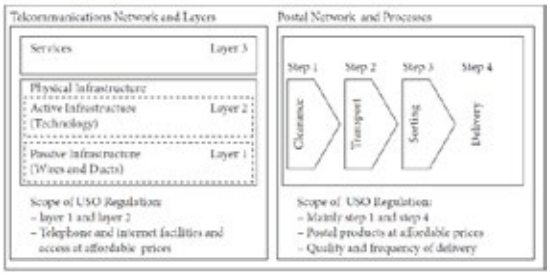

Fig. 1. Approaches to the network analysis: the telecommunication infrastructure vs. the postal value chain [1]

The biggest losers of the unbundling were those in rural areas, where privatized operators did not see a chance to make a profit. The state simultaneously took care of the amount of the costs and investments in the network.

The quality of the service was controversial in rural areas. Postal operators addressed this issue with the "exceptions to the five-day last-mile delivery" and telecommunication operators used interoperability as an option to make fixed-line replacements with mobile communications.

The public fixed telecommunication network is a telecommunication network which, is used in whole or in part to provide various public telecommunication services between the fixed terminal points of the network, including the access infrastructure, as well as the infrastructure for connecting public telecommunication networks inside a certain territory and outside it.

The public mobile telecommunication network is a telecommunication network which is implemented in whole or in part through the public mobile telecommunication network on certain radio frequencies [3].

2.3 The public postal and telecommunication network (PPTN)

Similarly to the rest of the global economy, the postal and telecommunication sectors are being faced with unprecedented change as the decades-long trends of liberalization and digitalization are continuing to transform the world or these two sectors. The United Nations system works towards the achievement of the 2030 Agenda and its Sustainable Development Goals (SDGs). Governments should decrease gaps in postal and telecommunication development through increased investments and focused policies and promote various ways to utilize networks for socioeconomic development. Regulators should harmonize and enhance the sector's regulatory framework. Operators should seek to enhance their performance by implementing diversified strategies and operational improvements. Ultimately, other stakeholders from the private sector and public institutions should pursue integration into the sector by engaging themselves with traditional stakeholders and *vice versa* [2,3].

In order to achieve the goals, it is necessary that services should be digitized, and the necessary infrastructure provided with the optimal communication capacities. In addition to telecommunication companies on the market, such as service and network operators, there may also be postal, courier and logistics companies developing their solutions by offering different types of services or the infrastructure. For example, the Post of Serbia has developed its own PTT net solution (now owned by Telekom Serbia). Today, the Post of Serbia has a very well-developed computer network reaching out to the rural area (1,500 locations). Such networks with interoperability with other networks providing different services may contribute to an increase in the communication capacity.

2.3.1 Synergy factors in PPTN

Today, technological connectivity – electronic communications are based on the use of a number of connected, technologically diverse networks. As a precondition for the system to work well in this area, technological neutrality is stated, which is justified from the point of view of achieving the maximum utilization of available resources, i.e. as a good platform for the further development of the infrastructure and research in the field of electronic communications. It should be borne in mind that periods have been changing throughout the history of telecommunications in which some of the existing technologies have fallen into oblivion, having been replaced by new ones. Later, thanks to new achievements in science and the technology of production of certain assemblies, cables or just signal transmission and processing techniques, the conditions have been created to return to the previous, now significantly improved directions of telecommunications development. Thus, in the last fifty years of telecommunication development, the periods of the domination of various system solutions have changed. Given the decline in the prices of optical telecommunication systems, as well as their strategic importance to the development of electronic communications networks, electronic services and information society as a whole, the predictions that the FTTH will be the most common Internet access in the next decade have had their justification, as shown in Figure 2. As the basic access to the Internet, the ADSL has completely been abandoned in developed countries. Copper cables are either being replaced by optical fibers, or a new infrastructure is being installed, which explains the trend of this technology's intense decline. Mobile telecommunications are also showing a declining trend, given the fact that the market has been saturated. What can be a great incentive for their further development is a possibility of introducing broadband access within the scope released on the basis of the digital dividend. The EU sees this as its way out of the economic crisis.

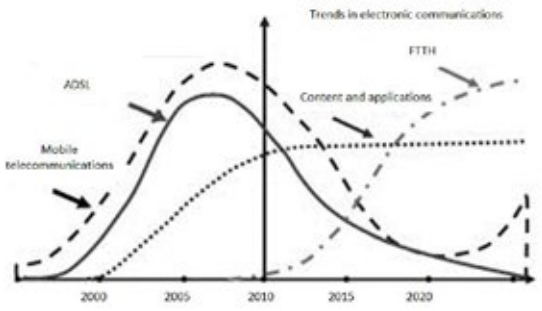

Fig. 2. The trends in the development of electronic telecommunications [4]

It is in this that a great opportunity for the synergy of the postal and telecommunications infrastructures is perceived in forthcoming years.

Availability – the postal and telecommunication networks are compatible. In rural areas, there was a telecommunication hub in each post office, which may continue to be crucial for access to optical networks. The services that the post office can offer are numerous. Availability is one of the features of the universal service, and post offices in rural areas are located at a maximum distance of 3-6 km from the last user. This potential cannot be provided by any network other than the public postal network. The existence of two networks creates big difficulties, especially so for the state itself, which must provide universal services. That is why the existence of a single universal PT service network is one of the solutions.

More services – The development of a public PT network would be the basis for the introduction of more services in the rural area. The network access could be enabled at affordable prices without discrimination (either universal or other services) with respect to operators and users.

A better quality – Prior public networks were built so as to satisfy universal services in both the price and the quality. The volume of the universal service was falling, and the network was a big burden. The consequences were the incurred losses and the operator's requirements to reduce the universal service obligation (USO). Not to mention the problems in applying the methodology for tracking costs and compensating USO losses.

The proposed PT network solution would be considered as a critical communication and state resource ready to respond to all challenges while simultaneously earning through the acceptance of all the existing services, affordable UPS prices and other commercial services under the access contract.

Of course, it is very difficult to form such a PT network under today's circumstances, in which the universal service providers have already heavily invested in their infrastructure. Most operators have been privatized in the EU.

In today's conditions, the PT network could be defined in those areas that represent a loss for the PT universal service operators. In this way, the state would avoid the obligation to compensate for losses incurred in universal services and would be given the opportunity to increase profitability by opening a PT network in unprofitable ventures for all PT services.

The critical communication capacity that may be achieved through the synergy of the postal and telecommunication networks and services is not just a simple sum. Synergies in rural areas would greatly reduce the network maintenance costs, and they would increase its availability and quality. In these areas, these networks are now working in parallel, with the engagement of twice as many human and material resources. In addition to cost reduction, the development of a single universal PT network in non-profit areas would ensure that revenues are sufficient to provide the universal service without any reduction with high-quality services.

2.3.2 The critical capacity PPTN design

Networks in rural areas are useful for increasing critical communication capacities in multiple ways. In addition to expanding the existing infrastructure and increasing the availability of all PT services, they create an opportunity for users in rural areas to raise the IT education level. An opportunity is being created for the development of rural regions not at the expense of any PT company, but exclusively as a result of a clear state policy on development.

Determining the area to be covered by the common state-owned PT network is very complex and requires a general analysis and answers to the questions where we are now, where we want to be, and how we will achieve it. The strategic management of the PT network planning is very sophisticated. Figure 3 briefly describes the area selection procedure and the implementation of the PT universal network.

3 Conclusion

The privatization and liberalization models in the postal and telecommunications sectors have not led to satisfactory results in all countries. Even in the European most developed countries there are the UPS postal operators that are making losses in the USO, while simultaneously the influence of private postal, courier and logistics companies has been spreading on the liberalized market in the most profitable segments. The latter do not have the USO and only provide the services that generate a profit for them.

In the telecommunications sector, the situation is a little different, because fixed and mobile telephony appears as a public service, i.e. services are established in rural areas through interoperability. The network maintenance and fieldwork are the problem with these operations, which provokes additional problems as well.

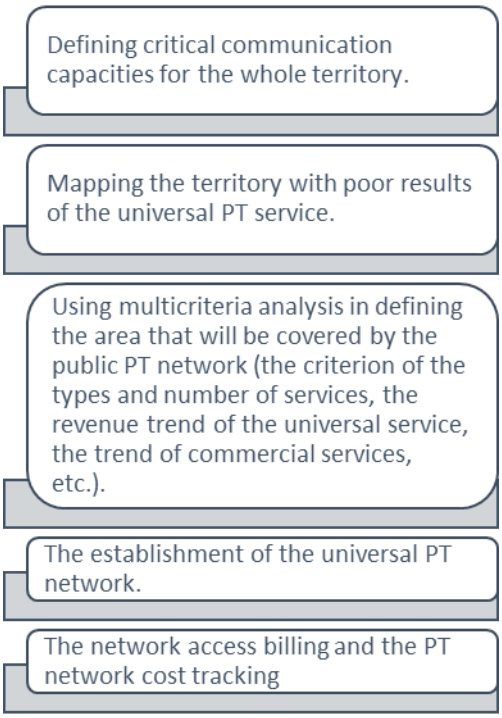

Fig. 3. The PT universal network establishment methodology

It is precisely for the reason of this fact that the synergetic effects of the public PT network establishment in peripheral rural areas would contribute to reduced costs in both areas. PT technical staff may simultaneously provide services in both these sectors and provide the necessary training to the population in order to make a greater use of IT.

The revenue generated from access to the PN network would be used for the development of the PT network and the services.

Acknowledgment

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Machine learning models for prediction of mobile network user throughput in the area of trunk road and motorway sections

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Abstract

User throughput in the telecommunications network stands out as one of the key performance indicators. Today, telecommunications service providers have the task of providing a reliable and secure connection for users in all geographical locations and at all times, and adequate network throughput to meet the growing need for streaming services. These requirements primarily apply to areas around important roads, such as motorways and trunk roads. The main goal of the research is to create models based on machine learning techniques for predicting the average user throughput in the M:tel network, in a geo-area that includes the section of Motorway "9th January" (M9J), Banja Luka-Doboj, between the Johovac node and the town of Prnjavor, and the area of the M17 trunk road section, between the Johovac node and the town of Doboj. Predictive models were created on the IBM SPSS Modeler software platform, and a comparative method was used to compare and select the models that show the highest prediction accuracy. The results have shown that k-Nearest Neighbors (k-NN)-based models have the highest prediction accuracy for both sections, with the model created for the trunk road section having significantly better performance.

Keywords*: Average user throughput, Predictive models, Machine learning techniques, k-NN*

1 Introduction

The development of wireless network technologies, the enormous increase in the number of mobile applications and the expansion of the range of telecommunications services have conditioned the need for constantly better network performance. Today, telecommunications service providers and network applications have the task of providing a reliable and secure connection for users in all geo-areas and at all times, and appropriate throughput in the network to meet the growing need for streaming services. These requirements primarily apply to areas around important roads, such as motorways and trunk roads. Special attention is paid to the throughput in downlink traffic which makes up the largest part of generated network traffic. To meet customer needs and improve the quality of user experience (QoE), telecommunications providers must use the prediction of key performance indicators, such as throughput, which determine the direction of development and expansion of network capacity and resources in the future. This task is solved by predictive modeling, where prediction is defined as a prediction modeling method from the present to the future based on data obtained in the past.

For the case study in this research, it was selected the geo-area of the road zone of Motorway "9th January" (M9J), Banja Luka-Doboj section, between the town of Prnjavor and the Johovac node and the area of the M17 trunk road section between the Johovac node and the town of Doboj. The observed sections are of great importance in the road system, i.e. the road network of the Republic of Srpska and Bosnia and Herzegovina. The M9J Banja Luka-Doboj is a key road connecting the western and eastern part of the Republic of Srpska, and the M17 trunk road is one of the busiest roads in BiH. The geo-area of the research is covered by the 4G – Long Term Evolution (LTE) telecommunications network managed by the M:tel BL provider.

Throughput prediction in the cellular network at locations related to roads is the subject of numerous studies. In the previous period, a large number of scientific papers referring to this topic were published. According to [1], methods for predicting user throughput can be divided into three groups: methods based on formulas, methods based on historical data and methods based on machine learning techniques. In [2], the authors presented the Random Forest (RF) model for throughput prediction in the LTE network, emphasizing its application in maintaining a reliable connection of autonomous vehicles with infrastructure. The same machine learning model was proposed in [3] for LTE network throughput prediction, for different mobility scenarios. Additionally, the RF model was created in [4] to predict Video Streaming throughput. As a result of research in [5], it has been created models based on different Deep Neural Network (DNN) approaches, which enable throughput prediction in areas where there is no previous data on mobile network performance. When using a Live Streaming service, especially at high vehicle speeds, frequent fluctuations of Uplink connection throughput occur, which causes service delays. As a possible solution to this problem, the authors in [6] suggest PERCEIVE, a bandwidth prediction framework based on the Long Short-Term Memory (LSTM) model. Throughput prediction in data transmission between vehicles in future 6G networks is the subject of research in [7]. For this purpose, the authors created several models: Artificial Neural Network (ANN), RF and Support Vector Machine (SVM). Ur Rehman et al. in [8] modeled downlink throughput in the LTE network based on several independent variables related to the conditions of radio networks (traffic) using multilayer neural networks.

The main goal of the research is to create models based on machine learning techniques for the prediction of the average user traffic throughput in the M:tel network in the observed geo-area. The sections are exposed to different conditions: different average speeds of users' vehicles, different number of handovers, different concentrations of users, different cell sizes, etc. Therefore, to increase prediction accuracy, it is necessary to create predictive models separately, for each section individually.

The syntactic structure of the paper consists of four sections. After the introduction, Section 1, Section 2 contains described materials and research methods. The main emphasis is on Section 3, which provides the most important research results and discussion. Concluding remarks are given in Section 4. At the end of the paper, there is an overview of references.

2 Materials and methods

Following the basic goal of the research, the paper uses the *Data-Driven Prediction* approach to create predictive models. The application of this approach has been in expansion in recent years along with the enormous increase in the availability of *Big Data*. As a result of the ability to learn from data, machine learning models establish connections between dependent (output) and independent (input) variables and, based on "learned" functions, generate output values for given inputs. The most well-known machine learning techniques are ANN, Decision Trees, SVM, k-Nearest Neighbors (k-NN), etc. Thus, the data-driven prediction approach implies the existence of a data set that is divided into two parts: a data set for training and a data set for model testing. Therefore, data collection is the first step of the methodological research procedure, which is algorithmically shown in Fig. 1.

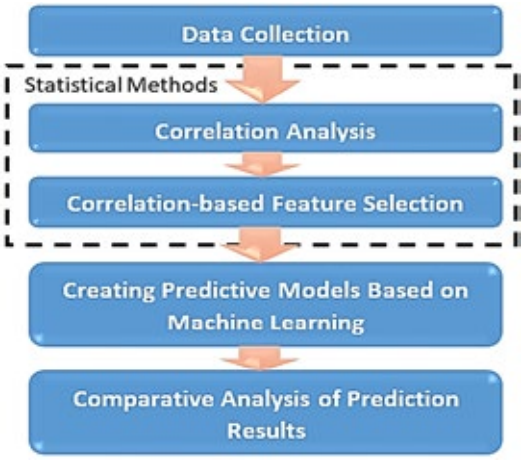

Fig. 1. Methodological research procedure

2.1 Data Collection

Fig. 2 shows the geo-area of the research. The length of the M9J Banja Luka-Doboj section from Prnjavor to the Johovac node is 35 km and in Fig. 2 is marked in blue. The section of the M17 trunk road, between the Johovac node and the town of Doboj in the length of 12 km, is marked in red in the same figure.

Fig. 2. Observed road sections: Prnjavor-Johovac (blue) and Johovac-Doboj (red)

Research data were obtained from the mobile operator M:tel based on a previously submitted Request specifying the necessary variables [9]. The obtained database for the LTE network contains data from a total of 71053 measurements. The values of the variables were registered in a period of 30 days (from 15 December 2020 to 15 January 2021), with a sampling frequency of one hour [9]. The data are structured into (input/output) vectors, where 17 independent variables, listed in Table 1, represent the input part, and the dependent variable –average user throughput (USER_DL_TR), the output part of the vector [9]. In addition to the names of variables, Table 1 also provides abbreviated labels (V…) used further in the paper.

Table 1. Names of independent variables with abbreviated labels

Name of Variable	Abbreviated Label
Downlink (DL) Physical Resource Block (PRB) usage rate [%]	V1
Average Channel Quality Indicator (CQI)	V2
Number of attempts by the User Equipment (UE) to establish a connection with an eNodeB	V3
Number of successfully completed connection setup procedures	V4
Average number of UEs in the connected state in the cell	V5
DL retransmission rate [%]	V6
Initial Block Error Rate (iBLER) [%]	V7
Total aggregated DL traffic in the cell [Gbit]	V8
Number of Transport Blocks (TB) with initial errors under 16QAM modulation	V9
Number of TB with initial errors under 64QAM modulation	V10
Number of TB with initial errors under QPSK modulation	V11
Number of retransmitted TB into DL shared transport channel under 16QAM modulation	V12
Number of retransmitted TB into DL shared transport channel under 64QAM modulation	V13
Number of retransmitted TB into DL shared transport channel under QPSK modulation	V14
Number of initially emitted TB into DL shared transport channel under 16QAM modulation	V15
Number of initially emitted TB into DL shared transport channel under 64QAM modulation	V16
Number of initially emitted TB into DL shared transport channel under QPSK modulation	V17

By extracting data from the obtained M:tel database, a set of a total of 9886 input/output vectors was formed for the Prnjavor-Johovac section, while 2301 input/output vectors were selected for the Johovac-Doboj section. This difference in the number of vectors for the two sets is due to the different lengths of the sections, and thus the different number of cells covering them.

2.2 Correlation Analysis

The quantitative expression of the measure of linear correlation between two variables is the Pearson correlation coefficient (r), which can be defined by the ratio of the covariance of two variables and the product of their standard deviations. The values of the Pearson correlation coefficient range from -1, which represents a

perfect negative linear correlation, and 1, which represents a perfect positive linear correlation. A value equal to zero means that there is no correlation between the variables. Any value from the specified interval can be interpreted according to the scale shown in Table 2.

Table 2. Pearson Correlation Scale [10]

Absolute correlation coefficient value	Qualitative assessment
$0< \|r\| \leq 0.19$	Very Low Correlation
$0{,}20 \leq \|r\| \leq 0.39$	Low Correlation
$0{,}40 \leq \|r\| \leq 0.59$	Moderate Correlation
$0{,}60 \leq \|r\| \leq 0.79$	High Correlation
$0{,}80 \leq \|r\| \leq 1.0$	Very High Correlation

2.3 Correlation-based Feature Selection (CFS) Method

The CFS method allows the number of input/independent variables to be reduced based on previously performed correlation analysis to simplify the machine learning model. Pearson correlation coefficients help identify independent variables that may have a stronger influence on dependent variables. Thus, a higher correlation coefficient means that the observed independent variable can be considered a strong predictor of the dependent variable [11]. According to [12], a set of variables is representative for the prediction model if, in addition to a strong correlation between independent and dependent variables, there is as low correlation as possible between independent variables. The mathematical function that defines this correlation is Merit – heuristic evaluation function:

$$M_s = \frac{k\, r_{cf}}{\sqrt{k+k(k+1)r_{ff}}} \qquad (1)$$

where M_S is the heuristic evaluation function of the subset S containing k variables; r_{cf} – arithmetic mean of correlation between independent and dependent variables; r_{ff} – arithmetic mean of correlation between independent variables. There are three heuristic strategies for finding the best subset (with the largest Merit): forward selection, backward elimination, and best first [11]. This paper uses the forward selection strategy, which is presented algorithmically in Fig. 3.

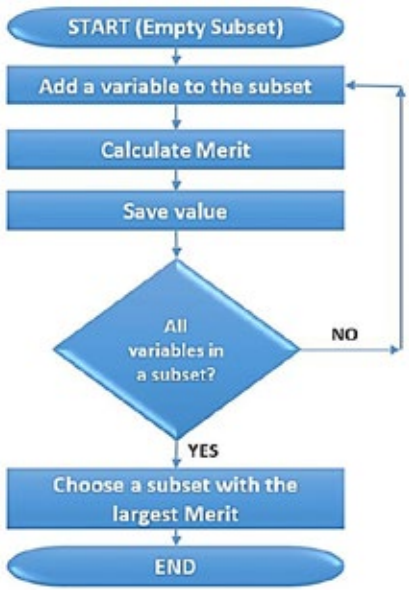

Fig. 3. Forward selection search algorithm

The algorithm shown in Fig. 3 starts with an empty subset of variables. In each subsequent step, based on a certain criterion (e.g. correlation), the following independent variable is added to the existing subset and Merit is calculated. When all the variables of the initial set are added to the subset, the subset with the highest value of the heuristic function is selected. The algorithm ends with that step.

2.4 Creating predictive models and comparative analysis of prediction results

Models for predicting average user throughput in the network were created in the SPSS Modeler software package. This software platform is one of the leading solutions in the field of Data Science, and especially machine learning. Supported techniques include Neural Networks, Classification and Regression Tree (C&R), Chi-square Automatic Interaction Detection (CHAID), linear regression, generalized linear regression, logistic regression, Bayesian Network, SVM, k-NN. A key role in this paper is played by the method of automatic modeling, which simultaneously examines several models of machine learning with different parameters according to a supervised learning paradigm. The SPSS Modeler automatically ranks offered solutions, which is possible based on correlation, relative error or the number of variables used. Comparative analysis of the offered solutions is given in the Results and discussion section based on relative

error, which represents the ratio of deviations of the observed values of the test set from those predicted by the model and deviations of the observed values from the arithmetic mean of the test set.

3 Results and discussion

This section presents the most important research results. According to the methodological steps in Fig. 1, first the results of correlation analysis are given, then the results of the application of the CFS method, and finally prediction results with comparative analysis of solutions are presented.

3.1 Results of correlation analysis

As an initial step in the statistical processing of data, a correlation analysis was performed to determine the measure of linear correlation of research variables. The matrix of Pearson correlation coefficients between the research variables for the M9J Prnjavor-Johovac section is shown in Fig. 4.

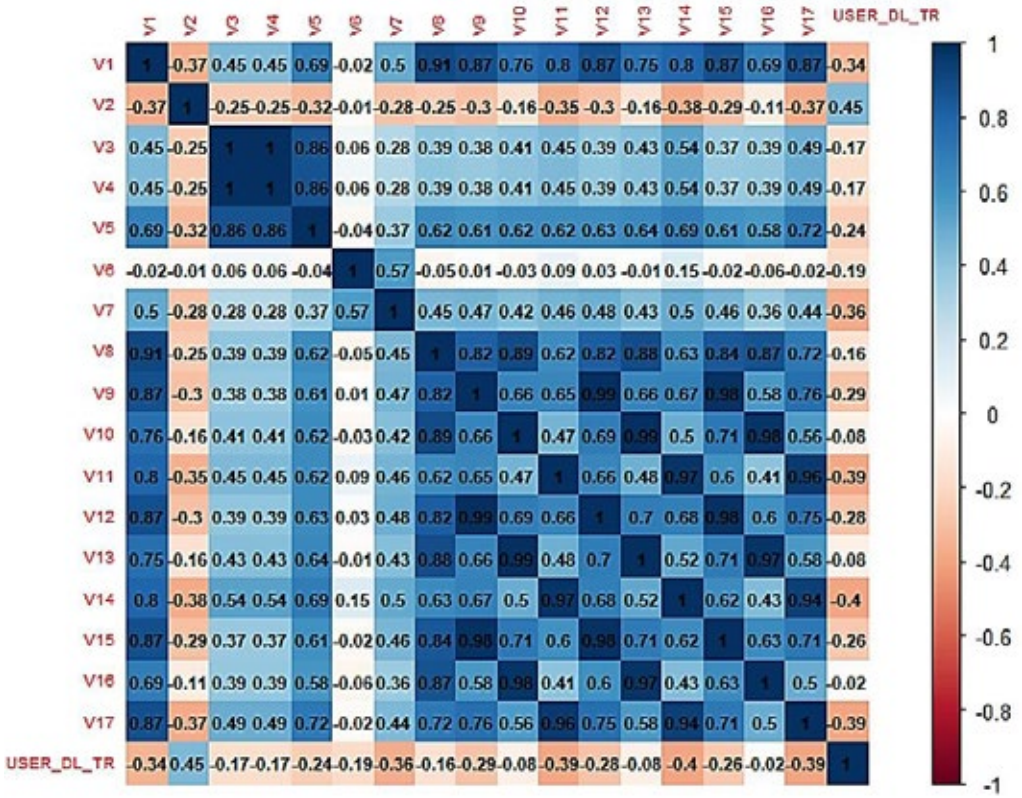

Fig. 4. Matrix of Pearson correlation coefficients (correlogram) of research variables for the M9J Prnjavor-Johovac section

Based on the values of correlation coefficients shown in Fig. 4, it is concluded that all independent variables, except V2, have a negative linear correlation with USER_DL_TR. According to the scale shown in Table 2, the variables V3, V4, V6, V8, V10, V13 and V16 have a very low correlation with the dependent variable. Low correlation defines the linear correlation of variables V5, V7, V9, V11, V12, V15 and V17 with the average user throughput. Variables V2 and V14 have a Moderate correlation with the observed output variable, which, for this section of the motorway, is the largest measure of correlation of independent and dependent variables. Therefore, the correlation coefficient higher than 0.45 (V2) was not determined between the independent and dependent variables for the observed section. Fig. 5 shows Pearson correlation coefficients between the observed variables for the M17 section, Johovac-Doboj.

From Fig. 5, it can be concluded that there is a negative correlation of all independent variables with user throughput, except variable V2, as is the case with the M9J Prnjavor-Johovac section (Fig. 4). Also, it is evident that there is a Very Low correlation between the variable V6 and user throughput. Variables V3 and V4 have slightly higher coefficients (r=-0.35) and

according to the scale shown in Table 2, they have Low Correlation with the dependent variable. Moderate correlation defines the relationship between variables V2, V7 and V16 with USER_DL_TR. Most of the independent variables have a high correlation with the observed dependent variable, namely V5, V8, V9, V10, V11, V12, V13, V14, V15 and V17. Variable V1 with a value of Pearson coefficient r=-0.80 has a very high, negative linear correlation with the average user throughput.

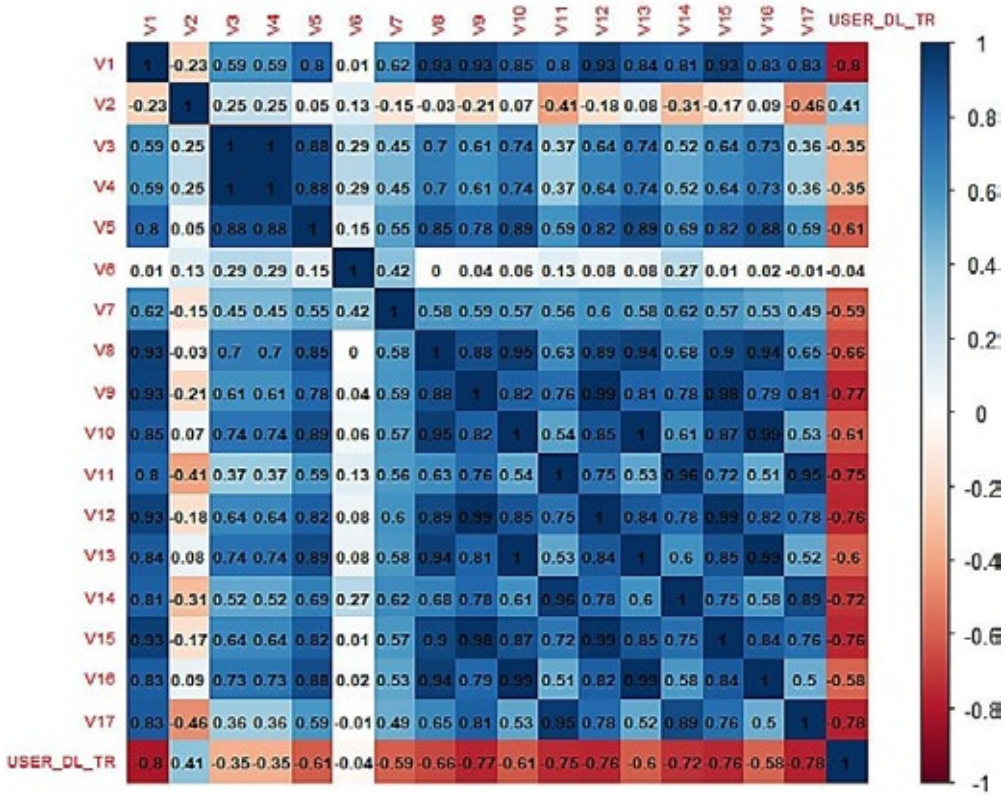

Fig. 5. Matrix of Pearson correlation coefficients (correlogram) of research variables for the M17 trunk road section, Johovac-Doboj

3.2 Results of CFS application

The Correlation-based Feature Selection (CFS) method was applied to reduce the dimensionality of the space of independent variables, based on the correlation coefficients presented in the previously given analysis. The subset of independent variables in the initial step consists only of the variable that has the highest correlation with the dependent variable. In the next step, the subset is expanded with a variable that has the second largest correlation coefficient with the average user throughput (from Fig. 4 and Fig. 5). This step is repeated until all available independent variables are included in the subset. For each subset, according to Eq. (1), Merit is calculated. The final subset of independent variables, used to create machine learning models, is the one with the highest Merit value. Table 3 shows the calculated Merit values for each subset of variables on the M9J Prnjavor-Johovac section.

Table 3. Merit values for each subset of variables on the Prnjavor-Johovac motorway section

Subset of independent variables (variable labels without the initial letter V)	Merit
2	0.447
2;14	0.508
2;14;11	0.487
2;14;11;17	0.470
2;14;11;17;7	0.491
2;14;11;17;7;1	0.475
2;14;11;17;7;1;9	0.459
2;14;11;17;7;1;9;12	0.442
2;14;11;17;7;1;9;12;15	0.426
2;14;11;17;7;1;9;12;15;5	0.417
2;14;11;17;7;1;9;12;15;5;6	0.431
2;14;11;17;7;1;9;12;15;5;6;3	0.422
2;14;11;17;7;1;9;12;15;5;6;3;4	0.411
2;14;11;17;7;1;9;12;15;5;6;3;4;8	0.394
2;14;11;17;7;1;9;12;15;5;6;3;4;8;13	0.376
2;14;11;17;7;1;9;12;15;5;6;3;4;8;13;10	0.358
2;14;11;17;7;1;9;12;15;5;6;3;4;8;13;10;16	0.338

Based on the values given in Table 3, it is obvious that a subset consisting of variables V2 and V14 (0.508) has the largest Merit. With the expansion of the subset, the decrease of Merit is evident, to a final value of 0.338. Table 4 provides an overview of the calculated Merit values for the subsets of independent variables, for the M17 Johovac-Doboj section.

Table 4. Merit values for each subset of variables on the Johovac-Doboj trunk road section

Subset of independent variables (variable labels without the initial letter V)	Merit
1	0.804
1;17	0.825
1;17;9	0.822
1;17;9;12	0.815
1;17;9;12;15	0.808
1;17;9;12;15;11	0.816
1;17;9;12;15;11;14	0.818
1;17;9;12;15;11;14;8	0.809
1;17;9;12;15;11;14;8;10	0.801
1;17;9;12;15;11;14;8;10;5	0.794
1;17;9;12;15;11;14;8;10;5;13	0.785
1;17;9;12;15;11;14;8;10;5;13;7	0.791
1;17;9;12;15;11;14;8;10;5;13;7;16	0.782
1;17;9;12;15;11;14;8;10;5;13;7;16;2	0.800
1;17;9;12;15;11;14;8;10;5;13;7;16;2;3	0.782
1;17;9;12;15;11;14;8;10;5;13;7;16;2;3;4	0.789
1;17;9;12;15;11;14;8;10;5;13;7;16;2;3;4;6	0.756

A subset of variables V1 and V17 has the highest Merit value (0.825), according to the results given in Table 4. Also, as is the case with the variables on the Prnjavor-Johovac section, the expansion of the subset leads to a decrease in Merit values. The complete set, with all independent variables, has Merit equal to 0.756.

3.3 Prediction results and comparative analysis of the results

Given that the average user throughput is continuous, in the SPSS Modeler software environment, training and testing data are processed using the *Auto Numeric* option to automatically create different predictive models. In this way, in just one pass through the modeling process, *Auto Numeric* examines models based on different machine learning techniques, different combinations of parameters for each of these models, and ranks the solutions according to relative prediction error. Table 5 presents the three best models of machine learning for both observed road sections.

Table 5. The best machine learning models ranked by relative error for both road sections

Section	Selected input/independent variables	Created machine learning model	Relative error
Prnjavor-Johovac	V2 and V14	1. k-Nearest Neighbors	0.549
		2. C&R Tree	0.699
		3. Neural Network	0.703
Johovac-Doboj	V1 and V17	1. k-Nearest Neighbors	0.183
		2. C&R Tree	0.241
		3. Neural Network	0.247

Based on the results given in Table 5, it is obvious that the models created for the Johovac-Doboj trunk road section have significantly higher prediction accuracy. The best model for this section is based on the k-NN machine learning technique and is characterized by a relative error of 0.183.

The most accurate model for the M9J Prnjavor-Johovac section is based on the same technique, but its relative error is three times higher and is 0.549. Fig. 6 shows the Scatter plot of the prediction results of the k-Nearest Neighbors model for the M9J Prnjavor-Johovac section.

Based on Fig. 6, it is obvious that there is a large deviation in the data obtained by prediction from the actual values.

The coefficient of determination (R^2), as an indicator of the quality of the model, is 0.416, which can be considered a Moderate correlation [13]. Fig. 7 shows a scatter plot of the prediction results using the k-Nearest Neighbors model for the Johovac-Doboj trunk road section.

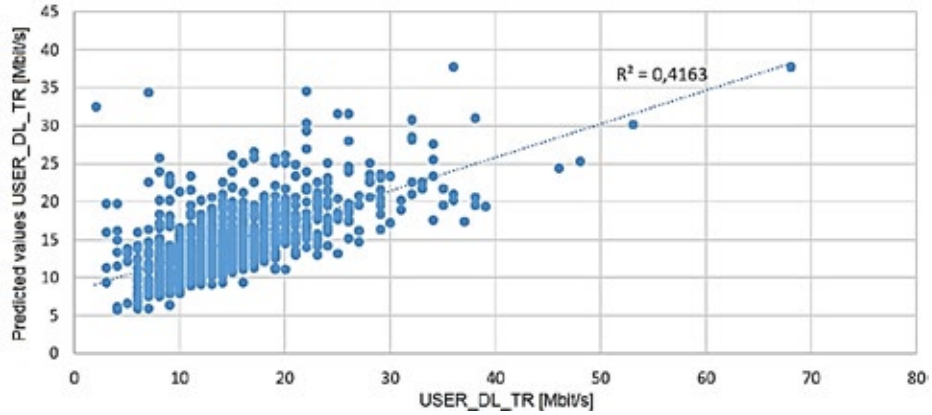

Fig. 6. Scatter plot of the prediction results for the M9J Prnjavor-Johovac section

In Fig. 7, it can be seen that the spots are largely concentrated in the vicinity of the line shown, which is indicated by the value of R^2 which is equal to 0.8005. This determination coefficient defines the High level of correlation of the data obtained by prediction with the real values of the dependent variable [13].

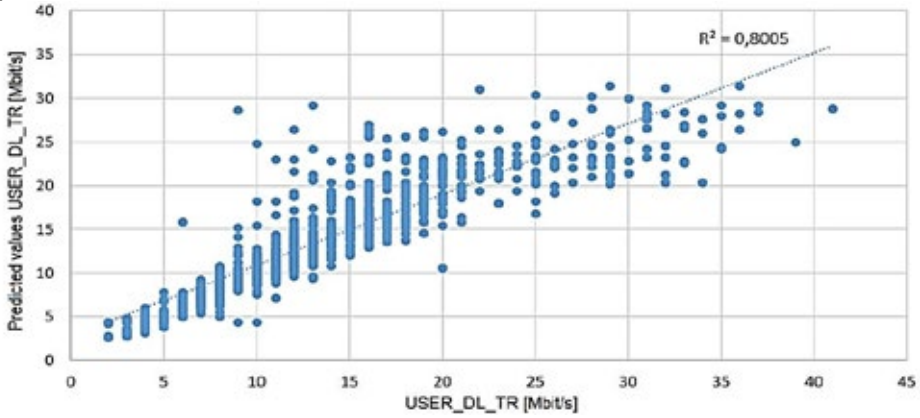

Fig. 7. Scatter plot of the prediction results for the M17 Johovac-Doboj section

4 Conclusion

In the paper, it is created several machine learning models for average user throughput prediction in the mobile network in the observed geo-area of the research. Based on the criterion of relative prediction error, the best solutions were ranked and one model was selected for each of the sections. The results showed much higher prediction accuracy for the selected k-NN model on the trunk road section, between the Johovac node and the town of Doboj. The reason for the determined difference in accuracy lies in the fact that there are not such large oscillations in the measured throughput on the M17 Johovac-Doboj road section, as is the case with the M9J section. Some of the main reasons are lower vehicle speeds on the trunk road, fewer handovers and fewer cells covering the 12 km long section. The research results and developed models have innovative theoretical and considerable practical significance, especially in terms of the needs of telecommunications service providers in the geo-area of the network that covers the observed roads. User throughput prediction in the network enables more precise planning and allocation of network resources in the future to meet user requirements. In relation to the previously published studies, which are listed in the introductory section, this paper is characterized by the following novelties: an original methodological approach to the application of machine learning methods in combination with modern statistical methods has been created; a combined geo-area in the zone of roads with different conditions for predicting the of telecommunication traffic performance has been selected; a representative set of correlative research variables in bimodal traffic has been identified. The orientation of future research may be to find other models for average user

throughput prediction on the M9J Prnjavor-Johovac section to determine a smaller relative error of prediction.

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Challenges of digital transport transformation in Europe

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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.

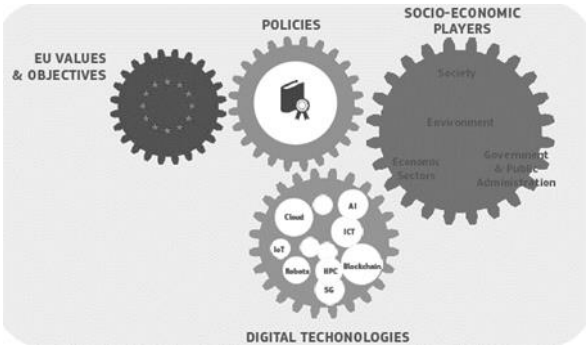

Fig. 1. Conceptual framework of the EU's digital transformation [1]

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.

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The impact of digitalization on the transformation of postal and logistics systems

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Abstract

The process of business digitalization has become inevitable for most industries. The logistics sector, one of the fastest-growing in the world, is also facing this challenge. Networking of all segments of the logistics and postal system through digitalization offers a lot of potentials to reduce costs and increase efficiency. The paper analyzes the possibilities for digitalization of business. Special attention is paid to some of the technologies that can be applied in the field of postal traffic and logistics. Also, there are some difficulties in initializing the digitalization process, that have been described.

***Keywords**: Digital transformation, Logistics system, Postal system, Technologies*

1 Introduction

The world is on the cusp of a new digital era. Digital transformation (DT) has emerged as an important phenomenon in research in recent years. It encompasses the profound changes taking place in society and industries through the use of digital technologies [1], [2].

Modern studies consider the DT mostly as a combination of effects arising under the influence of several implemented digital innovations. The result is the emergence of new economic structures and business practices, as well as new values and beliefs in the business environment [3]. Numerous studies have considered diverse aspects of DT [4]-[6].

Digitization is a step towards digitalization, which is about implementing new business models that have new value propositions. Organizations can be achieved this if they incorporate digital workflows and processes, have integrated systems that assist in better coordination and analytical operations, and remain open to embracing future technologies [7].

Cuenca et al. [8] described that a successful DT is related to four main factors:

- Clear process definitions;
- Defined implementation steps;
- People training;
- Standardization of the implementation process.

Brennen and Kreiss [9] and Ritter and Pedersen [10] define digitalization as „the exploitation of new technologies with processes to gain a competitive advantage and the potential to transform the logistics and supply chain sector". Digital innovation enables logistics players to drive efficiency and lower costs, as well as pursue new business opportunities [11]. Digital technologies can increase sales of services [12], as part of the offer of added value, thus meeting the needs of customers by offering innovative solutions, and creating a database of user habits.

DT has a major impact on all activities carried out by those organizations that adopt it. It offers opportunities for the growth of commercial, government, and public organizations, and it requires the full attention of business and information managers [13].

At the organizational level, companies must find ways to innovate processes with technologies by devising "strategies that embrace the implications of DT and drive better operational performance" [14].

2 Digitalization postal and logistics sectors

The postal system has been one of the first sectors to experience the effects of digitalization on traditional business models. Strong competition forced them to be innovative and efficient and to diversify their activity. Postal operators around the world have invested heavily in new operational technologies to reduce costs and increase operational efficiency [15].

DT of postal services has become a strategic priority as the digital economy is expanding. Postal operators worldwide are implementing new technologies to modernize, diversify and adapt services to customer demand [16]. DT provides opportunities to ensure their long-term relevancy and creates new sources of revenue. According to Universal Postal Union (UPU) research, over 93% of Posts provide some form of digital postal services either directly or in partnership with other companies to be agile. In that way, they share risks and reduce financial burdens. 73% of Posts indicate an increased investment in digital postal services. From basic digital postal services such as online track and trace, e-post through to e-government and e-commerce services (digital identities, national marketplaces, e-payments, and e-logistics) innovation continues at a pace [16]. Posts can help governments implement international, regional, and national digital transformation strategies. They are becoming key to ensuring digital inclusion for every society. The UPU is piloting projects to connect developing countries with the UPU's digital networks through the Customs Declaration System, International Postal System, and other IT tools [17]. The new digital era will require changes to existing legal and regulatory.

DT of logistics is reduced to the construction of specialized Information Technology (IT) platforms that allow for major changes in the logistics activities of enterprises. Digital progress has the most obvious impact on transportation [18].

DT plays an increasing role in the logistics and supply chain (L&SC) industry [19]-[21] and offers a wide range of opportunities for industrial logistics [22], [23]. Companies such as Amazon have fundamentally changed L&SC industry landscape through digital products and services [24]. They thus have embraced digitalization as a force of change and as an opportunity to create completely new products and services [25]. On the other part, sea or rail freight forwarders are still characterized by low levels of digitalization and manual processes [26]. In the past, logistics players such as DHL, Kuehne + Nagel, DB Schenker, UPS, and Nippon Express operated in a stable world, where efficiency, standardization, and low cost were the keys to success. However, digitalization has changed this focus, transforming the market. New, digital-native entrants are more able to adapt to emerging imperatives such as agility, customer centricity, and the need to constantly innovate [11].

3 Technologies

Digital technologies have shrunk the economic boundaries and the world is becoming a global village. The integration of information and communication technologies and the global connectivity of these technologies have enabled computers, telecommunication devices, and networks to collaborate and work together (exchange information) locally and globally [27].

Some authors deemed some technologies as key enablers for the DT postal and logistics sector [7], [28]. That technologies are: Blockchain, Artificial Intelligence (AI), and Cloud Computing.

Technologies like sensors, robots, automation, cloud computing, data analysis, 3D printing, autonomous vehicles, artificial intelligence, or blockchain technology supplement but do not replace the real world of logistics. They provide customers with higher logistics service value [29].

Technology allows increasingly accurate forecasting of requirements (including necessary capacity, personnel time, and other operating expenses) [11]. Delivery innovations, such as the use of parcel lockers and electronic signature capture are being developed to provide flexible delivery.

3.1 Blockchain

Blockchain is an open, global infrastructure that allows companies and individuals making transactions to cut out the middleman. This reduces the cost of transactions and the time-lapse of working through third parties. Technology is based on a distributed ledger structure and consensus process. The structure

allows a digital ledger of transactions to be created and shared between distributed computers on a network. The ledger is not owned or controlled by one central authority or company and can be viewed by all users on the network [30].

Advantages of blockchain can be very useful for use in modern logistics systems due to the following characteristics [31]:

- Public availability and transparency provide the ability to monitor products from suppliers to end customers;
- Decentralized structure provides the possibility of participation of all parties in the supply chain;
- Cryptography and immutability provide a greater degree of security.

This technology allows smart contracts to work. The nature of the functioning of smart contracts and their compatibility with the IoT concept enable high applicability in the logistics industry. Within the logistics industry, smart contracts can be used for [32]: granting letters of credit, creating electronic consignment notes, inventory management, monitoring of products by all participants, monitoring of cargo sensitive to temperature changes, etc. Blockchain has been implemented in companies that deal with logistics, but which are very different from each other in terms of development, market presence, approach and way of doing business.

The postal and logistics management community realizes how profoundly Blockchain could affect their industry. Blockchain can increase the efficiency, reliability, and transparency of the overall supply chain, and optimize the inbound processes [33]. It can significantly reduce costs.

Under its .POST Group (DPG), the UPU has launched a new blockchain project aiming to create a digital marketplace to trade, host, and track crypto-stamps. The project allows for creating, developing, and operating a digital stamps marketplace, which will use blockchain for transactions such as issuing, trading, collecting and paying for crypto-stamps [17], [34].

Regarding digital public services, in particular, those provided by postal operators - blockchain is a big opportunity. Because of its unique characteristics (traceability, immutability, transparency, and decentralization), it is a way to efficiently redesign these services. However, the different blockchain applications raise issues related to the legal framework in place. Thus, regulatory issues must be taken into account for the efficient use of blockchain [35].

By applying blockchain technology, postal operators could become the leading service for money transfers in the country and abroad. This would encourage the exchange of funds in cryptocurrencies in a decentralized payment system. Along with IoT and RFID tags on shipments, blockchain would improve visibility and transparency, not only for operators but also for customers who can track goods in real-time [36].

3.2 Artificial Intelligence (AI)

AI improves capacity, flexibility, reliability, safety, energy efficiency, and cost-effectiveness in many industries, so in the postal and logistics sectors. AI could improve the efficiency of transportation and optimize performance in warehousing operations. By collecting and analyzing data, AI could predict inventory, flows of materials, demand, and supply, as well as other factors in business and technology.

AI technology may impact the operations of the postal sector by using drones, robotics, and automated machine to communicate with customers. Also, can assist the supply chain, and improve transport services [37]. It can be used: to improve the parcel and mail handling process; the collecting, sorting, tracking; and last-mile delivery of postal mail [38]. In some automated centers, an optical character recognition image and fingerprint digitization constitute a unique identity called biometric technology.

Implemented AI in distribution centers can enhance the quality of the logistics process and can increase human capabilities. AI improves product monitoring: traceability, locating, control flow. In addition, it can significantly improve the work environment and minimizing accidents at work [39]. AI makes the warehouse more dynamic, more agile, and more responsive [40]. The possibilities of applying AI technologies are numerous. Small mobile robots can bring shelves or bins of articles to an order-picking station. Robotic arms can use for palletizing or depalletizing. Inventory drones can crisscross the aisles of shelves. Exoskeleton-type

frames can handle assistance. Connected glasses or augmented reality help for picking by vision, and connected gloves for scanning parcels [38].

According to the ABI Research [41] released in 2019, more than 4 million commercial robots will be installed in more than 50.000 warehouses worldwide by 2025. Robotics was designed to offer “last mile” delivery solutions to businesses and communities. Each robot can be programmed to automatically move through pedestrian areas and delivery from the pick-up point (kiosks, stores) to the delivery point (the customer's home). Robots may inside warehouses perform tasks that are risky, tedious, or repetitive. This allows people to focus on things that are creative and that are less manual [42].

One powerful type of AI is the vision sensor system. This is a field of computer science that reconstruction of complex parts of the human visual system. It can identify, track, measure, detect and classify objects [43].

Also, AI can make autonomous vehicles safer by being able to navigate complex scenarios and traffic. Automated Guided Vehicle technology helps reduce operating costs and achieve optimal productivity in a warehouse.

3.3 Cloud Computing

The postal and logistics sector, in the face of a large-scale data set, so can no longer meet the massive and multi-source access and processing of heterogeneous data. With the development of cloud computing, big data, and the Internet of Things, this work is easier [44]. Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [45]. This cloud model is composed of five essential characteristics, three service models, and four deployment models. Essential characteristics are [45]: On-demand self-service; Broad network access; Resource pooling; Rapid elasticity; Measured service. Service models are [45]: Software as a Service (SaaS); Platform as a Service (PaaS); Infrastructure as a Service (IaaS).

Cloud computing services provide essential benefits for individuals and organizations, but some challenges negatively impact public confidence regarding their adoption and use. The public confidence challenges foster doubt and uncertainty regarding the safety, privacy and loss of control of data in the cloud computing environment [46].

4 Barriers to implementation

In the papers [47]-[49] following risks for the implementation of previously mentioned technologies were identified: (Cyber) security, privacy, and trust, high investment and setup costs, lack of technical skills and standardization, lack of infrastructure, as well as the digital transformation of the legacy system, the absence of competence in IT security, workers' fear of losing their jobs, negative effects on the workers' motivation, and resistance to change.

Some of the challenges that will increasingly impact the future application of digital strategies include [17]:

1. Trust/cyber security - The importance of digital trust is manifold. That is the belief that customers’ private information is protected.

2. Digital identity - It allows individuals to prove who they are. It enables customers for accessing benefits and services via digital platforms. This move toward Digital Identity platforms can increase the efficiency of service delivery, reduce transaction costs, and increases transparency.

3. Big Data - This enables the use of Big Data techniques for capacity building, creating digital awareness, and delivering technical assistance.

4. Digital ecosystem - This is a platform enabling digital economy including digital postal and logistics development. It comprises companies, people, data, processes, and IoT that are connected by shared use of digital platforms.

5 Conclusion

Researches on the application of new technologies in the postal and logistics industry are still insufficient. The researches are mostly theoretical with insufficient examples and analyses from practice. The existing literature mainly talks about the advantages and

possibilities of applying the mentioned technologies. The goal of all mentioned technologies is to improve business, increase efficiency and security, more efficiently monitor and reduce costs and risks. The next step for all the mentioned and other modern technologies, and in general, towards the digitalization of postal and logistics processes is their wider adoption. Although often expensive, digitization provides significant benefits to every sector that realizes it. Digitalization is expected to help create new, alternative sources of employment which are more relevant to emerging times and relearning new skills.

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Unmanned Aerial Vehicle in the Aviation System: An Overview of the Safety Risk Management Approaches

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Abstract

The global transportation sector is faced with a great number of innovative solutions that are expected to make transportation more efficient, sustainable, and environmentally friendly. Such a solution is the Unmanned Aerial Vehicles (UAV) which are recognized as a leading innovation that simultaneously provides various business opportunities and luxury to humanity. However, this innovation brings high risk to the manned aviation industry, and also to third parties on the ground. As aviation is the most vulnerable industry, since UAVs and aircraft share the same airspace and therefore potentially catastrophic consequences if collisions occurred, it is important to learn how to manage those safety risks. The aim of this paper is to present an overview of the different approaches for safety risk management for threats that arise from UAVs operations in the aviation system, and to discuss included steps, methods, and associated challenges. Some of the methods are proposed through examples for which purpose they are adequate. The paper concludes by highlighting current advanced approaches in the analyzed field, developed by aviation regulatory organizations.

***Keywords**: Aviation safety, Risk management, UAV, Risk assessment, SORA, MEDUSA*

1 Introduction

The UAV is on the way to changing the transportation industry as we know it. The increase in UAV use over the last few years, as well as a wide range of their applications, has led to the need to understand and manage safety risks emerging from UAV operations, especially in those environments in which drones may influence air traffic in progress [1].

Different involved entities (airlines, airports, air navigation service providers, civil aviation authorities, etc.) will have different perspectives and approaches for risk management related to UAVs as safety issues. Despite mentioned differences, there is a common generic process that should be followed. This process needs the application of appropriate safety methods/models.

Like the many developments in aviation are initiated as a direct result of aircraft accidents [2], the development of risk and safety methods/models dated from the beginning of the 1960's. As a reaction to accidents, first causal methods/models are developed with the aim to find out their main causes in order to prevent further ones. At the same time, collision risk methods/models appeared with a proactive role in redesigning the air traffic system in order to safely accommodate increasing traffic demand. Since 1970's, the aviation community becomes more concerned about the human role in accidents, resulting in the development of Human factor errors methods/models. Moreover, during the 1990's public increased awareness of the severity of accidents in airports' vicinity and their influence on surrounding inhabitants and the environment resulting in the development of Third-party risk methods/models [2]. In civil aviation, the modeling of safety risks is in most cases performed using one of the models/methods within these four accepted groups. Examples of some models/methods that should be appropriate for analyzing safety issues, from different perspectives, are presented in the paper. However, in order to respond to specific threats, such as UAVs, the entities involved tend to develop specific methods. In practice, this new method usually involves combining several

common methods, or their basic principles, in order to adapt to the new system and its environment. Moreover, in order to respond as quickly as possible to exposed threats, and manage the risks arising from them, aviation organizations are entering into joint ventures (cooperation) which results in advanced, specially-designed risk management approaches.

Currently, two complementary methods for assessing risk from UAV operations developed by aviation organizations are Specific Operational Risk Assessment (SORA) and Methodology for the U-Space Safety Assessment (MEDUSA), both with the aim of enabling safe integration of UAVs in the airspace. The main principles of those two methods are presented in the paper as an example of good practice.

2 Safety Risk Management Approaches in Aviation

The risk management process is a main part of the Safety Management System (SMS). The SMS is based on systematic hazard identification and risk assessment in order to minimize negative consequences that may arise from the unsafe events (loss of human life, damage or destruction of property, and financial, environmental, and social costs). As safety is defined in relation to the risk, any safety consideration must include the risk concept. The risk management approaches can be roughly divided into two groups: traditional and modern/advanced approaches [3].

I. Traditional approach in the safety risk management

The traditional approach to aviation safety management involved monitoring of air traffic/aviation system, isolating adverse events, and implementing measures to prevent them from occurring. In practice, it means a reactive approach, i.e. a reaction to the existing situation, instead of defining minimum standards based on practical experiences and/or predictions of potential trends.

II. Modern/advanced approach in the safety risk management

Unlike the traditional approach, the modern approach to risk management is aimed at the active prevention of adverse events (safety violations). It is important to emphasize that this approach builds on the obligations that states, regulatory agencies, and other organizations accept through the application of international and national standards and recommended practices. In addition to adequate enforcement, in order to manage risk, it is necessary to harmonize other important factors such as:

- Application of scientific methods for risk management

- Establish a safe environment based on the exchange of information at all levels

- Training and licensing of safety personnel

- Effective application of standard operating procedures, including checklists and briefings

- Establishment of a system for mandatory and voluntary reporting of safety events

- Encouraging those responsible to report incidents and hazards while respecting the principles of safety culture

- Systematic investigation when an unsafe event occurs

- Systematic monitoring of system safety performance in order to reduce or eliminate areas with increased risk

It can be said that after establishing a framework of the safety risk management process, the focus is on the application of scientific methods for risk management. Within the application of scientific methods, one thing is of great importance – data. Namely, effective safety management is highly dependent on the effectiveness of safety data collection and analysis, since their presence is the basis for data-driven decision-making. Reliable safety data and safety information are needed to identify trends, make decisions, evaluate safety performance in relation to safety targets and safety objectives, as well as assess risk [4].

However, data (both historical from similar threats, or current from available databases) on the subject problems is not always available, as the situation is with UAVs in the aviation industry [4]. In such situations, operational experience from industry experts, handled by skilled people within the safety field, is of crucial importance. In advanced safety management approaches, this experience is usually incorporated via brainstorming sessions (as an integral part of methods application), followed usually by the use of fuzzy logic as the

quantification process to convert linguistic expressions into numerical probabilistic values.

3 Safety Risk Management for UAV operations

Safety risk management can be considered a major part of the overall safety management process. This process needs to be performed with respect to principles, standards, and recommendations posed by regulatory agencies. Within the aviation industry, it can be said that there are no two similar safety assessments because each assessment needs to be adapted to the specific safety issue, environment, involved stakeholders, etc. It means that there is a wide spectrum of modern/advanced approaches with a lot of different methods for risk management that can be used. On the other hand, the generic safety process includes the same logic. Figure 1 illustrates the generic process that should be followed within safety assessment when a new safety problem arises, in this research UAVs operations.

3.1 Safety issue

The first step "Safety issue" means the problem identification, as well as the problem description. Usually, problem identification is connected with an increased number of reported events in which safety is compromised. Moreover, when new technology is introduced, like in the case of the UAVs in the aviation system, it is of great importance to conduct safety assessments on predictive basis. This manner is under the principles of the modern risk management approach.

For illustration, if the "positive" UAV usage is considered, for example, the use of UAV for inspection of runway contamination, the included airport authorities should perform SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis [5] for exploring the positive and negative side of introducing new technology, in which manner the safety problem can be identified.

3.2 System description

After the safety problem is identified, the following step includes a system description. In terms of UAV operations, it is needed to analyze intended operations and the environment in which these operations are planned.

The UAV operations have a very different concept compared to manned civil aircraft and operate in a very different environment (day, night, clear weather, complex weather) including the different airspace (controlled, uncontrolled) and the different areas (airport vicinity, urban populated area), so it is important to define system borders that are analyzed.

Regarding intended operations, UAVs originally developed and used for military purposes, have found applications in many civil sectors during the last decade. Depending on the onboard equipment, mentioned applications have been gradually expanding across leisure, commercial and governmental fields from surveillance and rescue operations, to delivery and people mobility [6].

Fig. 1. Generic safety assessment process

3.3 Hazard Identification, Risk management, Safety Performance and Safety Improvement

After the definition of the system and its environment, the following steps include: "Hazard Identification", performing the "Risk Management" process to access risk emerging from those hazards, checking results with the system "Safety Performance", and for risks that are not with respect of the target level of safety, taking actions within "Safety Improvement" process.

The following chapter discuss different methods/models that should be taken within the "Risk Management" step.

3.4 Methods/Models for UAV risk management

It is mentioned that in civil aviation, the modeling of safety risks is in the most cases performed using one of the models/methods within the four accepted groups: Causal models/methods, Collision models/methods, Human error models/methods, and Third-party risk models/methods. Depending on the nature of the safety issue and the subject who performs the risk management process, different methods can be adequate. The following examples propose models/methods that will be adequate for different situations:

Example 1

If positive use of UAVs is considering from the aspect of the airline who wishes to introduce them

in their processes (for example for aircraft visual inspection), an adequate approach will be the use of the HAZOP (Hazard and Operability) methodology that aimed to identify potential hazards and operability problems caused by deviations from the design intent of both new and existing processes [1].

Example 2

If it is considering the failure of a technical system that is involved in the UAVs operations (for example the collision avoidance system), an adequate approach will be the use of the FTA (Failure Tree Analysis) methodology [7]. A Fault Tree is a graphical representation of the logical relations between the fault and its causes. The structure of the "tree" provides a mathematical basis for combining the probabilities of individual events to determine the overall risk.

Example 3

If the use of the UAVs is considering for purposes that include a high risk of mid-air collision (MAC) with manned aviation (for example for the runway pavement inspection), an adequate approach will be the use of Reason's model of accident causation [5]. It is widely acknowledged that accidents in complex systems occur owing to the concatenation of multiple factors. Complex systems contain such potentially multi-causal conditions. Moreover, system's vulnerabilities are often "latent". The reason model shows how accidents could be seen as the result of interrelations between real-time unsafe acts by front-line operators and latent conditions.

As within introduction section said, to respond to specific threats quickly, the regulatory agencies and involved entities tend to develop specific methods/approaches. In practice, methods developed by joint ventures result in advanced, specially-designed risk management approaches. Such approaches are presented in the following section.

4 EASA Risk Management Approaches for UAS operations

In In recent years, the European Union Aviation Safety Agency (EASA) began to develop a regulatory framework for all kinds of Unmanned Aerial Systems - UAS. In traditional manned civil aircraft, critical failures pose a high risk for humans such as pilots, cabin crew, or passengers. For UAS, the potential risk of fatalities and damage to critical infrastructure depends on the actual operation in combination with the operational environment. Therefore, the focus of the regulation can be changed from an aircraft-centric risk assessment to an operation-centric risk assessment [8].

With such focus, the EASA introduced three new UAS categories included in a new regulatory framework: [9]

- The *Open category* covers low-risk operations. This category requires only a few operational rules, such as "stay away from people", as well as

product safety requirements and mass limitations.

- The *Specific category* covers medium-risk operations, for which authorization from a national aviation authority is required.
- The *Certified category* covers operations with higher risks that are comparable to risks in manned aviation. Hence, the requirements to obtain authorization under the Certified category are quite similar to those of manned aviation.

Mentioned regulatory framework includes a recommended methodology for risk management. Namely, in the Specific category, a risk assessment has to be carried out to attain operation permission from the competent authority. The risk assessment considers the risk not only of the operation but the operator's competencies and UAS performance and characteristics as well. One acceptable means of compliance to perform such a risk assessment is the use of the SORA methodology [10].

4.1 SORA Methodology

Specific Operational Risk Assessment (SORA) is the methodology developed by JARUS (Joint Authorities for Rule-making on Unmanned Systems). The SORA present a novel approach to how to safely create, evaluate and conduct UAS operation. It presents a multi-stage process of risk assessment that focuses on assigning to a UAS-operation two classes of risk, a ground risk class (GRC) and an air risk class (ARC) [11].

The concept is based on the idea of the "hazard" that a UAS operation could become "out of control". It looks at the "threats" that could cause this loss of control and the impacts (or "harms" as it calls them) that it could have. SORA enables the operator to specify the barriers and mitigations to these threats and impacts that have been put in place to minimize these risks [11]. A schematic representation of the SORA concept is in Figure 2. In such an approach, there can be found logic of the known method/model Event Tree.

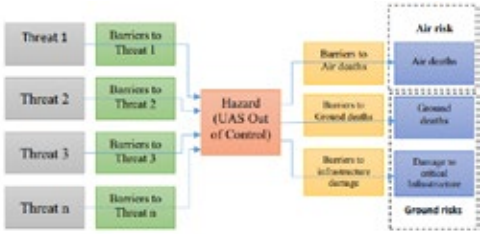

Fig. 2. SORA Concept [11]

To facilitate the SORA process, additionally, the so-called Standard Scenarios (STS) may be developed for certain types of operations, with known hazards and acceptable risk-mitigations. The STS may then be used by operators and regulating authorities as a template to reduce the amount of work involved with approving UAS-operations [12].

4.1.1. Scope and applicability

The SORA could be used to evaluate safety risks involved with the operation of UAS of any mass, any size or performance, operating anywhere [13]. On the other hand, the carriage of people or dangerous goods on board the UAS has not been covered. Additionally, risks of collision among UAS are not addressed. Until now, security and privacy also have not been covered.

Carrying out SORA might be complex but this is always proportionate to the complexity (and initial risk) of the operation. Overall, it can be said that the main idea of SORA is to establish an easy-to-use qualitative risk assessment for UAS operations.

4.2 MEDUSA Methodology

Methodology for the U-Space[1] Safety Assessment (MEDUSA) provides a structured and systematic way of determining what happens in an airspace volume, and how it is organized. MEDUSA follows a holistic approach by not only considering the operators' viewpoint (as proposed in SORA) but by extending the scope to airspace safety. The airspace safety assessment takes into account, among other

[1] U-Space is a set of new services relying on a high level of digitalization and automation of functions and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones. https://www.sesarju.eu/U-space

sources of information, the airspace design, the ATS service provision, and the available U-space services [14].

With such an approach, MEDUSA includes a process for integrating individual SORA assessments, to help obtain insight from multiple SORA assessments sharing the same volume of airspace. The MEDUSA methodology, focus on identification and evaluation of risks from "success" and "failure" approaches [14]. The "success" approach evaluates what requirements or mitigation means are necessary to reach the required level of safety in the volume of airspace considered. In this case, the positive contribution of U-space to aviation is addressed by assessing how effective these U-space services would be when everything is working as intended. Opposite, the "failure" approach (negative effect of U-Space on the risk of an accident) assesses system-generated risks of the U-Space services, including systems and procedures.

In relation to the risk determination, three areas are proposed to assess the mitigation level provided by U-space services: [15]

- Level of mitigation of air risk (unmanned-manned / unmanned-unmanned)
- Level of mitigation of ground risk (prevent fatalities on the ground and damage to critical infrastructure, including aviation infrastructures like Control towers, Ground Navaids, etc.)
- Level of mitigation of incursion into "no-fly zones" (airspace infringement).

It can be said that the development process helps ensure a clear overview of current operations, identification of positive and negative aspects within considered service, as well as, a basis for airspace and/or procedures changes. The Figure 3 presents MEDUSA concept.

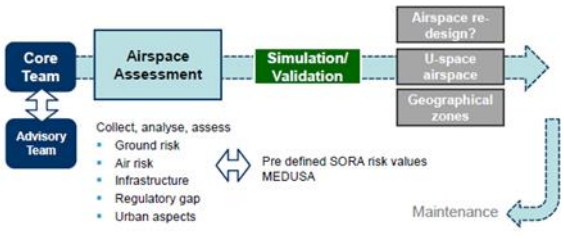

Fig. 3. MEDUSA Concept [16]

5 Conclusion

The technology of unmanned aerial vehicles (UAV) has increasing potential to compete successfully with more traditional alternatives in a number of sectors including commercial, governmental, and leisure purposes. However, this innovation brings high risk to the manned aviation industry, and also to third parties on the ground. The present paper gives an overview of the risk management approaches within the aviation industry, with a focus on the approaches for the safety threats that arise from UAVs operations. Opposite to the traditional approach, that is related to the reactive actions, the modern/advanced approaches are focused on proactive actions in order to prevent unsafe events.

In addition to the implementation of the common-known methods/models, in order to respond to specific threats in a quick manner, the regulatory agencies and involved entities tend to develop specific methods. In practice, these methods developed by joint ventures result in advanced, specially-designed risk management approaches such as SORA and MEDUSA methodology. The SORA methodology is focused on the operations of the UAVs from the operator's point of view and helps establish an easy to use qualitative risk assessment, while the MEDUSA methodology is focused on airspace safety and helps ensure a clear overview of current operations, identification of positive and negative aspects, as well as, the basis for airspace and/or procedures changes. Despite the fact that both methods are in the early stage of the implementation, it can be concluded that these two methods present a good practice to deal with risks that arise from the UAV operations, but also that those methods would speed up the process of integration of the UAVs in the aviation systems. Future research will be related to the analysis of the outcomes of SORA and MEDUSA implementation.

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Review of algorithms for monitoring urban traffic in smart cities

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Abstract

Urban traffic, as a complex socio technical system, is one of the most challenging issues for monitoring in urban environments. It becomes one of the main concerns in smart cities. Recently, urban traffic monitoring attracted both researchers from academia and practitioners from variety of technical and social sciences. Although several specific solutions have been proposed and implemented in the practice, there is a need to provide comprehensive literature reviews to reveal recent publishing trends, areas of research, and point out possible further research directions. This paper presents a literature review of algorithms for monitoring urban traffic in smart cities, based on the recommendations for conducting systematic literature reviews. The objectives of the presented literature review are to inquire which types of algorithms are used for monitoring urban traffic, and which segments of urban traffic are monitored. Results of the presented review contribute to the general knowledge base on urban traffic and can be used as starting point for further review studies on specific algorithms or areas in urban traffic. In addition, presented results can serve as a starting point in finding possible solutions to specific problems in practice.

Keywords: *Smart city, Urban traffic, Monitoring algorithms*

1 Introduction

Increased number of studies dealing with traffic monitoring in urban environments cause publishing of literature reviews about some specific aspects, such as classification of vehicles by using intelligent monitoring systems [1], vision-based monitoring of road intersections [2], urban traffic monitoring by using Unmanned Aerial Vehicles (UAVs) [3], urban traffic congestion monitoring [4], and shortest path algorithms for monitoring and management urban traffic [5].

Based on inquiring existing literature and own research experience, one of the problems in smart cities is the creation of noise caused by traffic on city roads, because such roads pass through urban settlements, near hospitals, schools, and cultural monuments [6]. Studies on road traffic monitoring and eliminating traffic noise using Dijsktra and Floyd-Warshall algorithms for monitoring and navigating traffic in smart cities have recently attracted attention and popularity [7]. Important challenge in smart cities is also air pollution in road traffic in urban areas [8].

Many published papers deal with real-time parking monitoring solutions and detecting irregularities when parking vehicles using UAVs or drones. In smart cities, drones are used for the purpose of remote image collection during flight. One of the roles of drones is to detect irregularities in vehicle parking, manage parking spaces and impose penalties in case of parking violations [9]. Parking monitoring systems are based on real-time visual information.

One of the mostly researched segments of urban traffic relates to congestions. The literature

review for urban traffic congestion monitoring presents smart route planning systems and navigation systems to avoid traffic jams in smart cities. Deshmukh et al. [11] suggested alternative routes that avoid traffic jams using devices built into cars. The system enables smart route planning and navigation systems to avoid traffic jams in smart cities by suggesting to drivers the shortest way to travel to save time and fuel.

Terroso-Sáenz et al. [11] proposed an architecture for the use of external data sources to detect traffic jams. The architecture is suitable for distributed traffic information systems and uses complex event processing technology to detect congestion on the highway. Xu et al. [12] proposed two methods for estimating bus travel time using the average T-window and the average N-window, as well as the congestion indicator. Estimation methods do not support vehicles moving in spare lanes.

Bauza et al. [13] presented a traffic congestion detection technique based on communication between vehicles and fuzzy logic. The technique does not involve the use of sensors to detect traffic congestion. Leontiadis et al. [14] in their paper proposed a way to collect data on traffic jams and redirect vehicles accordingly.

The shortest path algorithms are used to monitor and manage traffic to guide the driver along the shortest route to the final destination, which results in a reduction in the total cost of setting up traffic networks [5]. The shortest path is represented by using graph theory.

There are several types of shortest path algorithms [15]: Dijkstra algorithm, Floyd-Warshall algorithm, Bellman-Ford algorithm, and Genetic algorithm. One of the most well-known algorithms for shorter paths is the Dijkstra algorithm, which has proven to be reliable in solving the problem of single-source graphs, directed and non-directed graphs [16]. Dijkstra algorithm in some cases of traffic congestion, do not suggest the shortest path.

Based on the previous considerations, the main objective of this paper is to review use of algorithms for monitoring urban traffic in smart cities. The second section presents our review methodology and results, while the third one contains discussions of results, constraints, and benefits. Concluding remarks and future research directions are presented in the last section.

2 Review methodology

The review study was designed based on guidelines for systematic literature reviews [17][18], but with appropriate simplifications as the study is a preliminary review. These simplifications are reflected in planning and conducting phase of the study in which some activities are simplified or excluded (e.g., judging the quality of the primary studies).

Design of the literature review study is presented in Figure 1. Three main phases of the presented literature review are:

- *Planning*. It includes activities necessary for planning all further activities. The most important steps are determining research questions, identification of the search keywords, identification of digital libraries in which the search will be conducted, as well as proposal of inclusion/exclusion criteria for studies.
- *Conducting*. This is the main phase in review. The activities are planned in the first phase of the study (planning). It includes searching for primary studies, appliance of inclusion/exclusion criteria, identification of primary studies and aggregation of findings based on the proposed research questions.
- *Reporting*. This is the last phase in which all relevant details of the study are reported.

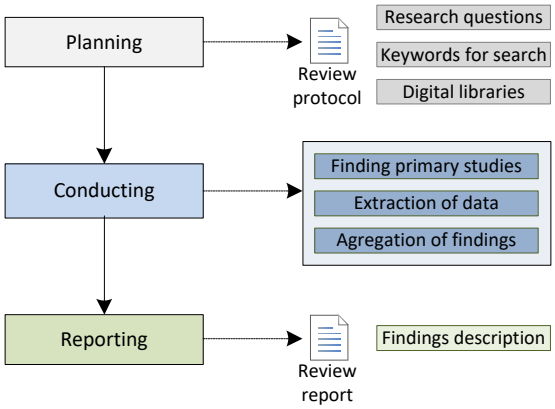

Fig. 1. Design of the literature review study

2.1 Planning

The research question proposed for this review are based on the main objective of this paper to review algorithms for monitoring urban traffic in smart cities. The following research questions are determined:

RQ1: *Which types of algorithms are used for monitoring urban traffic?*

RQ2: *Which segments of urban traffic are monitored?*

Based on the proposed research questions the following keywords for search are proposed: "urban traffic" and "monitoring algorithms". For the search are used Google Scholar and IEEE Xplore digital library because majority of the identified search result are listed in IEEE Xplore. Composed search string is:

"urban traffic" AND *"monitoring algorithms"*

Inclusion criteria for the selection of the studies used for further detailed analysis are: the study presents monitoring algorithm for urban traffic environment, the study is written in English language, the study is published in refereed journal or international conference or it is master or PhD thesis. Studies written in other languages are excluded, as well as studies for which full text is not available.

2.2 Conducting

The search for studies was performed on Google Scholar and IEEE Xplore, and it includes the period from 2012 to 2022, which ensures that the studies selected for further analysis are up to date and present the recent development in the field of research.

All identified studies are analyzed based on the proposed research questions. The selection process included analysis abstract, keywords, and introduction section of the collected papers. In some cases, when it was necessary, the whole papers were analyzed. After the analysis and implementation of the inclusion/exclusion criteria, 15 relevant studies are selected and presented in Table 1. In Table 1 are also listed used algorithms and segments of urban traffic. These studies are called Primary Studies (PS).

2.3 Reporting

In this subsection findings of the detailed literature review are presented. The findings are organized based on the proposed research questions.

RQ1: *Which types of algorithms are used for monitoring urban traffic?*

Different types of algorithms are used for monitoring traffic in urban environments. In some cases, the authors called them algorithms, methods, approaches, or procedures, which is the subject for another research. The following types of algorithms are used for monitoring: (1) multi-UAVs traffic monitoring with computation offloading/sharing policy [PS01], (2) map-based monitoring and management of object movement [PS02], (3) computer vision [PS04][PS11], (4) inertial reference data based algorithm for trajectory reconstruction and estimation and event detection [PS05], (5) neural network [PS03], (6) digraphs based recovery methods to estimate road delays and congestion [PS07], (7) Inertial Measurement Unit based estimation [PS06], (8) route planning algorithm based on spatial visualization, spatial navigation and spatial thinking [PS08], (9) algorithm based on position of magnetoresistive sensors [PS09], (10) Genetic Algorithm [PS10], (11) intelligent agents with behaviour-based model [PS12], (12) network tomography [PS13], (13) Kullback-Leibler distance (KLD) and exponential weighted moving average (EWMA) procedure [PS14], and (14) range filtering on three orthogonal planes [PS15].

Table 1. List of selected primary studies, used algorithms and segments of urban traffic

Primary Study	Reference	Algorithm	Segment of urban traffic
PS01	Alioua, A., Djeghri, H. E., Cherif, M. E. T., Senouci, S. M., & Sedjelmaci, H. (2020). UAVs for traffic monitoring: A sequential game-based computation offloading/sharing approach. Computer Networks, 177, 107273. doi: 10.1016/j.comnet.2020.107273.	monitoring with computation offloading/sharing policy	monitoring road traffic
PS02	Marchetta, P., Natale, E., Pescapé, A., Salvi, A., & Santini, S. (2015). A map-based platform for smart mobility services. In 2015 IEEE Symposium on Computers and Communication (ISCC) (pp. 19-24). Larnaca, Cyprus. doi: 10.1109/ISCC.2015.7405448.	map-based monitoring and management of object movement	smart parking services, public and private transportation fleets

			management, road traffic conditions estimation, and warnings management
PS03	Huang, Y.-Q., Zheng, J.-C., Sun, S.-D., Yang, C.-F., & Liu, J. (2020). Optimized YOLOv3 Algorithm and Its Application in Traffic Flow Detections. Applied Sciences, 10(9), 3079. doi: 10.3390/app10093079.	neural network	urban traffic flows in different scenarios and weather conditions
PS04	Liu, G., Shi, H., Kiani, A., Khreishah, A., Lee, J., Ansari, N., ... & Yousef, M. M. (2021). Smart Traffic Monitoring System Using Computer Vision and Edge Computing. IEEE Transactions on Intelligent Transportation Systems. doi: 10.1109/TITS.2021.3109481.	computer vision	traffic congestion detection and speed detection
PS05	Mousa, M., Abdulaal, M., Boyles, S., & Claudel, C. (2015). Wireless sensor network-based urban traffic monitoring using inertial reference data. In 2015 International Conference on Distributed Computing in Sensor Systems (pp. 206-207). Fortaleza, Brazil. doi: 10.1109/DCOSS.2015.21.	inertial reference data based algorithm	road traffic monitoring
PS06	Lei, T., Mohamed, A. A., & Claudel, C. (2018). An IMU-based traffic and road condition monitoring system. HardwareX, 4, e00045. doi: 10.1016/j.ohx.2018.e00045.	Inertial Measurement Unit based estimation	real-time traffic estimation and road condition monitoring
PS07	Qi, X., Wang, Y., Wang, Y., & Xu, L. (2014). Compressive sensing over strongly connected digraph and its application in traffic monitoring. In IEEE INFOCOM 2014-IEEE Conference on Computer Communications (pp. 1222-1230). Toronto, ON, Canada. doi: 10.1109/INFOCOM.2014.6848054.	digraphs based recovery methods	road traffic monitoring
PS08	Liu, R., Su, G., Tang, W., & Su, H. (2015). PTEMS: a novel public transportation emergency management system based on GIS. In Proceedings of the 1st ACM SIGSPATIAL International Workshop on the Use of GIS in Emergency Management (pp. 1-4). Bellevue, Washington, USA. doi: 10.1145/2835596.2835612.	route planning algorithm based on spatial visualization, spatial navigation and spatial thinking	public transportation vehicles management and improvement of the public transportation safety situation
PS09	Tang, Y. (2020). Monitoring Algorithm for Speed Information of Autonomous Vehicles Based on Magnetoresistive Sensor. Jordan Journal of Mechanical & Industrial Engineering, 14(1), 43-52.	algorithm based on position of magnetoresistive sensors	speed of autonomous vehicles
PS10	Novaes, A. G., Bez, E. T., Burin, P. J., & Aragão Jr, D. P. (2015). Dynamic milk-run OEM operations in over-congested traffic conditions. Computers & Industrial Engineering, 88, 326-340. doi: 10.1016/j.cie.2015.07.010.	Genetic Algorithm	dynamic vehicle routing procedure for a picking-up OEM service
PS11	Lira, G. R. (2015). A computer vision approach to drone-based traffic analysis of road intersections. Master thesis. Integrated Master's in Informatics and Computer Engineering. Faculty of Engineering of the University of Porto. Porto, Portugal.	computer vision	road intersections monitoring
PS12	Vallejo, D., Villanueva, F. J., Albusac, J. A., Glez-Morcillo, C., & Castro-Schez, J. J. (2014). Intelligent surveillance for understanding events in urban traffic environments. International Journal of Distributed Sensor Networks, 10(8), 723819. doi:	intelligent agents with behaviour-based model	urban traffic environments with pedestrians and vehicles

	10.1155/2014/723819.		
PS13	Zhang, R., Newman, S., Ortolani, M., & Silvestri, S. (2018). A network tomography approach for traffic monitoring in smart cities. IEEE Transactions on Intelligent Transportation Systems, 19(7), 2268-2278. doi: 10.1109/TITS.2018.2829086.	network tomography	realistic traveling times for cars over such topologies
PS14	[Zeroual2018] Zeroual, A., Harrou, F., Sun, Y., & Messai, N. (2018). Integrating model-based observer and Kullback–Leibler metric for estimating and detecting road traffic congestion. IEEE Sensors Journal, 18(20), 8605-8616. doi: 10.1109/JSEN.2018.2866678.	Kullback-Leibler distance (KLD) and exponential weighted moving average (EWMA) procedure	road traffic congestion estimation and detection
PS15	Tao, H., & Lu, X. (2018). Smoky vehicle detection based on range filtering on three orthogonal planes and motion orientation histogram. IEEE Access, 6, 57180-57190. doi: 10.1109/ACCESS.2018.2873757.	range filtering on three orthogonal planes	Smoky Vehicle Detection

RQ2: *Which segments of urban traffic are monitored?*

Variety of urban traffic segments were investigated in primary studies. Majority of studies implement different types of algorithms for monitoring road traffic [PS01][PS02][PS03][PS05][PS06][PS07]. Other segments of urban traffic in which monitoring algorithms were applied are: (1) smart parking [PS02], (2) transportation fleets management [PS02], (3) warnings management [PS02], (4) traffic congestion management [PS04][PS14], (5) public transportation [PS08], (6) autonomous vehicles [PS09], (7) vehicle routing [PS10][PS13], (8) road intersection monitoring [PS11], (9) movement of pedestrians and vehicles [PS12], and (10) detection of smoky vehicles [PS15]. Detailed insight int the selected primary studies revealed that road traffic monitoring is the most challenging and the most researched segment because some studies classified into other specific segments (e.g., traffic congestion management or vehicle routing) also target specific aspect of road traffic management.

3 Discussion

Presented findings in the previous section indicate that different types of algorithms, based on variety of computing and visualization techniques, are used for monitoring different segments of urban traffic. However, majority of studies are focused on specific aspects of urban road traffic monitoring.

Although presented review lists variety of monitoring algorithms, there is a need for conducting a more comprehensive and detailed review of studies based on which a more detailed systematization or taxonomy of used algorithms can be produced. This is treated as a limitation of this study conducted as a preliminary literature review. This limitation will be addressed in further research.

Despite the stated constraint related to the scope and depth of the review, there are some benefits of it. The first is the presentation of a review methodology that can be used for small scale review studies to get quick preliminary results and ideas for further research. The second is initial review of algorithms that can be considered in designing empirical studies related to traffic management.

4 Conclusion

Monitoring of traffic in urban environments is challenge for both research and practical studies because of increased population and detection of variety of problems in urban environments. This study provides a preliminary review of algorithms that can be used for monitoring traffic in urban environments, as well as a review of possible segments in which algorithms can be applied.

Further research will be directed in many directions. The first one is more detailed and systematic literature review aimed at creating systematization or taxonomy of monitoring algorithms. This review will also include search in other scientific databases and libraries such as Scopus, ScienceDirect, Wiley, and Springer.

The next extension of the research can include inquiry of other interesting aspects of monitoring urban traffic, such as review of used technologies, review of used architecture styles in proposed monitoring systems, and review of consequences of implementing monitoring systems. In addition, development of specific algorithms and systems for monitoring specific segments of urban traffic (e.g., identification of congested areas in the city using a fleet of drones) is promising research direction.

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The function of IT integration in better postal delivery service positioning in the e-commerce market

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Abstract

Growth in e-commerce significantly affects changes in the postal services market. Besides the opportunity for offering various types of electronic postal services, demand for online bought product delivery services is becoming increasingly important. Shopping in the e-commerce market, especially in the B2C segment of this market, necessarily implies the delivery of purchased products. Different user expectations regarding delivery services such as free or lower shipping price, faster delivery, or the possibility to choose a delivery method are gaining importance. It indicates that common inflexible delivery services do not meet customer expectations. Enabling the delivery method to be chosen by the consumer implies various delivery options being offered through the e-commerce „check out“ process which requires an appropriate integration of the IT (Information Technology) system of the postal operator and the e-retailer's web store. This paper examines customer delivery service preferences and API functions as IT tools for offering various delivery options within the e-commerce „check out“ process, allowing customers to choose delivery options that meet their needs with the aim of better positioning of postal delivery service in the e-commerce market.

Keywords: *E-commerce, Delivery options, IT integration, APIs*

1 Introduction

The e-commerce (electronic commerce) market is experiencing significant growth. Since the delivery of purchased products is an indispensable part of e-commerce, especially for the B2C (Business-to-consumer) segment of the e-commerce market, e-commerce market trends create huge opportunities for USPs (Universal service providers), while at the same time, the presence of many delivery service providers makes the e-commerce market very competitive. Moreover, along with the increase in market value and competition, the needs and wants of users are also changing, creating new delivery service-related habits. Customers may prefer various delivery service elements, like delivery speed, service charge, visibility, place and time of delivery, return options, etc. Generally speaking, customer preferences are focused on customizing the delivery process, which implies offering customer selection of various delivery options. Both e-retailers and

USPs may benefit from additional delivery options. By offering additional delivery options enabling customers to customize the delivery process e-retailers and USPs as delivery service providers can differentiate themselves from the competition and thus gain a competitive advantage. However, enabling customers to customize the delivery process and control it at certain phases requires the exchange of data between the e-retaile r, e-platform and delivery service provider. In this paper, we will give a brief overview of customer preferences regarding e-commerce delivery services and USPs' services market position. The main focus of the paper is to describe IT integration functions' role in enabling various e-commerce delivery options that meets e-shopper and e-retailer needs thus improving USPs' market position.

2 E-commerce trends

Digital transformation, an increasing share of individuals using the internet as well as companies trying to reach the consumers in a cheaper and more efficient way have a significant impact on e-commerce growth. E-commerce refers to a business model that allows companies and individuals to buy and sell goods and services over the Internet in a much more cost-effective way than traditional commerce [1]. In 2020, e-commerce sales in Europe grew to

€757 billion euros which is an increase of 10% compared to 2019 and the growth trend is forecasted to continue [2]. Although Eastern Europe has only 6% of total European e-commerce turnover, the impressive growth rate of 36% in 2020 was recorded in this part of Europe [3].

The growth in e-commerce impacts postal operators in different ways. Increasing demand for delivery service offers new possibilities but also requires changes and modification in the traditional postal value chain in a way that meet market trends. The delivery of physical goods is considered one of the key elements of e-commerce. However, the importance of the delivery of products bought online makes the e-commerce market highly competitive in terms of delivery service.

2.1 Customer preferences

Adequate positioning in the e-commerce market requires delivery service providers to offer delivery services that meet customer needs. Consumer expectations and needs are mainly focused on the following service elements: shipping price, delivery speed, visibility, place and time of delivery and return of goods.

Shipping price – Delivery charge is one of the biggest considerations for customers shopping online given the fact low prices are one of the main reasons for purchasing online. Customers are very satisfied with the free delivery charge. The most important reason for European e-shoppers to purchase from one online store over another is free shipping. About 68% of European customers abandon their checkout if they consider shipping costs too high, while 40% are not willing to pay for shipping at all when the order value exceeds €150 [4]. E-retailers, who are the ones who bear the costs of delivery, are not always able to offer free shipping since their capability to bear the costs depends on the order value on the one hand and the cost to deliver that order on the other. Only 23% of e-commerce stores in Europe generally offer free shipping while 46% only above certain order value [4]. About 69% of European online shoppers are likely to add another product to their shopping basket to reach a free shipping threshold. The fact that e-retailer ability to offer free shipping depends not only on order value but on the delivery costs as well, has to be considered by USPs in their effort to offer competitive delivery service. Furthermore, bearing in mind e-shoppers' readiness to buy more products to reach the free shipping threshold, postal operators should be able to offer more price different delivery services instead of only one. This would enable e-retailer to lower a free shipping threshold, i.e. to offer free shipping for lower-value orders.

Delivery speed is another delivery service element very appreciated by e-shoppers. Fast delivery service generally costs more than ordinary service so e-retailers cannot be expected to offer delivery service that satisfied customer preferences for both free and fast delivery service. Given the fact that some customers prefer delivery speed over free shipping, introducing various services in terms of speed (i.e. express and non-express) or one service with more options in terms of delivery speed, USPs may offer a long-term solution for both e-retailers and e-shoppers.

Visibility – Visibility of the delivery process is an important part of the customer experience. Customers expect to be updated about the delivery status of their orders. A bad experience with the delivery company is one of the main reasons for European consumers to choose one online store over another and the ability to track shipment plays a major role. One-fifth of European consumers would not re-order at an online store at all if the possibility to track the shipment is not available or limited. As tracking updates are often very standard and impersonal, there is much space for USPs to improve the visibility of delivery service by enabling proactive communication all the time during the delivery process [4].

Besides fast, charge-free, and visible delivery services, customers show preferences for flexible delivery options. What customers want is actually the ability to choose between more delivery options and thus personalize the delivery process in accordance with their preferences. One of the main reasons European consumers choose one online store over another is flexible delivery options (71%) while (18%) abandon their shopping cart during the checkout process when the preferred delivery method is unavailable [4].

Service point/Parcel locker delivery - Although the Home delivery is still the most preferred e-shopper's method of delivery of e-commerce bought products (57%), providing alternative delivery options gains importance. The parcel locker delivery method is preferred by 15% while service point delivery by 16% of European consumers [4]. Due to Universal Service obligation USPs have a wide post office network cowering whole national territory thus ensuring high territorial service accessibility. However, post offices have limited working hours. By launching parcel lockers systems that can be used 24/7 placed at convenient locations, postal operators provide convenient delivery enabling customers to pick up parcels at a preferred time and place thus improving accessibility of the service point delivery network.

Delivery day and time - Time of delivery or day of delivery are two delivery service elements that customers consider important and want to be able to choose. More than 70% of European consumers want to be able to select a time frame for their delivery or to choose the exact day of delivery during check out implying these delivery options are available for selection on e-platforms [4]. Furthermore, around 50% of consumers consider the ability to change the delivery time slot when the parcel is on the way to delivery as important [4]. Postal operators enable this option by sending notifications via e-mail, SMS or similar e-message to customers informing them about expected delivery, thereby allowing customers to change delivery time by selecting a preferred delivery time slot.

By offering various delivery options, delivery service providers are able to reduce the first delivery attempt failure rate. Delivery at Parcel lockers or at the post office reduces the number of items that have to be delivered to the home address, thus reducing the number of items that the first delivery attempt can potentially be unsuccessful. Furthermore, by enabling customers to communicate to delivery service providers their preferred delivery time, USPs will carry out delivery on the day and at the time when the recipient is available at his/hers home address. Therefore, besides improvement of customer experience, introducing above mentioned delivery options will result in USP's "last mile" process optimization and cost reductions.

Returns - Along with the increase in purchases, the share of returns is also growing. Returns have become increasingly important for customers. In Europe, online consumers have the right to return goods purchased online within 14 days. Goods can be returned for any reason, without the obligation to inform the retailer about the reason for returning the item [5]. From the customer's standpoint, having the right to return an online bought product is one of the great advantages of shopping online. There are many reasons why a customer may need to return a purchase they made online, like damaged in transport, the product doesn't match the description, it is of poor quality, etc. The current state of returns shows that more than half of European e-shoppers always check the return policy before they decide to buy a product and typically return a product if they are not satisfied. About 45% of consumers prefer to take a parcel to the drop-off point (post office or parcel locker) while 36% want their return parcel to be picked up at home [4]. Given the importance of return for customers and their preferences to take return shipments to drop-off points, USPs can gain a competitive advantage by offering low-cost return service by using post offices as return service points. In order to improve the online customer buying experience, USPs can provide e-retailers with solutions that enable smooth and efficient returns services, like easy creation and print of return labels, picking up parcels at home upon customer's request or the possibility to use a wide range of post office network for return parcel drop off service.

2.2 USP e-commerce market position

In light of significant growth potential in e-commerce deliveries, many USPs have been expanding their business to B2C e-commerce deliveries. In most EU (European Union) member states, in terms of volume, USPs have estimated market shares above 20 percent in their domestic market [6]. While in the Western and Northern EU member states USPs deliver more than half of B2C parcels, in the Southern and many Eastern EU countries USPs often do not meet the service requirements of e-retailers and online shoppers and thus have not yet managed to reach significant market shares in the delivery of B2C parcels [5]. The adaption of delivery services in a way that meets customer requirements is the only way USPs can seek a better competitive position and market share.

This necessarily includes improving the availability of delivery services and offering various delivery options that meet customer needs. Like all other products in the e-commerce market, postal delivery services should be available for customers in the e-commerce market in order to be sold, whereby e-platforms serve as distribution channels also for postal services. Concerning the availability of USP's delivery service in the e-commerce market, competitor analysis of shipping service providers shows a significant difference in USP's delivery service offered on best-ranked e-platforms in European countries. While USPs in Sweden, Switzerland and Denmark are the most offered delivery service providers on best-ranked e-portals in those countries (in 81%, 75%, and 75% of cases, respectively) the most of USPs in Europe are offered on less than 50% e-platforms [7]. According to indicators [6] and [7], it can be noticed that USPs e-commerce market share corresponds to the availability of their services on e-portals. In order to improve the availability of their services for customers, USPs have to improve the integration of their IT systems with e-platforms. The more e-portals integrate with postal delivery-related services, the better USPs delivery service availability will be [8].

3 USPs e-commerce delivery service integration

3.1 E-commerce market players

E-commerce IT systems need to communicate with each other using defined standards and protocols for data exchange. The technological integration should cover all the processes involving the Post [9] and the parties involved in e-commerce data exchange related to delivery service. From a delivery service value chain perspective, the parties involved in the e-commerce delivery value chain are e-shoppers, e-retailers and e-commerce platforms whereby IT systems of e-retailers and e-platforms should be integrated with the USPs IT system.

E-shoppers - The e-shopper initiates the purchase, makes a payment, chooses the delivery service, and, in most cases, receives the goods. Unlike the conventional postal market where the sender of a postal item chooses the delivery service, in the e-commerce market the recipient, who is the buyer of goods, is the one who chooses the delivery service. Given the fact that buyers of goods are recipients of postal items, it is quite expected they are mainly focused on the "last mile" i.e. on the possibility to choose between various "last mile" delivery-related options that best suit their preferences and requirements.

E-commerce platforms – E-commerce platforms are virtual marketplaces where retailers and consumers can sell/buy goods. Today's e-commerce platforms are comprehensive IT solutions that operate a web store with features like search, cart, payment, etc. The most important functions in terms of delivery service are those used for the collection of shipping information and choosing shipping methods. These functions are integrated into one single process called "check out" which finalizes the shopping process. The typical checkout process has the following steps: shopping cart, billing information, shipping information, shipping method, order preview, payment and order confirmation [10]. Delivery services aimed for the delivery of online bought products should be offered on online platforms and chosen within the e-commerce check-out process. In the e-commerce market, online platforms replace post offices and serve as distribution channels being the place where customers chose delivery services. Unlike at the counter, at the online store, the customer does not have the possibility to ask a post office counter clerk for more information or for a delivery service recommendation. Therefore, the online platform must be able to provide all relevant delivery service information which can be decisive for customers to choose the appropriate delivery service.

E-retailer/seller - E-retailer sells products on the e-commerce marketplace and is responsible to arrange the delivery of products to the e-shopper. The online sale can be concluded through the e-retailer's own website or through a third-party e-commerce platform. The e-retailer concludes the contract with the delivery service provider on the provision of delivery service. Whether the e-retailers prepares good for shipment or hires a third party to do so, in addition to customer needs, e-retailers expect USP's services to meet their own needs in terms of postage calculation, facilitating shipment preparation, accounting process, and return policy.

There are many ways to exchange data between IT systems of involved parties, from file sharing to web services. The best way would be to build interfaces that enable data exchange, such as an API (Application Programming Interface). An API allows one web-based application to interact with another. It is now common for Posts to develop APIs to enable external users such as e-platforms to integrate postal service-related data into their platforms and to provide e-shoppers access to postal services.

3.2 API integration of postal delivery services into the e-commerce value chain

Generally speaking, an API (Application Programing Interface) exposes a set of data and functions to facilitate interactions between computer programs and allow them to exchange information [11]. The most commonly used type of APIs are the Web APIs, which enable the exchange of data and functionality sharing between web-based systems. The API consists of two components:

- A technical specification defining the functions of the API, how they are used altogether with the specification of parameters and feedback and all other instructions necessary for the implementation of the API and
- Software interface implemented in accordance with the defined specification [14]

The REST architectural style is commonly applied to the design of APIs for modern web services. REST stays for Representational State Transfer which is an architectural style for designing distributed applications [12]. It is an architecture style for the building of modern web software that in recent years has strength popularity and is used as a way to build distributed services recognized as REST or RESTful services. Web APIs that comply with REST architectural constraints are called RESTful APIs. Most used RESTful API functions (methods) to work with resources are: GET - Obtain information, POST - Add information, PUT - Replace information, PATCH - Update certain information and DELETE - Delete information [13].

API provides an interface used for the integration of e-platforms and the application system of the postal operator. This interface includes methods enabling the e-platforms to obtain delivery service-related information before, during, and after purchasing process, like type of service, delivery service request, track and trace, return service and label print, etc. The following is an overview of the key phases along the postal delivery value chain that should be covered by IT integration and where API methods could be used thus enabling USPs to meet the needs of all parties involved in the e-commerce delivery process.

Addressing Postal codes - Postal value chain in e-commerce begins within the process of e-commerce “check out”. The first important delivery-related step in check out process is collecting address data, so-called “shipping information”. The aim of API in this phase of the postal value chain would be to ensure that customers through e-platforms are able to enter only the correct addressing postal code. This API provides the access to USP’s IT system retrieving a list of addressing postal codes customers can select from. In addition to the postal code list, using API service the USPs can provide an operational list of street names, thus providing a fully valid entry of the recipient's address on the e-platform.

The next important delivery-related step within the e-commerce check-out process is the “shipping method”. Within this step, the e-shopper should be able to choose a delivery service.

Service type - After providing address information e-shopper selects the type of service. Typically services offered to customers are standard (basic) end express (premium) services. Since the type of services is a small data set which do not change often, this list is typically not retrieved through an API method but specified in the API documentation, which means that the e-platform offers a delivery services list without calling the API method. However, a lot of other parameters like weight and dimension limits, delivery speed, delivery deadline choice as well as additional delivery options are determined by service type. This implies the service type is passed to other API methods like Service Generation Request and Postage price calculation. Therefore, it is crucial for service types to be described in API technical documentation [14].

Delivery options – The aim of API within this step of "check out" would be to provide e-shopper with information about available delivery options and ensure that customers through the e-platform are able to select only those delivery options postal operator offering for previously selected service type. This API should return a list of delivery options e-shopper can select from like: Home delivery, delivery at the post office, delivery in a Parcel locker, etc. [14].

Post office locations - In case a parcel has to be delivered at the post office e-shopper have to select the post office for delivery. The aim of API would be to provide e-shopper with information about available post offices serving as collection points and ensure e-shopper chooses the correct and most suitable post office for parcel collection point. This API should provide the access to USPs IT system and retrieve the list of postal offices serving as collection points customers can select from, containing information about post office postal code and name, street name, working days, work hours and location coordinates [14].

Parcel lockers - The same as in the case of post offices, the aim of API in case of delivery in parcel locker would be to provide the customer with information about available parcel lockers serving as collection points and ensure the customer chooses a parcel locker which suits him best. This API method should retrieve the list of parcel lockers from the USPs database e-shopper can select from, containing information about parcel locker name or ID, street and location coordinates [14].

Postage price calculation – After completion of address data and selecting delivery service type and options e-platform calculates postage price. Postage price depends on many previously selected parameters like service type, delivery option, and order value as well as on item weight and dimensions. Furthermore, in this phase of the e-commerce checkout process API method should enable the calculation of the postage price. Postage price or model of its calculation can be specific for every e-seller. Different pricing models between e-retailers and postal operators are possible. The price for the e-shopper that will be displayed on the e-portal depends on this pricing model. The simplest pricing model from USPs is the model where e-retailer or e-shoppers bears all costs of delivery service. Unlike this model, the e-retailer can opt to bear the full amount of postage price, regardless of the value of the order or only in case the order value reaches a certain threshold, offering the e-shoppers "free shipping". Also, e-retailer can offer e-shoppers a "flat rate" bearing the cost difference between postage price and flat rate. This API sends all parameters required for postal price calculation including e-retailer ID as the reference to a specific pricing model which should be applied and returns price information to e-buyer and e-seller. Depending on e-commerce check-out design and customer preferences to base their service selection on price and speed, postage price can be calculated prior to service type selection. In this case API method sends order-related parameters (value, weight and dimensions) and as a result, provides the customer with a list of eligible service types with prices and expected delivery times so the customer can select the preferred shipping method based on cost and speed [14].

Generating service requests – Delivery service request is the most important phase in the e-commerce delivery value chain. The function of the APIs so far has been to control data entry on the e-platform side, without causing any data change in the UPS's IT system. Generating service requests is usually related to the final step of the e-commerce checkout process, namely order confirmation. The API method in this step should have two main functions. The first would be to send all postal-related data, collected during check out process to USP's IT system for validation. The minimum set of input parameters that should be sent by e-platform through API method to USP should in order to create delivery service request include:

- Information on the sender of the shipment (Name and surname / Name, Address, Contact information)
- Information on the addressee (Name and surname / Name, Address, Contact information)
- Order Data (Weight, Insured Value, COD amount,)
- Information on delivery options

After USP's IT system has performed the data validation process the result the API should return is either a validation error description or a unique service request identifier. In addition to a

unique service request identifier API method returns a unique postal item identifier (according to UPU (Universal Postal Union) S10 standard - the specification for 13-character item identifiers for universal use [15]) which is also generated within the process of generating a service request. The purpose of both identifiers returned by the API method is to enable further data exchange between IT systems of e-retailer, e-platform and delivery service provider, generated along delivery process like parcel status, COD payment status, etc. It is important to emphasize that this API method is typically not limited to a single service request but rather allows sending more delivery service requests within a single call, forwarding the list of requests. In this case, in addition to postal-related data order ID must be sent within the API method to make the e-retailer able to link the order with the service and postal item identifier.

It is crucial that the type and range of values are precisely defined in technical documentation for all parameters passed to this API method including data for which entry control has previously been imposed on the e-platform, using described API methods. These identifiers, returned as a result of the API method, are basically the key to the integration of three IT systems: the information system of the postal operator the e-retailer, and the e-platform. These key identifiers serve as parameters for all further API functions which can be used along the delivery process like tracking shipment status, summary manifests generating and printing, address label generating requests, generating shipment return requests, etc. [14].

Service request revoke (DELETE request) - Every service request should have the possibility to be revoked. Revocation is possible until the shipment is picked up from the retailer, or until the delivery service request changed its status to "Parcel picked up from the sender". This API method should enable e-platform or e-retailer to send a service delete request to USP, check the service request status, and return the final request status.

Shipment and order status - Status requirements differ for buyers and retailers. While the customer requires full visibility of the parcel along the delivery process, the e-retailer prefers to have only those statuses that are relevant to the order like delivered, returned to sender and COD paid. This method should return the status of a parcel or order using any of the two identifiers as parameters: service request ID or postal item ID. Furthermore, the API method used for shipment status, initiated by the e-shopper, contains typically parameter for a single item, namely a unique postal item identifier, while the method for order tracking, initiated by the e-retailer, should enable obtaining the list of service requests statuses using, in addition to service request ID, date period and specific status of the order as parameters [14].

Address label print – In the shipment preparing phase address labeling could be supported by using API methods. Using a unique service request identifier as a parameter, this API method should return a set of data in a print format like PDF or data interchange format like XML, JSON, etc. The structure and format of the data should be defined in detail in the technical specification of the API. PDF format is commonly used by e-retailers who don't change USP's predefined label pattern while XML and similar address label formats are aimed for e-retailers who do not provide complete address data within the requesting delivery service process and/or want to integrate address data in their own application system [14].

Deliver choice - The aim of this API method is to call the service which is used to send a notification to the addressee about the planned delivery day and/or time and to collect information about the day, place and/or time of delivery selected by the addressee. In this case, the USP uses the API method of the SMS service provider. SMS is a common way of sending delivery-related notifications, although other communication channels such as e-mail, Viber, etc. can be used as well. Within this API method, the USP sends to the addressee information about the planned day and time of delivery of the parcel, in case it should be delivered to the customer's home address, or information about the arrival of the parcel at the delivery service point, in case the parcel is addressed to service point location like the post office, parcel locker, etc. Within the same message, the customer is offered an alternative day and/or time slot of delivery and/or the option to redirect the parcel to an alternative location for delivery like the post office. As a result, this API method returns the delivery method (day, time, and place) chosen by the addressee.

Generating return service requests – The process of returning the package, especially generating return requests as its key part, must be as simple as possible for the customer. Offering API method within the process of returning goods USPs should enable e-shopper to request a return by simply selecting the order on the e-platform he wants to return. Based on the existing delivery service ID selected by the customer and data available, new service requests and return labels are created. Within the request for return service API method should send the original service request identifier and as a result return a unique return service request identifier and unique postal item identifier (according to UPU S10 standard) which are linked to unique order identifier thus enabling further data exchange between IT systems of e-retailer, e-portal, and delivery service provider, generated along the return process.

Error handling - An important functionality that has to be implemented within the APIs is the processing of errors. The simplest way to handle errors is to provide customers with response messages related to the processing of certain methods containing appropriate status code. In addition to basic response codes, USP should, within the API technical documentation, precisely define the list of response codes related to every method i.e. every phase within the e-commerce delivery value chain, making all parties involved better understand errors.

4 Conclusion

E-shoppers have different preferences and expectations regarding e-commerce delivery services while e-retailers expect to have technical support in the process of converting an order to a postal parcel, postage price calculation and return process. No matter if e-shoppers' preferences are related to postage price, visibility, place or time of delivery, easy return, or another delivery service element, they all have ultimately the same goal: customizing the delivery process. Also, retailers' preferences are focused on custom-tailored support for their processes. Enabling customization of the delivery process necessarily implies offering customers the possibility to choose between various delivery service options, which is an interactive process that requires the exchange of data between parties involved in the postal value chain. Developing and offering web APIs within the e-commerce postal delivery value chain is a simple and effective way for USPs to enable the exchange of data between parties involved in e-commerce thus enabling e-shoppers to customize the delivery process and provide expected support for e-retailer and all to improve the availability of USP's delivery service on the e-commerce market.

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Digital Transformation Challenges: The Cyber Security Threats of Cryptocurrency Technology Use

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Abstract

Digital transformation is unstoppable and ongoing process that affects all segments of our everyday lives such as healthcare, banking and finance systems, public administration, or postal and logistics systems. One of the main engines of this process, among many, is the use of cryptocurrencies. Both of these concepts are usually addressed from the firm perspective, but they should be considered from the individual's perspective as well. Cryptocurrencies recently face increased cyber security threats, thereby affecting the digital transformation and posing additional challenges to it. Therefore, this paper gives a brief overview of security threats and challenges characteristic for cryptocurrency technology today and discusses what can be expected tomorrow. We provide insight how these challenges can affect digital transformation process and propose ways to increase the level of protection for both individuals and organizations.

Keywords: *Cryptocurrency, Cyber, Digital Transformation, Logistics, Security, Threats*

1 Introduction

Digital transformation has become an imperative for most organizations worldwide, but the term is broadly (mis)used and it leads to confusion. There are many definitions of digital transformation [1] and one defines it as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" [2]. Digital transformation is omnipresent trend in all business branches: banking and financial systems, healthcare, public administration, power systems, postal and logistic systems, and many more. However, so far it has been investigated primarily from the point of view of firms and less from the perspective of individual non-firm practices that drive the transformative digital phenomenon more broadly [3]. In this process it is important to consider both, firm and non-firm actors.

Nowadays the most prominent digital technology fueling the rise of digital transformation is cryptocurrency, since through its versions, such as Bitcoin, Ethereum, etc., it has a massive global market capitalization. A cryptocurrency is an encrypted, decentralized digital currency that allows people to exchange value and pay services by exchanging crypto tokens and it is used to buy and sell goods and services [4]. This technology is also mostly considered from the business perspective and less from customer's point of view, i.e., assuming that non-firm actors remain passive when faced to new digital technologies and processes [3]. However, cryptocurrencies also need to be addressed from both perspectives, business and customer.

As stated earlier, digital transformation process has a significant impact on logistics [5], while cryptocurrency technology in this domain is mostly mentioned in terms of blockchain usage [6]-[8]. However, the evolution of new technologies, financial innovations, and the dramatic evolution of digital currencies transforms the way we use money in general, but in terms of logistics services as well [9]. Therefore, cryptocurrencies, as well as the technologies supporting it, will become the basis of logistics systems functioning in both aspects: organizational and customer. With that in mind, one has to consider broadly the impact of usage of cryptocurrency technologies in digital transformation of these systems.

At the same time while the abovementioned trends are developing, the number of cyber security threats and challenges in the digital world is constantly on the rise [10]. Cyberattacks are the 5th top rated risk in 2020, while only in 2021, cybercrime, including everything from theft or embezzlement to data hacking and destruction, is up to 600% as a result of pandemic [11]. Given that the cryptocurrency money is being increasingly used and a lot of cybercrime acts will be related to this technology [12], the security challenges it introduces must be seriously addressed.

Taking into account the importance of security of cryptocurrency technology used in logistics systems, from both business and customer's point of view, this paper aims to give a brief overview of security challenges and threats that cryptocurrencies face today and they will face tomorrow. The paper is organized in the following way: Section 2 gives short overview and explanation of cryptocurrency basics in terms of functioning and main notions. Section 3 discusses and analyses the current security threats and attacks targeting cryptocurrencies, while Section 4 gives future trends in cryptocurrency security one needs to pay attention to. Protection measures and conclusion is given in Section 5.

2 Cryptocurrency Basics

Cryptocurrencies are based on cryptography, peer-to-peer networks, and open-source concept (Fig. 1). They are primarily a software – logs within program installed on interconnected computers. The first component, i.e., cryptography, is a multidisciplinary science based on mathematics and computer science for more efficient data coding and decoding. It is defined also as an art of solving codes [13]. Cryptography is done to protect the communication between two or more ends. The second component, peer-to-peer networks are networks of personal computers, each of which acts as both client and server. Each computer can access any of the others, although access can be restricted to those files that a computer's user chooses to make available [14]. The third component, open-source software represents software whose original source code is available and it can be distributed and modified [15].

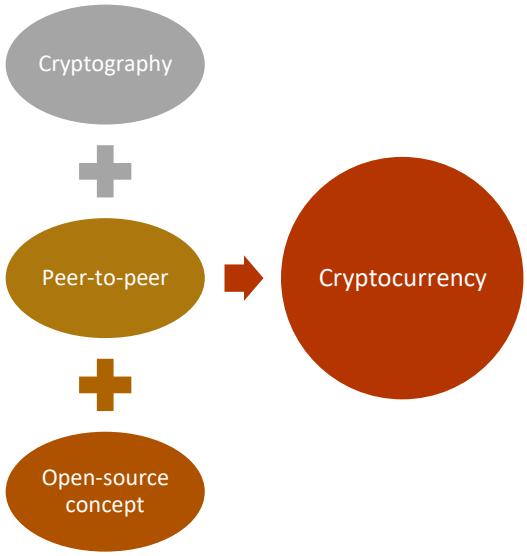

Fig. 1. Basic concept of cryptocurrency

Basic terms in cryptocurrencies are: transaction, wallet, blockchain, private and public key, and mining. Cryptocurrency **transaction** is transfer of value between two digital wallets registered in blockchain [16]. This transaction via Internet is based on cryptographic system of two keys: **private and public key** and cryptographic signature. This concept is used by many online applications for safe communications via Internet. In order to have cryptocurrency transaction, one needs to have a wallet. **Cryptocurrency wallet** is a software solution that can be installed on user device or smartphone, used on Internet as online web wallet or as specialized device, i.e., hardware wallet. Obtaining the wallet is informal process that requires no institution and it can be done completely anonymously [17].

The sender of crypto money sends the transaction in the network and waits for it to be confirmed. The network that verifies the transaction is consisted of computers that can gain reward in crypto money for doing the math. This concept is called mining. **Cryptocurrency mining** has several roles: creates new crypto money, creates trust by ensuring the confirmation of transactions, and makes cryptocurrencies special, decentralized, and secure mechanism [18].

Each transaction the miners confirm go to the main book, i.e., blockchain [19]. **Blockchain** is a data block connected into one-way chain in which each block depends on the value of older block. It is based on cryptography due to importance of security and privacy. Also, it can be considered as decentralized book of events

which cannot be edited once the data is inserted. Blockchain contains classified logs related to each transaction ever made, while each transaction in blockchain is confirmed by the consensus of the majority of the participants in the system. This technology has enabled for the first time transparent transactions that do not require trust among the participants [20]. Working principle consists of the following: (i) anyone can request a transaction; (ii) the requested transaction is broadcasted to a peer-to-peer connection to nodes; (iii) the nodes validate the transaction and user's status using the existing known algorithms, (iv) a validated transaction can exhibit cryptocurrency records, contracts, and other important information; (v) the transaction is merged to form a new block with other transactions; (vi) the new block is combined to the existing blockchain in permanent and unchangeable manner; and (vii) the transaction ends [21][22].

3 Cyber Security of Cryptocurrency Technology: Today

Given that is current and attractive technology, one of the main drive engines of the digital transformation, and often in public perceived as the money of the future, the use of cryptocurrency technology is on the rise. However, on rise is not the knowledge related to its functioning as well as risks and challenges it presents in security terms which is consequently used by cybercriminals. Cybercrimes are more rampant in 2022 and their rate is increasing every year. Furthermore, it is said that cybercrime affects the security of more than 80% of businesses worldwide today [23].

Some interesting statistics related to security challenges that cryptocurrencies face are as follows [24]: the biggest cryptocurrency heist was Coincheck hack in 2018 with $532 million stolen; John McAfee, accused in a $13 million fraud "pump and dump" scheme was found dead; 2021 saw a 23% year-on-year increase in cryptojacking attack, while 2020 cryptojacking attacks on healthcare rose almost 1400%; cryptocurrency hack and thefts increased almost 40% in 2020; losses from cryptocrime rose 79%; over half of billion dollars in cryptocurrency was stolen in 86 attacks in 2020, while around $4 billion in 2021, etc. As one can see, the lack of knowledge has left the door opened for cybercriminals to scam, steal, and otherwise exploit the concept. Thus, cryptocurrencies are used in darknet scams and business, drug, alcohol, weapons, and human trafficking, financing terrorist activities, ransomware, organized crime, and money laundering.

Vectors of attack in terms of cryptocurrencies, i.e., the ways one can become a victim, are countless. Also, there are many context-oriented classifications of those vectors, but the main ones can be in general grouped in: (i) unintelligent activity, (ii) manipulation; (iii) attacks on technology, and (iv) greater force. In accordance with the proposed taxonomy, unintelligent activity means that one does something and consequently becomes a victim of an attack. This can include clicking on a malicious link, or opening an e-mail message attachment which can result in malware infection, or one can become a victim of a phishing attack. Also, one can give remote access to his/her computer or smartphone to potential attacker which can lead to loss. Therefore, this attack vector is solely the result of individual's irresponsible and unintelligent behavior. Further, one can become a victim if he or she is manipulated to reveal the true identity or give away sensitive information. This is usually done through form of social engineering. Third group are attacks on technology that individual cryptocurrency user cannot prevent. Some of the most prominent examples of such attacks are blockchain network attacks, attacks on technology of user wallets, smart contract attacks, transaction verification mechanism attacks, or mining pool attacks [25]. More details on security issues that can be exploited in terms of blockchain is given in [22]. Finally, greater force is an event for which no party can be held accountable such as hurricane, foods, etc.

The most common crypto attack vectors that are discussed nowadays are given in Table 1. It is important to note that even cybercriminals become victims of crypto attacks. Therefore, it is important to individually stay updated with the current and new angles of attack vectors, while the organizations need to update their security policies and practices.

Table 1. Cryptocurrency attack vectors for 2021 [26][27]

Attack vector	Description	Mitigation measures
Reverse proxy engineering (session hijacking)	Using phishing techniques to steal money from crypto wallet	Using two-factor authentication Skepticism to e-mails with clickable links Double checking the correctness of sender's email address and URL
Cryptojacking	Stealing the processing power to mine Infecting the victim with malware and including the machine into a mining botnet	Updated antivirus and antimalware software Awareness regarding e-mail link from unknown senders Installing browser plugins Avoiding public Wi-Fi
Cryptocurrency dusting	Putting the small amount of cryptocurrencies (dust) on addresses and analyzing them in an attempt to identify the individual or company standing behind the wallet	Generate a new wallet address for every transaction
Cryptocurrency clipping	Clippers (malware) secretly substituting the wallet addresses of the intended recipient with that of the attacker	Double-checking the inserted address No downloading of suspicious applications and revising their permissions
Ransomware	Malware locking electronic files on devices and attacker asking for payment to decrypt them	Using antivirus and antimalware software Monitoring of applications Frequent backups User training Nomoreransomware.org

Legend: URL (Uniform Resource Locator), Wi-Fi (Wireless Fidelity).

4 Tomorrow's Cryptocurrency Cyber Security

It is hard to predict what to expect in terms of cryptocurrency security in the upcoming period given that this technology is rapidly developing and the number of users is accelerating. This motivates cybercriminals to invent new ways to attack the technology and users. However, according to the pool of experts in security [28]-[31], the upcoming period could bring the following challenges which will reflect on digital transformation and all the sectors where it is present.

Information stealers will additionally rise and consolidate in the future and continue to monetize attacks. They will be used against financial assets due to their simplicity and effectiveness in attacks. Stolen information is very useful in several ways. Namely, it can be sold in the illegal market and used to profile the victim for further attack. Those attacks can be ransomware or the traditional ones, and they can include cryptocurrency, but the regular money as well.

Targeted cryptocurrency attacks will be on the rise since the cryptocurrency business continues to grow, and individuals as well as firms continue to invest their money in this market because it is a digital asset and all transactions occur online. In addition, it also offers anonymity to users which is an important feature for cybercriminals and state-sponsored attackers. Furthermore, there will be more cryptocurrency-related threats such as fake hardware wallets, smart contract attacks, DeFi (Decentralized Finance) hacks, etc. In this context, cybercriminals will exploit devices with various malwares (ransomware, Trojan, virus, backdoor, etc.), use social engineering, or other methods to steal the financial assets. What is sure is that when money becomes purely software, cybersecurity will change in ways we cannot predict and expect.

The pandemic caused moving of many companies' systems to digital and online

environment. People had to rely on online markets and payment systems as well as cryptocurrencies. However, the rapid shift is not followed by the appropriate security measures which lures cybercriminals. This issue is particularly severe in developing countries. Also, a lot of personal data is stored in our devices because of payment systems and other types of applications which are used from the same devices that we use for cryptocurrency affairs. Therefore, cybercriminals will continue to attack personal information with innovative and complex strategies (deep fake technology, advanced malware, artificial intelligence, etc.). Again, as in information stealer case, this data can be monetized in several ways.

Also due to the pandemic, many employees had to work from their homes. Now, around two thirds of them state they would not return to an office if they do not have to. Working from home brought us additional challenges in terms of security. Namely, a lot of employees conducted their personal and private affairs via their work devices, i.e., they have inadequately used their business devices. Seemingly, those are innocent activities such as music listening, movie watching, reading books, learning, gaming, etc. However, inadequate activities can lead to cybercriminals and their activities of spreading malware and stealing logins, personal and payment information, business information, etc. Once infected, employees as individuals but their companies as well are susceptible to blackmailing, sabotage, reputation destruction, and many other things which can be monetized in cryptocurrencies. This trend is not a temporary phenomenon, but something that is here to stay and affect the security of our online and digital affairs and lives.

5 Protection Measures and Conclusion

This paper gives a brief overview of cyber security threats and challenges characteristic for cryptocurrency technology today and discusses what can be expected tomorrow. We provide insight how these challenges can affect digital transformation process for both individuals and organizations in any business branch (public administration, logistics systems, etc.).

In order to protect themselves in the context of cryptocurrency technology usage in the process of digital transition, individuals and organizations should practice the basic principles of cyber hygiene thereby improving their knowledge, awareness, and behavior [32]. This includes at least the basic knowledge on used digital devices, who access them and where they are; the usage of antivirus and antimalware software together with enabling the security features on devices; better password management and controlled personal information and data sharing policies; regular software updates; and finally repeating all said. Furthermore, these basic activities should be strengthened in the context of cryptocurrency technology by the following five principles [33]: (i) set and use strong and unique passwords, (ii) use secure two-factor authentication, (iii) do not give remote access to accounts, (iv) protect private keys, and (v) do not make yourself a target.

From organizations perspective, protection measures should include adoption, regular update, and enforcement of security policies and practices addressing all aspects of cryptocurrency technology usage. This includes acceptable use, security awareness, incident response, network security, change management, password creation and management, access control, and remote access policy. More funds should be allocated for security management and staff should be regularly educated and trained.

When it comes to future work regarding the impact of cyber security of cryptocurrency technology on digital transformation in logistics should cover examination and quantification of the effects, creation of specialized trainings in order to raise awareness and knowledge of individuals and within organizations, invention, application, and regular update of protection measures, as well as novel legal regulation of this concept.

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The Development of the Concept of Consolidation Centers in Using the Sharing Economy in Postal Services / Logistics

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Abstract

Switching the business philosophy from "having" to "sharing/using" is especially important when it comes to information technologies, where there is a direct connection between interested parties which, at the same time, can be potential providers and users of services. This principle has found its place in various areas (transportation, services, education, entrepreneurship, real estate, commerce, finance, information technologies). Through its application, companies gain the possibility to demonstrate their potential for contributing to the community, reducing environmental impact, and staying profitable. As the interest in goods in urban areas has been on the rise in the whole world, the necessity for measures which would lower the negative effects of freight traffic is inevitable. In that context, in this paper, we will consider the possibilities of applying different models of the sharing economy concept in postal services, as well as the factors which affect the application and implementation of this concept.

Keywords*: Sharing economy, Urban areas, Freight traffic, Postal services*

1. Introduction

The concept of the sharing economy is a new paradigm that turns the existing consumer society into a more transparent, more inclusive, and more responsible system. Rachel Botsman, a sharing economy expert, in considering the usage of the term, also introduces related terminology depending on the context and focus of usage – access, behavior, business model, or market structure (access economy, circular economy, collaborative consumption, collaborative economy, gift economy, gig economy, on-demand economy, peer economy, rental economy) [1]. An inherent part of the sharing economy in the process of service networking is the usage of technology as a means to build trust, a dependable relationship with the unknown, and a reputation that connects the real and the virtual identity. In this democratic process, communities and relationships become important, as opposed to isolation and separation; social capital is just as important as financial capital; access is more important than ownership; sustainability comes before consumerism; and cooperation takes the place of competition. This concept has been named one of the "top 10 ideas that will change the world" by Time Magazine [2]. The Economist has labeled it an "area of immense potential" [3], while Forbes introduced it as "the disruptor of economic power" [4].

The paper is divided into several parts. The first part contains introductory concepts. The second part offers an overview of the notion of sustainable business in the postal sector. The third part shows a short overview of literature with models of the sharing economy present in the postal sector.

The fourth part deals with the concept of the consolidation center as a specific form of collaboration between designated and private operators with the goal of achieving a sustainable business model and increasing the contribution to society. Aside from some unavoidable conditions to successful business operations, there are several clearly defined factors which have, or may have in the near future, an inevitable effect on the demand for consolidation centers.

In the last part, we offer final considerations and potential routes for further development and application.

2. The Concept of Sustainability in the Postal Sector

Sustainable development is an important element of postal operations that contributes to an improvement of efficacy, development of new markets, and strengthening of the relationship with consumers. Through the implementation of various activities, the postal sector raises awareness of social and health issues and contributes to the fight against isolation. Everyday activities at the local level have a positive impact on the development, functioning, and maintenance of local communities, as well as the quality of life of individuals.

The goals of sustainable development, also known as global goals dealing with the basic causes of poverty and the universal need for development for the benefit of all people – these 17 goals of sustainable development will be the backbone of the social and economic growth until by 2030. The Universal Postal Union, as a specialized agency of the United Nations, has a key role in achieving these goals through integration, innovation, and inclusion. The postal sector has a potentially great effect, especially on goals 8, 9, 11, and 17:

8. Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all;

9. Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation;

11. Make cities and human settlements inclusive, safe, resilient, and sustainable, and

17. Strengthen the means of implementation and revitalize the global partnership for sustainable development [5].

Fig. 1. Circular economy

The circular economy is a narrower term than sustainable development, and it refers to the increased possibility of repeated usage of resources. (Figure 1)

The circular economy model is completely opposite of the currently dominant linear economy (Figure 2), which promotes the concept of production called “take (from nature), make (in the production process, use, waste (throw away)”.

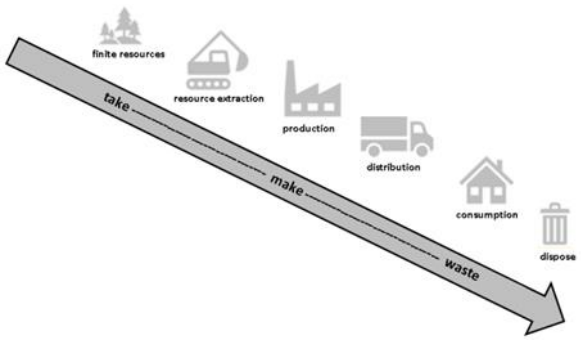

Fig. 2. Linear economy

The circular economy is a system that aims to reconcile economic growth with environmental protection, keeping in mind the limitation of resources. The emphasis is put on making resources last as long as possible through a product design that will enable longevity, business models such as sharing, reusing, and repairing, and only eventually recycling. In this way, a circle in which there is almost no waste is created. Reverse logistics (the process of planning, implementing, and managing of effective and efficient flow of raw materials, semi-finished products, and finished products (goods), along with accompanying data, from the point of consummation to the point of origin – production, with the goal of receiving back a part of the value or with appropriate disposal) [6] can help in closing the loop of a product’s life cycle and switching over to circular economy.

In December of 2021, the Universal Postal Union organized an virtual event called “Posts, Planet, and Economies: A circular route to postal sustainability”, that explored the role and the opportunities of the post as a consumer, employer, and one of the key elements of the logistic chain in accelerating the transition toward the circular economy [7]. One of the conclusions is that the logistic process is a critical element for the sustainability of the circular economy, with an emphasis on the importance of the postal sector in the reverse commerce process. A unique advantage of the postal sector is the ability to reach each individual consumer, as well as traditionally

good partnerships with the business sector that collects data on the location of objects that could be recycled, reused, or repurposed [8]. In addition, DHL has published a new white paper titled Delivering on Circularity [9], in which they state that the largest contribution to the circular economy can be made by the fashion industry and consumer electronics. New circular business models will diversify existing products and services but also initiate a different behavior in consumers as supply chains switch over to supply loops.

3. Sharing Economy Models in the Postal Sector

In the paper, the authors [10] consider existing and potential forms of collaboration in the postal service sector:

- Access to a public postal network, which would allow a user of the access to accept parcels from a user of postal services, and then turn them over to a predetermined postal network access point for further routing, transport, and delivery to the address of the recipient, or to do the same with one's own parcels, i.e., to use the postal network and deliver parcels to the address of the recipient;
- Crowdsourced delivery, as a model of shared delivery in which individuals deliver parcels on behalf of the company for certain compensation;
- The development of the IoT concept, which allows companies in the postal-logistic sector to connect and organizes resources into a unique system;
- The interaction and collaboration of people and machines through the augmented reality concept; and
- Sharing the logistic infrastructure with the competition.

The sharing economy concept based on access to goods/services, as opposed to ownership, can be applied as a new business model for the postal sector, especially the designated operator, which, as a rule of thumb, has a developed network where the role of a shared mobility station can be fulfilled by a postal network unit [11].

Postal operators are in a good position to help in the bridging of the digital gap using the development of an array of services in the financial and social inclusion domain, which create a specific social value, leading to an improvement in the lives of individuals and the society as a whole. According to research [12], post offices are the most desirable choice of location by consumers for internet access, and 11% of participants who have never accessed the internet were willing to receive online training from their local post office staff in order to learn the use the system. In fact, in many countries, post offices are considered non-stigmatizing places open for all, and post office workers are considered dependable and caring people, which is especially important in the development of a just and sustainable digital society.

In the digital environment, companies communicate with consumers through online platforms. This concept is neither new nor in opposition to the characteristics of postal organizations. Where the physical element plays a role, postal operators are at an advantage owing to their strong reputation built on direct personal contact with consumers, with an especially important social role within communities. The physical presence and trust of consumers can be crucial for added value to many online activities. Postal operators could become the basic platforms for an array of activities on online platforms: government services, digital identities, insurance and finance management, telecommunication products, and trade mediation. There are also social and socially responsible programs such as environmental pollution measuring and senior assistance. Postal platforms could become a sort of "personal assistants in life" for people affected by the issues of digital transformation, given their local accessibility [13].

An especially important notion related to the sharing economy is *coopetition* – derived from the words *cooperation* and *competition* and used to define complex multidimensional business relations that companies today have with one another, and which enables the sharing of resources instead of duplicating. Modern post offices are already attempting to think differently and apply strategies of openness in terms of the physical network and infrastructure, as well as of service delivery and logistics [14]. Amazon.com has been using this business model since as early as 2000, and the paper [15] points out that the

concept, although counterintuitive, leads to market expansion, increased resource efficacy, and fiercer competition, not only for Amazon.com but its whole cooperative network.

Sustainable development of urban areas and increased demand for delivery services in urban communities calls for the connectedness of urban logistics and the postal sector through the creation of the reverse logistics system [16]. Both designated and private operators have expressed interest in urban consolidation centers, although there are many uncertainties in terms of implementation of the consolidation scenario, such as the number, location, and size of consolidation centers, car pool, regulatory and market framework, and operative agreements [17].

4. Trends That Could Affect the Further Development of Consolidation Centers

As stated in [18], consolidation centers (CCs) should connect several operators in order to lower individual loads, especially in central urban zones. There can be one or multiple centers covering specific service zones defined based on statistical data on the number of parcels and location of requests. In addition, they can function on a voluntary basis or through mandatory participation in consolidation. In both cases, the basic idea is that they are located as close as possible to the area of service demand, enable maximum flexibility in business operations, and lead to lower transportation expenses and a smaller car pool.

Accordingly, every CC faces a minimum of three unavoidable conditions for successful functioning: to be in accordance with consumer demands, limitations defined by the local and national legislature, and limitations and conditions on the road.

On top of these three conditions, there are three clear factors that have, or may have in the near future, an unavoidable influence on the need for the development of consolidation centers:

- Lack of workforce,
- Further development of e-commerce,
- Environmental protection.

These factors, which can be classified as social, economic-technological, and environmental factors, have been apparent for a while, but their importance grows with time, so it is only now that they are receiving the attention they warrant.

4.1 Lack of Workforce

Experience has shown that the conditions of the job market from the point of postal-logistic operators have changed drastically and negatively. The possibility of easily finding professional staff and having a simple hiring process is a thing of the past. The root of the issue can be found in the high rate of migration abroad, but we must also not forget the amount of compensation employers are prepared to offer.

The first independent regulatory body which managed postal services in the Republic of Serbia began working on February 1st 2010, and that year marks the beginning of the liberalization of the postal market in the country. According to official data [19], 45 operators are currently active. This information should imply a competitive market. However, if we take the definition of the oligopoly market – a situation where the number of suppliers is so low that each one of them has a direct impact on price and competition – and add to it the impact on employee compensation, it poses the question of what kind of a market that really is. Currently, not a single operator in Serbia has stood out, nor is prepared to stand out in that sense.

CCs would at least somewhat enable the overcoming of the lack of workforce issue caused by migrations primarily owing to the optimization of the process of delivery, exchange, and sharing of human resources.

On the other hand, using CCs as access points where a service is realized, transportation rationalization, and better utilization of flexible transportation capacities would lower the overall transport expenses, [20] which would also aid in solving the second listed issue.

If we consider the number of working hours couriers would require in order to conduct delivery for each separate courier service provider in an urban area and then add the expenses of vehicle exploitation, it becomes clear that a consolidation center network is much more efficient.

4.2 Further Development of E-Commerce

With the urban population increase, the development of e-commerce, and the increase in the number of e-commerce platforms, the expectations of consumers to receive what they want, when, where, and how they want it has increased as well. Although the internet has led to lower logistic expenses in terms of information transfer and money flow, it also poses higher demands for faster distribution of physical products.

E-commerce has not entirely replaced traditional shopping, but its growth in Serbia has been recording unprecedented results. In terms of online card payments in Serbian dinars, 2020 saw an increase of over 100% compared to 2019. Turnover realized through payment on delivery is not included in the graph [21].

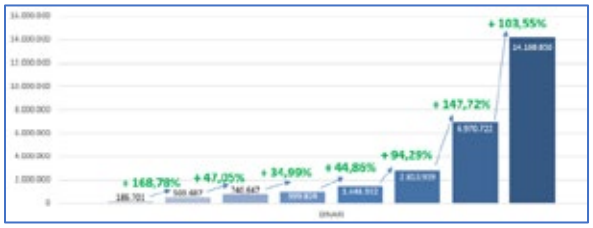

Fig. 3. Growth trend of the number of card transactions in online stores in Serbia

The pandemic has furthered accelerated this trend, but it is expected that these consumer habits are here to stay, as well as that the attitudes of consumers towards e-commerce in Serbia have changed permanently.

Further growth of the scope of electronic commerce leads to an increase in the number of delivery vehicles with a mandatory route optimization based on IT technologies, as well as hiring new staff. Amazon has hired 450,000 people since the beginning of the pandemic and is planning to hire 125,000 more all across the US [22].

In accordance with the idea of following the latest global trends, postal operators can find an interest in the sharing economy and forming a joint consolidation center.

Let us use the Belgian and Dutch Posts as an example – they are developing a project based on the desire to enable coordination of the operations of several logistic enterprises that offer delivery services in central urban zones. Parcels from multiple carriers are consolidated at warehouses outside city centers for the post to deliver the last mile, similar to the Postal Service's Parcel Select service. The Belgian Post estimates that their project saves about 30 percent of the total miles driven [23].

Collaborative logistics can help posts fortify their position as the last mile delivery partner of choice, especially in congested downtowns. By leveraging IoPT, the Postal Service could develop collaborative logistics platforms to manage last-mile deliveries [23].

4.3 Environmental Protection

The constant growth of the urban population, high population density, and economic activity are primarily causing a high level of air pollution. According to the report from the European Environment Agency, urban areas inhabited by over 70% of the EU population see high levels of pollution that are mainly attributed to the high level of emissions from road traffic and residential combustion in urban areas [24].

Many cities have opted to introduce low emission zones or congestion fees. The city of London has developed a strategy in this area to ensure that 80% of all commutes in city zones are done by foot, bicycle, or public transport by 2041 [25].

In the Republic of Serbia, the Law on Air Protection, among other things, states that agglomerations with high air pollution must have Air Quality Plans [26].

As a consequence of the abovementioned issue, there is a need to reexamine and redefine transportation logistics, as transport in city areas is very difficult and, in some cases, impossible.

One possible solution are consolidation centers, which would enable the sharing of data on request numbers with the goal of lowering the mileage and the number of vehicles used, directly increase traffic safety, lower carbon emissions, and enable the optimization of the utilization of warehouses, defining of key routes and their optimization, and loading area utilization of a joint vehicle.

5. Conclusion

The postal sector is characterized by personal and territorial access, which, on top of adequate infrastructure, includes human, technical, and technological resources. The decision of postal operators to strive for sustainable business

operations, implementation of new business models, and diversification of existing products and services are bringing to life a new business philosophy that requires new expertise and different relationships on the market between all interested parties – regulators, service providers, and consumers.

The development of urban areas and increased demand for delivery services among the urban population requires a relationship between city logistics and the postal sector, which is especially important for smaller providers that need a sustainable business model. The encouragement of the development of consolidation centers is one of the ways of increasing the accessibility and efficacy of postal operators and realizing inclusive and sustainable solutions for the community through a new definition of services on the postal market and appropriate regulations.

The presented idea may serve as a starting point for solving a part of the issues in transportation, at least in terms of delivery in city zones, as well as a good basis for a new form of collaboration of competing organizations that promotes inclusion, transparency, and sustainable business models.

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Digital transformation of postal services – key success triggers

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Abstract

With the advancements in Information and Communication Technologies and widespread adoption of digital services at an ever-growing rate, postal operators are facing inevitable digital business transformation. The introduction of digital technologies in the postal sector over the last decades yielded a plethora of new opportunities but also poses some threats. To overcome revenue losses due to a substantial decrease in mail delivery services and changes in the postal services market, postal operators recognized the need for digital transformation in their core business activities. Digital innovations, e-commerce, data collection, and digital identity have accelerated the postal operators' efforts to offer new services, improve efficiency, and adapt business strategies to the requirements of the digital economy. Thus, digital transformation has become a strategic priority for postal operators. In this paper, we analyze the main drivers of digital transformation in the postal sector. Key technological pillars of digital innovations in postal networks are highlighted. Furthermore, key success enablers and possibilities for improvements in digital postal services provisioning are presented.

***Keywords**: Digital Transformation, Digital Innovations, Postal Operators, Postal Services*

1 Introduction

Nowadays, the world is embracing digital technology at an ever-increasing rate. In general, digital transformation represents an integration of new Information and Communication Technologies (ICT) into all areas of an organization, stated in [1]. Technological integration inevitably leads to the transformation of traditional business models. Moreover, the regulatory aspects must be considered in the process of digital transformation in all areas of interest. Digitalization is often considered a global maturity model that involves the implementation of new processes in all dimensions, including processes, people, governance, etc, shown in [2]. It can also be described as the capacity for interaction between customers and technology to support decision making [3]. The core of the digital transformation process is the transformation of the business itself. It should be emphasized that digitalization is not the goal, but a tool to improve the efficiency and sustainability of the business. The concept of a digital ecosystem encompasses organizations interconnected by a common interest in the prosperity of digital technology to materialize their innovative product or service, as we can conclude from [4]. However, the digital ecosystem can be observed not only from the interconnected organizations' perspective but widely, as an environment where digital objects are embedded in changing interdependencies with other entities, according to [5].

The majority of Postal Operators (POs) under the Universal Postal Union (UPU) provide digital postal services, directly or in partnership with other companies. Customers, both senders and receivers, are expecting to interact with the Post via digital channels. POs tend to provide e-government, e-commerce and e-finance services to persons with disabilities and other persons with specific needs. Therefore, the postal sector is an integral segment of consultations in which governments, policymakers, regulators and other international organizations design strategies to foster digital inclusion. Furthermore, numerous POs have raised their investment in digital postal services. Thus, the digital postal environment continues to evolve to adapt to the digital age to remain relevant and competitive. The

digitalization of postal services is needed for effective competition. There is an urgent need for POs that have not fully digitalized to speed up the process to become reliable digital service providers for e-government, e-commerce and e-finance services. In this paper, we analyze challenges and opportunities for POs in the era of digital transformation. The main triggers of digital transformation and the relevant aspects of digital transformation in postal services are presented. Several factors are recognized as critical for success in the digital transformation process and for providing POs with a competitive advantage in the digital market.

The remaining of the paper is organized as follows. Section 2 provides an overview of the global trends in the postal digital environment. Current challenges and the technological drivers of the digital transformation in the postal sector are indicated in Section 3. Section 4 represents some future trends and guidelines for the successful digital transformation of POs. Finally, Section 5 provides concluding remarks.

2 Global Trends in Postal Digital Environment

Digital transformation is an essential segment of strategic positioning in the market for all organizations. Main triggers for the digital transformation range from technology ubiquity, to the demand for novel business models and delivery excellence, stated in [6]. The role of digital services in present business models is crucial because organizations interact with customers, businesses and other relevant entities via those services. Two dimensions are recognized as important for successful digital transformation: ubiquity and change. These dimensions reflect digital transformation maturity. Ubiquity is the degree to which digital services support the requirements of stakeholders and harness the organization architecture, while change shows the pace at which stakeholders deliver digital services to meet customers' expectations, especially in terms of regulation, policy, strategy, and structure.

Ubiquity and change yield four distinct levels of digital transformation maturity: digital trailblazer, digital leader, digital follower, and digital laggard, concluded in [6], as shown in Fig. 1.

Fig. 1. Levels of digital transformation maturity

Digital laggards lack in both ubiquity and change, often applying a fragmented and disjointed approach to services. This group of stakeholders cannot embrace the potential of transformation and does not orchestrate success factors to their advantage. Digital followers prefer gradual steps with minimal disruption in the process. This group of stakeholders usually is not the first to embrace transformation, thus lacking the political and operational capability for significant improvements. In the case of impediments, the follower may even reverse the benefits of digital transformation. Digital trailblazers adopt digital technologies quickly, in stark contrast to digital followers. They are aware of the necessity for digital transformation. Digital leaders expand in both dimensions and encompass characteristics of both digital followers and digital trailblazers. Leaders have recognized the change as an essential success enabler for digital transformation.

Pathways to digital transformation maturity are shown in Fig. 2. The majority of organizations begin the digital transformation as digital laggards due to the speed at which digital technologies are available, the take-up is slow and lacks success. Once the digital transformation begins, there are three basic options. The organization can become a trailblazer, it can build progressive consensus and internal capability before pressing ahead, or it can directly step into the leader position, bypassing the transition levels. However, without sustained effort, it is possible to move backwards.

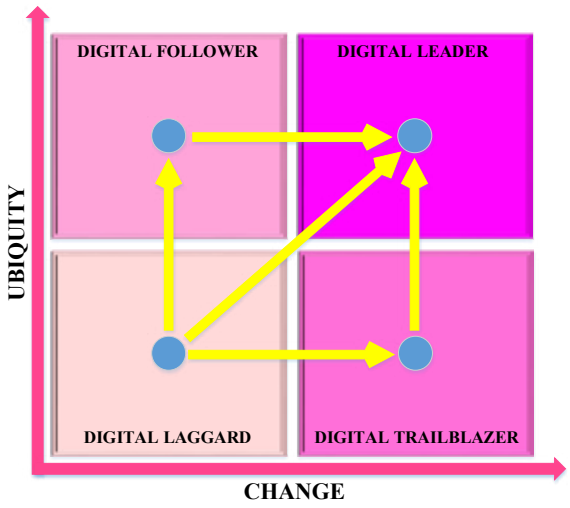

Fig. 2. Pathways to digital transformation maturity

The introduction of digital technologies also raises new challenges. The digital tools diverse the structure and the communication channels in the organizations, thus indicating the need for new business models. These new technological triggers affect the digital transformation of the postal industry. Major challenges for future digital postal strategies are trust and cybersecurity, digital identity, inclusion, Big Data and the overall digital ecosystem, as discussed in [7].

Digital trust is critical for postal services. It assures positive long-term relationships with the customers and other stakeholders. Relations between POs and customers in the digital era rely not only on the digital services but also on the assurance that customers' private data is protected. Hence, postal services' digital trust is the foundation for the acquisition and retention of customers and stakeholders. POs' digital infrastructure and customers' private data can be endangered by cybercrime. Significant efforts are needed to improve the security of postal digital processes and e-services. An appropriate cybersecurity framework is required to prevent cyberattacks and build trust among digital postal customers and stakeholders.

Nowadays, digital identity becomes highly important. It enables postal customers to embrace benefits via digital platforms. Digital identity platforms can enhance the efficiency of postal service delivery, reduce transaction costs, improve transparency and support postal development.

Postal networks can use their vast infrastructure to enable Internet access and alleviate digital divides. Digital services encourage inclusion by providing accessible information on postal services and connecting customers who may have never been connected via traditional communication channels. Digital platforms aim to maximize scale and reach across income and gender divides.

Big Data poses additional challenges to postal networks. To support evidence-based decision making and foster postal digital development, postal networks should improve their capabilities and measure Big Postal Data. The potential of Big Postal Data can be used to measure digital postal development at regional and international levels. Furthermore, it creates postal digital awareness and improves postal capacity building.

In general, a digital ecosystem refers to a platform that comprises organizations, customers, data, processes and the Internet of Things (IoT). New digital platforms enable organizations, including POs, to be more agile and adaptive. POs can move towards creating a digital postal services platform and comply with the ever-changing needs of their customers and stakeholders.

3 Technological Drivers of Postal Digital Transformation

Postal services have an irreplaceable role in economic development by supporting connections among customers, economies and countries. The postal sector represents an important means of communication and trade, particularly in terms of economic perspective, stated in [8]. During the last three decades, the postal sector has experienced significant changes. Key pillars of innovations in the postal sector over the years are presented in Fig. 3.

Improvements in ICT triggered the first wave of postal digital innovation, i.e., e-substitution, that caused a progressive shift from paper-based to electronic communications. Recently, the scope of digital innovation is widened substantially and affects all processes and functions of POs, from operations to customer service. Digital innovations also generate new types of competitors, for instance, on-demand delivery platforms that may endanger the postal "last mile". However, the advantages of postal digital innovations are enormous, including the protection of postal core business, improvements in cost efficiencies, and innovations in new

products and services. Furthermore, new opportunities arise in terms of long-term relevancy and diversification by creating new sources of revenue.

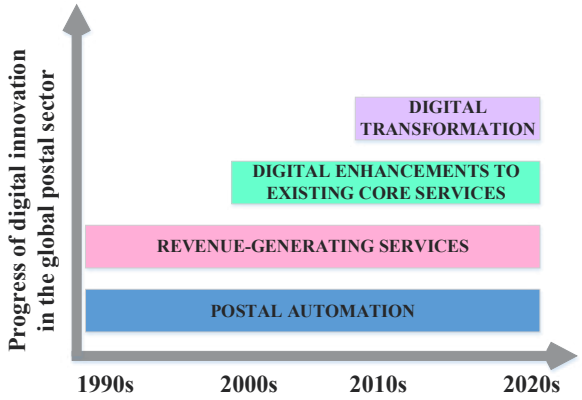

Fig. 3. Progress of digital innovation in the global postal sector

The first notable changes in the postal sector started with postal automation. The digital efforts were mainly focused on rationalizing and automating sorting centers. Mail tracking, primarily used for high-end express items, was extended by an intelligent mail barcode. Sorting facilities introduced machines for sorting letters. Currently, POs are shifting investments from mail-centered to parcel- and recipient-centers value chains, due to the expansion of e-commerce and reduced mail volumes. It is expected that sorting and delivery will be further enhanced by the use of robotics, IoT and on-demand delivery apps.

Mail revenue losses highlighted the need for the creation of new revenue-generating digital services. New trust-based services are offered, including certified electronic communications, online identity verification, secure electronic mailboxes, online payment, government services platforms, etc.

The increased broadband penetration and ICT services expanded customer access to postal services. New services that combine elements of a digital first mile (using digital means to enter a piece into the mail stream) and the ubiquity of the physical last mile (such as hybrid mail and print management) have emerged. To enhance customer convenience and simplify access, some elementary postal services (postcode lookup, change of address, price calculators etc.) are put online. Lately, mobile apps and new data collection technology have further improved customers' experience. Thus, POs' digital and core businesses rely on the Internet and ICT services to provide customers with immediacy, control and information. Further integration of postal information systems with e-merchants, technology partners and other stakeholders will enable POs to respond to customers' requests in real-time.

Digital transformation encompasses innovations in technologies, processes, culture and business models. For instance, cloud computing and data analytics accelerate more informed data-driven decisions, thus supporting faster responses to customers' evolving preferences and providing more flexible delivery options. Investment in digital transformation across the PO's network is a long-term pathway to improvements.

To embrace the potential of digital transformation, POs have to acquire or improve their ICT capabilities. The development of a digital business technology platform can bring numerous benefits to POs. Five major capabilities can be distinguished in such a platform: an information systems platform, a customer experience platform, data and analytics platforms, an IoT platform, and ecosystem platforms. The information systems platform aims at supporting back office and core systems (such as Enterprise Resource Planning). The customer experience platform contains customer portals, multichannel commerce and mobile customer applications (such as delivery management apps). Information management and decision-making capabilities are supported by data and analytics platforms (for instance, data analytics powered by machine learning can be used to predict volumes and prevent or mitigate operational bottlenecks in postal networks). The IoT platform provides sensor-based management of a postal fleet, capturing of sensor data, location intelligence (for instance, the digital mapping of postal vehicles or routes and customers' actual locations), analytics applied to the data and their integration to the PO's operational technology systems. Finally, ecosystem platforms provide connection of external marketplaces, communities, or supply chain partners, thus supporting cooperation between, for instance, e-commerce portals and shipping platforms, or large mailers and consolidators. All those platforms enable POs to overcome some of the most important challenges, including synchronization of the

supply chain (from shipping to delivery, both domestically and beyond borders) and modified parcel delivery in urban areas.

4 Guidelines for Improvements in Postal Digital Transformation

POs should rely on their competitive advantages, but concurrently, transform key aspects of their business to be able to offer sustainable digital services. Several factors provide POs with a crucial advantage in the competitive digital market. Primarily, the capacity of the postal sector, including post offices and postmen going door-to-door daily, is one of the largest physical networks in the world. Post offices should be complemented with new digital services to expand the competitive edge in terms of network size and density. Additionally, the access to financing for digital projects is vital, since current investment resources are usually insufficient to ensure the full development of services. More investment is needed for POs to fully digitalize their organization at the operational and product level. Taking part in sponsors' round tables and conventions organized by international organizations may assure access to funding for digitalization projects. Over the years, POs have experienced the transition from traditional postal administration to corporations that need to compromise social impact and financial sustainability. Building partnerships with the public and private sectors can boost POs digitalization and reduce financial burdens. An essential segment of POs digital transformation is the alignment with the government's digital strategies. It is necessary to recognize the postal network as a tool for advancing digital inclusion. Thus, POs should take part in regional and national digital strategies.

Main enablers of digital transformation in the postal sector, such as broadband Internet, mobile and social networks, IoT, robotics, and other technological innovations depicted in Fig. 4, are long-term trends that will increasingly impact postal strategies in the future, concluded in [9].

The benefits of successful implementation of the postal digital strategy include increased revenue, decreased operational costs, improved customer satisfaction, and enhanced differentiation of postal products and services. The main impacts on each of these dimensions are depicted in Fig. 5.

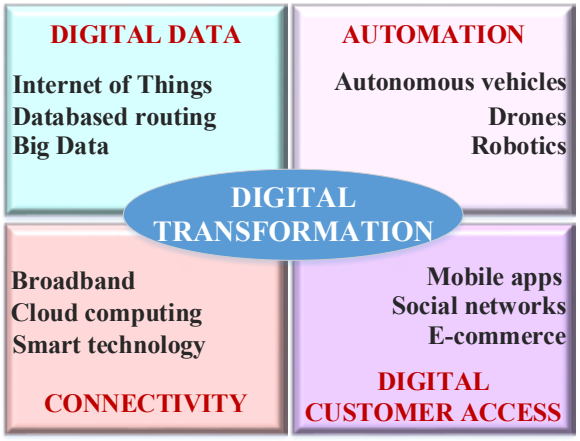

Fig. 4. Progress of digital innovation in the global postal sector

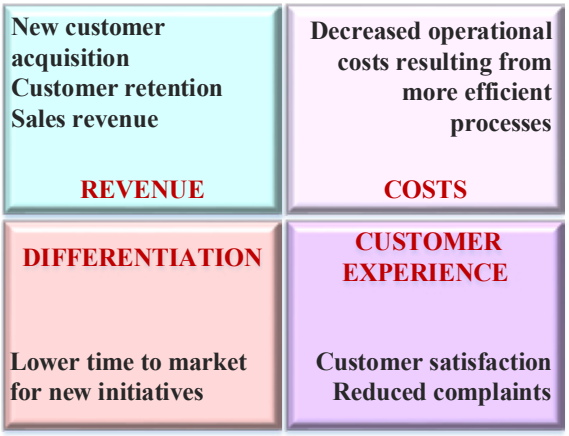

Fig. 5. The impact of the digital transformation in the postal sector

5 Conclusion

The changing ICT landscape transforms the way POs provide postal products and services to customers, businesses and governments. It is expected that the ICT impact on the postal sector will continue to have even greater effects in the future. Digital transformation provides POs to move from a purely physical services-based business model toward a multi-channel business model. It causes large-scale changes across multiple dimensions of business for the POs and provides new opportunities for value creation and inclusiveness for society. Digital postal services are a tool for leveraging trust and competencies, diversifying, and improvements in the core business of POs. Positive impacts that digital transformation brings to the overall POs' business organization trigger the new waves of

increasing investment in the digitalization of the postal sector.

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Improvement of urban mobility supported with IoT technologies

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Abstract

Urban mobility is one of the most significant factors in the successful development and sustainable future of large cities. The increasing demand for fast, safe, and eco-friendly transportation services is a trend in modern society. These requirements pose the challenge of finding corresponding solutions for efficient mobility of people in urban areas. However, many problems are caused by the increased traffic in cities, leading to high congestion, negative impacts on the environment, rising security challenges, etc. Therefore, the research community and other stakeholders have increased their focus on finding solutions for these issues. The Internet of Things (IoT) has enabled the development of efficient and cost-effective solutions to enhance urban mobility. Enabling IoT technologies has become a significant driver for smart mobility concept development. The continuous development of IoT has led to various applications focused on urban mobility improvement. This paper presents some IoT possibilities and potentials for developing solutions for smart urban mobility.

Keywords: *Urban mobility, Internet of Things, Smart city, Smart parking, Traffic light management, Bicycle rental*

1 Introduction

In recent years, the population of urban areas has continuously increased. Therefore, large cities are experiencing a major urban transition that leads to higher carbon dioxide emissions (up to 80%), increasing waste, environmental pollution, heavy traffic jams, traffic accidents, etc. [1]. Many of these issues have been addressed by using ICT-based solutions. These solutions aim to achieve efficient urban mobility (the movement of people in urban spaces in an organized manner). The concept of smart mobility implies the development of a connected, efficient, and flexible transportation system. This system is the basis for improving life in urban areas through better public transport, car and bicycle-sharing services, traffic light management, etc. Smart mobility provides more efficient movement of people, thereby improving their quality of life. ICT-supported transportation systems enable easier, faster, and more reliable travel of passengers by using public transport. Therefore, new approaches to solving problems related to urban mobility are mainly based on the concept of intelligent transport systems [2]. Most urban traffic management systems (TMS) allow real-time monitoring of public transport vehicle routes. In addition, many modern TMS enables monitoring of the entire traffic system including the number of vehicles on roads and parking lots, detecting traffic accidents, monitoring the use of alternative means of transport (e.g., bicycles and mopeds), etc. This information is used to manage traffic with a special focus on enabling unhindered and fast public transport and emergency services (e.g., ambulances, firefighters, and police). Also, there is a trend of promoting other forms of passenger transport in cities that suffer from traffic jams. Therefore, in a large number of cities, special focus is placed on the bicycle rental system. These activities seek to reduce congestion and negative environmental impact through the collection of various data on human movement. Thus, the concept of smart urban mobility implies a specially developed TMS.

Every TMS implies the need for data collection in the right place, at the right time, and the corresponding device. These processes enable the connection of various components and transportation system infrastructures. This data collection should be efficient with reasonable costs and the possibility of real-time processing [3]. One of the most efficient ways to develop a smart TMS is to apply the concept of the Internet

of Things (IoT). Therefore, IoT greatly contributes to the development and improvement of urban mobility [4]. This paper presents the IoT potential for urban mobility improvement. The first chapter describes the concept and indicators of urban mobility. The second chapter describes the benefits of using IoT technologies to enhance urban mobility for specific user groups. Certain urban mobility services based on IoT systems are described. The fourth chapter describes some of the most common applications of IoT technologies to enhance urban mobility such as traffic light management systems, smart parking, and smart bike rental systems. The fifth chapter contains concluding remarks.

2 Urban mobility

The concept of urban mobility represents the movement of people between sources and destinations, at different times, using different means of transport and modes of travel. Urban mobility is shaped by the demands for fast, efficient, safe, and economical transport. In earlier years, mobility was mainly associated with a product that included vehicles, physical infrastructure, and the fuels needed to move people. Today, mobility is increasingly seen as a service. Mobility enables people to provide basic living needs and contributes to improving the quality of life. In urban areas, the existence of high-quality mobility is essential for the success of other urban sectors and the creation of new jobs.

The urban mobility assessment aims to identify the weaknesses and strengths of the transport system as well as to identify the key and critical elements of the same. It provides a better understanding of urban mobility and creates a foundation for improving existing and creating new services. Procedures for assessing urban mobility depend on the information available on the transport system, which could be collected from a variety of sources. Most often, data is collected by public transport companies, road charging institutions, national statistical agencies, etc. In addition to the above data sources, one of the key ways to collect the necessary data is through sensors and cameras installed on traffic infrastructure. These are the most common components of modern information systems used for traffic monitoring and management. They are often used to develop these systems. Also, new data sources such as data from public mobile telecommunications networks and services such as Google Maps are increasingly being used. The primary function of these technologies is not to collect or generate data on urban mobility, but they can generate information that can be used to assess and improve mobility.

An indicator is a quantity that shows the state or change in the state of a system, or the course of a process. They enable the display of the system concerning the desired state and efficient and simple monitoring of system changes over a while. Indicators of urban mobility are formed and based on appropriate data from different segments of the transport system (Fig. 1).

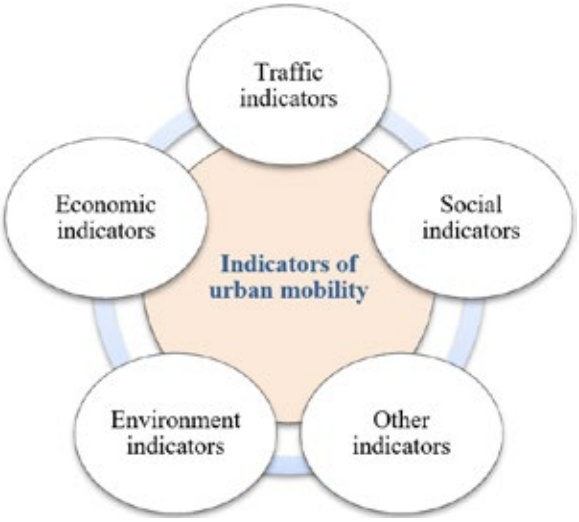

Fig. 1. Indicators of urban mobility

The traffic indicator shows urban mobility through categories related to the traffic aspect, eg. travel time and speed. The economic indicator shows the impact of certain economic components on urban mobility like as fuel prices and parking prices. The social indicator shows urban mobility through its social acceptability (e.g., number of traffic accidents, number of casualties, number of injured). The environmental indicator shows urban mobility through categories related to the environment and meteorological conditions, eg. emissions of harmful gases, and noise. Additional indicators are those that cannot be classified in any of the above categories, eg. the existence of regulatory frameworks, traffic management, and planning bodies, etc.

3 Impact of IoT technologies on urban mobility

Smart TMS development requires data collecting to enable an efficient decision-making. IoT technologies enable real-time data collection and provide seamless connectivity between various physical and virtual objects [5]. These services contribute to the improvement of urban mobility. Also, Green IoT (G-IoT) is a promising technology that will drastically improve the quality of life in smart cities and change our environment to be smarter, healthier, greener, and more economically sustainable [6].

The implementation of the IoT system improves the capabilities of traditional infrastructure by enabling the collection of data from physical infrastructure, their exchange between different components, and automated decision-making based on real-time data processing. Examples of IoT applications that have significantly improved certain aspects of urban mobility are adaptive traffic management systems, smart parking, smart public transport ticketing, pedestrian crossing control, travel planners, vehicle and bicycle-sharing services, etc. These solutions are the basis for the further development of smart urban mobility. Fig. 2 shows some of the most common IoT-based services that significantly contribute to the urban mobility improvement.

Fig. 2. IoT based services to improve urban mobility

Smart parking increases users' ability to locate free parking spaces which reduces waiting times, congestion, costs, negative impact on the environment, etc. Smart ticket issuance allows easier and faster payment for transportation services with the integration of different payment systems. IoT technologies enable efficient real-time travel route planning. Smart monitoring centers enable traffic data collection to enable efficient control and management mechanisms to improve safety, reduce congestion, etc.

The IoT also provides additional services to improve vehicle sharing systems (e.g., car-sharing and bicycle-sharing). For example, IoT-based bike-sharing systems improve passengers' interest in this alternative way of traveling and connecting. The usage of these smart systems reduces the number of vehicles on roads, which causes a congestion reduction as well as mitigation of negative effects on the environment. Also, IoT-based services used for taxi reservations allow easier access to taxi services with improved quality.

The following potential user groups have key benefits from using these IoT-based smart mobility services:

- Travelers - improving the travel experience in urban areas, improving travel reliability, reducing travel costs and time, etc.
- Transport operators - creating a balanced supply and demand, more efficient use of resources, reducing costs, planning a better supply, etc.
- City authorities - planning the development of infrastructure and the provision of transport services, ensuring a more environmentally sustainable transport system, traffic control to improve safety, etc.

Thus, some of the key benefits of applying IoT technologies to enhance urban mobility are reducing congestion and passenger frustration, improving safety, reducing travel time, reducing the negative impact of traffic on the environment, improving the travel experience, reducing costs, etc. Most IoT-based systems are based on real-time data collection to enable integrated services such as traffic management and control.

4 Examples of IoT application to improve urban mobility

IoT technologies are used a lot in transport systems for urban mobility improvement. These technologies contribute to more efficient traffic management and control, better use of available resources, integration of traffic and other systems, improvement of traffic safety, etc. These effects are achieved through efficient real-time data collection mechanisms that are the basis for quality decisions. Some of the most commonly used areas of application of IoT technologies that contribute to the improvement of urban mobility are adaptive traffic management systems, smart parking solutions, and bicycle-sharing systems.

4.1 Smart traffic light management system

The smart road concept integrates advanced IoT technologies and management algorithms to enable traffic flow prediction and management. This integration can improve travel time, and road safety, reduce congestion, increase vehicle throughput, etc. [7]. The improvement of the traffic management system is mainly based on the optimization of the work of traffic lights at intersections (Fig. 3). The smart traffic light system is an automatic vehicle management system that combines new technologies (sensors) and artificial intelligence techniques to control the flow of traffic at signalized intersections [8]. This system enables significant improvement of traffic congestion management through the implementation of a fully adaptable and dynamic way of decision making. Signaling schemes change according to the real-time traffic situation. In some cases, traffic conditions change abruptly due to an event, accident, or special situation. That is why smart systems based on IoT technologies often include the detection of road conditions such as weather conditions and unforeseen situations such as traffic accidents.

Traffic light management systems are mainly based on the use of microprocessors and usually, work on a pre-programmed algorithm. The system requires data collecting from sensors including microwave radars, laser radars, passive infrared sensors, ultrasonic and passive acoustic arrays, and special cameras. Most of traffic management models are based on similar processes of collecting data that is transmitted to the control unit to determine the current state of the traffic flow. The queue length and waiting time at each intersection are then calculated while the adaptive neuro-fuzzy system automatically estimates the duration of the traffic green/red light and the cycle time to minimize the waiting time. Thus, sensors installed at key locations collect data on high-traffic crossings and areas where cars are automatically diverted based on the current situation. This can be achieved by using IoT technologies. Long-term data collection can be used to create data warehouses. This data can be used for further analysis and optimization of traffic signaling.

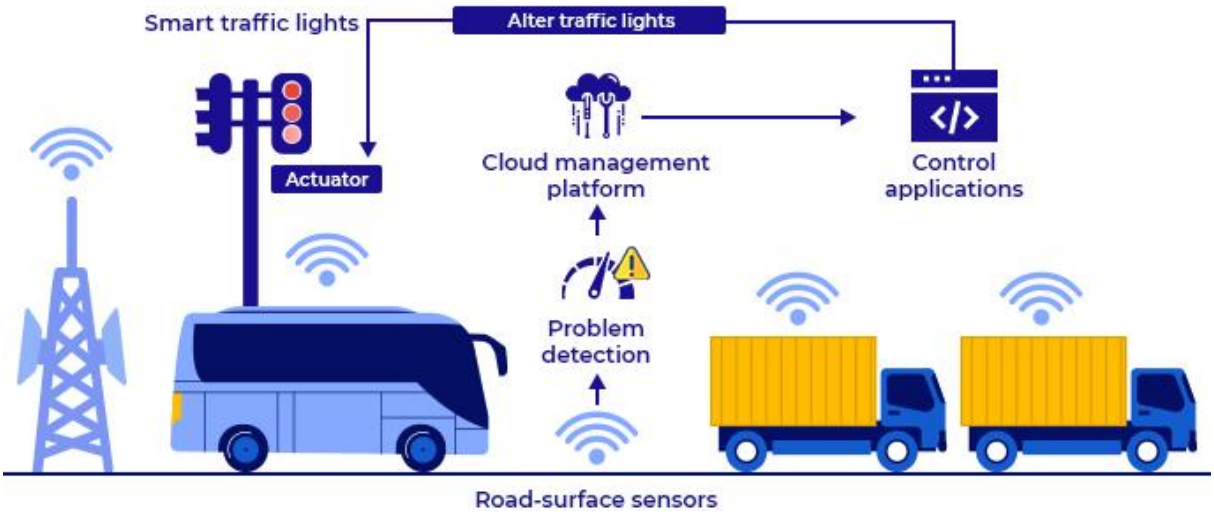

Fig. 3. Illustration of a smart solution for traffic light management [8]

Also, IoT technologies can be very useful for informing drivers and alerting them to road conditions in real-time. For example, the application of these technologies can detect collisions caused by collisions. Informing drivers is crucial to deciding on choosing an alternative route. When the driver is aware of a potentially dangerous obstacle on the road, he can drive carefully or choose an alternative route, avoiding a potentially fatal collision or preventing drivers from injuring people on the road. More advanced systems also allow proposing alternative routes based on available data. This can be done by using roadside displays or by sending information directly to drivers via in-vehicle info systems. This is especially useful for services such as ambulances, police, firefighters, etc.

4.2 Smart parking

Smart parking is a system that uses sensors to detect parking space occupancy. This information can be passed on to drivers to reduce the time it takes to find a suitable car park. In many cities, the number of vehicles has long exceeded the number of available parking spaces. To solve the problem of parking, it is necessary to consider all the factors that affect stationary traffic in a city such as the number of vehicles and parking spaces, geographical location and relief of the city, urban division of the city, gravity zones, etc.

The key goal should be a sustainable solution for stationary traffic terminals that will provide a sufficient number of parking spaces for all users in the long run. This goal can only be achieved by applying smart parking solutions. A large number of smart parking solutions include options for detecting free parking spaces as well as directing drivers to free parking spaces using the integration of IoT and GIS systems. Also, these solutions enable the development of the *Park and Ride* system, parking time restrictions, information in parking lots, etc. Thanks to these capabilities, smart parking systems are beginning to offer certain solutions to improve urban mobility. The application of IoT and sensor technologies enables the collection of data on parking availability and road conditions in real-time (Fig. 4).

These data enable traffic management, which results in reduced traffic, reduced emissions, shorter travel times, shorter parking time, etc. All these effects are significant indicators of the impact of IoT on improving urban mobility. IoT systems implemented in smart parking solutions can generate a large amount of data. The vast amount of data presents challenges related to their processing, storage, management, and manipulation. An effective solution to these problems is the application of Cloud technologies [9]. An example of the functioning of such a system is that data on free spaces in the parking lot is detected by sensors and then forwarded to Cloud servers. At the request of the driver, the data can be transmitted to the user via the web or mobile application.

Fig. 4. Illustration of an IoT-based solution for smart parking [10]

4.3 Smart bike rental and sharing systems

Bicycle sharing and rental services in urban areas are growing rapidly in cities that are trying to solve the problems of traffic congestion and protection from the negative impact on the environment. The basic premise of the concept of smart bike-sharing and rental is sustainable transportation. Therefore, bicycle rental systems are being introduced to increase mobility choices, improve air quality and reduce congestion. IoT enables the development of an intelligent public bicycle management system using sensors, GPS, wireless technologies, mobile phones, object identification technologies (e.g., QR), etc.

The traditional way of implementing these services included subscription, using the screen terminal at the rental station, returning the bike to defined locations, and other rather

complicated processes. IoT technologies simplify these processes, which greatly influences their popularization among residents and tourists. Smart bike rental solutions make it easier and simpler to rent, use mobile phones instead of displays at rental stations, integrate with the public transport system, the ability to use different business models, etc. [11].

Many IoT-based solutions include a bicycle track, which is important for improving safety and the possibility of more flexible use of rented bicycles (Fig. 5). For example, the user can leave the bicycle at any location in the city, and not only at certain stations, as provided by the traditional bicycle rental system.

The most commonly used GPS tracker allows you to locate your bike in real-time. In addition, it is possible to create route records that can be viewed later to optimize locations for bicycle rental, theft protection, and other services. Thus, new systems are based on smart technologies and provide users real-time information on bicycle availability. This is enabled through various user-friendly platforms including web and mobile applications. These smart bike rental systems provide the missing link between existing public transport and desired destinations, offering a new form of mobility that complements existing public transport systems.

Nowadays, due to climate change, traffic congestion and many other facts affecting daily life a trend to use eco-friendly transportation ways has arisen. The idea of real time bicycle tracking has been around for a while. These systems have been greatly accepted in the different cities around the world. They are increasingly popular in cities world-wide as a sustainable, eco-friendly and flexible transportation mode [12]. Therefore, smart bike-sharing and rental systems are becoming as one of the world's most widespread public IoT applications.

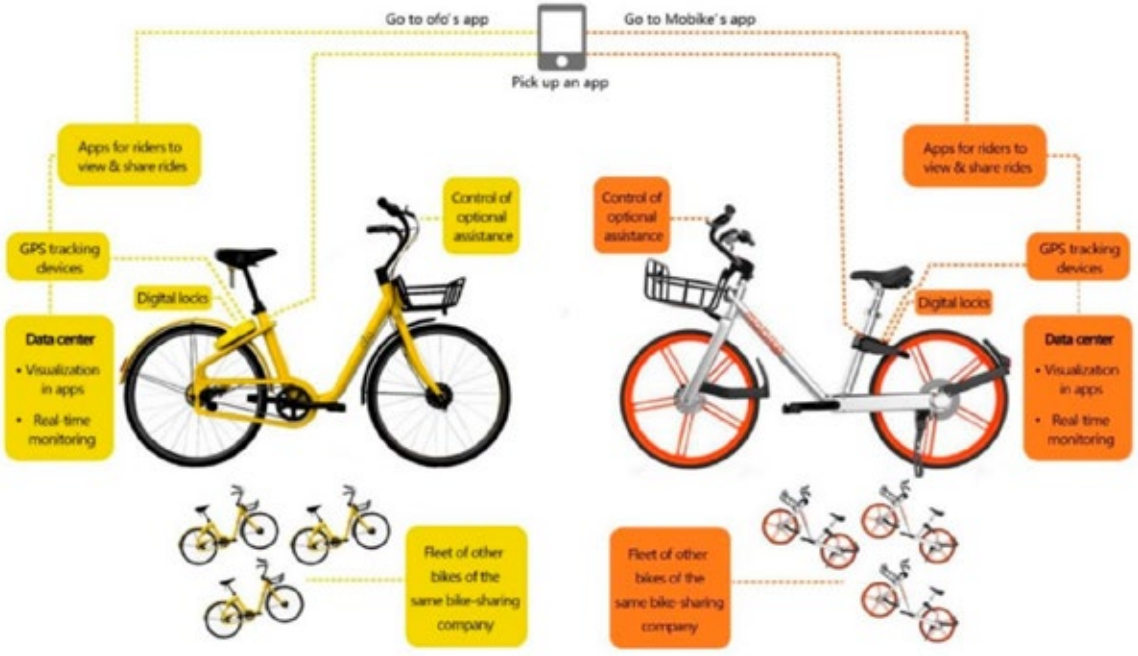

Fig. 5. Station-less bike equipment and devices [13]

5 Conclusion

Sustainable mobility aims to ensure efficient mobility, which means the rational use of available space and resources while reducing the negative impact on the environment. In this paper, we presented the importance of IoT for urban mobility improvement. We highlighted some advantages, benefits and potentials of the IoT-based solutions for sustainable urban mobility. Also, the paper presented some examples of these solutions for urban mobility systems including smart traffic light management, smart parking, and bike-rental system. The users of these systems are numerous and include residents, tourists, decision-makers, and other stakeholders. In an environment where urban congestion is growing every day, its residents can use smart solutions for urban mobility in various ways. One of the key benefits is the reduction of travel time and costs. Also, these solutions mitigate the negative impact on the environment, which significantly affects the improvement of the quality of life in cities. Tourists can get the necessary information and use optimal means of transport more simply. Planners and decision-makers can use the data generated by the IoT devices to make appropriate proposals and decisions to further urban mobility improvement. Also, new solutions can be integrated by connecting different information and passenger transport systems, which opens additional opportunities for further improvements in urban mobility. All these facts show potentials of the IoT for the urban mobility improvement. Therefore, this topic is interesting area for many stakeholders such as researchers, urban planners, traffic engineers, city authorities, etc.

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Challenges and advantages of introducing electric vehicles in logistics operator's fleet

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Abstract

The current market situation indicates an intensive increase in services offered by the logistics sector. To fulfill the growing demand, the logistics sector in the department of distribution of goods has several challenges, such as increasing fleet, increased mileage, difficulty in achieving an environmentally-friendly distribution chain. Each of these challenges requires organizational and managerial interventions in the process of functioning of the logistics sector. Given the needs of the market, environmental restrictions at the global level, the global issue of conventional fuels, research in this paper will focus on one of the elements for achieving an environmentally friendly and sustainable distribution chain. This paper targets to point out the challenges and advantages of replacing conventional vehicle vehicles with more environmentally-friendly vehicles. In the concept of Green Logistic, the basis for achieving an environmentally friendly logistics distribution chain are electric vehicles. The paper will identify the impact of logistics operations on the environment on the example of the vehicle fleet of a logistics operator in Bosnia and Herzegovina, which provides goods distribution services, using European models for assessing the environmental performance of vehicles. Research and application of scientific methods will determine the advantages, challenges, and possibilities of introducing electric vehicles in logistics operator's fleet.

Keywords: *Green Logistic, Electric Vehicles, Logistics Operator, Life Cycle Assesment*

1 Introduction

Due to the inhabitant's increase in cities and the process of digitalization, the logistics sector is becoming extremely attractive. On the other hand, environmental protection restrictions are also increasing. These two parallel processes impose main managerial and organizational changes for logistics operators. Meeting the growing needs of users and the needs of environment is a particular challenge for logistics operators which must comply with the principles of sustainable development. These principles of sustainable development, which link user requirements and sustainability in the example of urban transport, are shown in Table 1 [1].

To satisfy the principles of sustainable urban transport, there was a need to introduce the concept of Green Logistics which enables the realization of growing customer requirements, through the protection of the environment and the needs of future generations [2].

Table 1. Principles of sustainable urban transport

Principles of sustainable development (meeting the requirements of users)	Principles of sustainable urban transport (conditions for logistics operators)
-Social equality (intergenerational equality, stable social system) -Economic growth -Environmental protection (retention or reduction of existing pollution from all elections)	-Preservation of human health -Maintenance and capital growth -Efficient economy -Environmental protection (emission limitation, waste management, land use restrictions)

To fulfill the concept of Green Logistics and the set goals, all elements of Green Logistics need to analyze at a satisfactory level. That means meeting the basic principles of logistics grouped into aspects of sustainability [3]:

- System-wide sustainability (principles: consistency, adaptability, development, self-organization, and competence);
- Economic viability (principles: polluter pays, equity, efficiency and security, optimality and savings/resource reuse);
- Environmental sustainability (principles: minimal impact, innovation, rationality, and hierarchy) and
- Socio-cultural development (principles: accountability, transparency, and rational spending).

To satisfy sustainability, it is necessary to adhere to these four principles. One of these principles is minimal impact, which is in a relationship with the distribution chain in the logistics process. This principle implies the reduction of negative impact on the environment through the processes of production, transport, use, and recycling. Since the transport process is one of the main parameters for fulfilling the set principles, there is a need to change the elements of the system in this domain. One of these elements are the driving units.

2 Defining important criteria for fleet evaluation sustainability

In this paper, the focus of research will be on one segment of the potential solution to the problem, the justification of electric vehicles introduction in logistics processes. Due to the insufficient response from companies for changing the fleet structure, there is a need to determine justification of electric vehicles introduction in this sector.

To compare selected features of different types of vehicles, it is necessary to define evaluation criteria. Selected criteria for comparing electric and conventional vehicles are:

- Total cost of ownership (TCO);
- Eco score fleet rating and
- Range and supply of vehicles.

Other indicators are important and they must be included to obtain overall results. Since these indicators are not in the function of propulsion energy, they will not be considered. Details for all fleets analysis indicators can be found in the professional literature [4].

2.1 Total cost of ownership (TCO)

Observing costs through the procurement of vehicles is quite rough and incomplete. The reason is that the vehicle, together with fixed purchase costs, requires additional spending during operation. Therefore, the Total Cost of Ownership (TCO) methodology obtains actual images of vehicle ownership costs. One of the definitions of TCO is that it is actually a purchasing methodology and philosophy, which aims to understand the actual total price of a particular good or service [5]. TCO is a calculation that is extremely useful for estimating the direct and indirect costs associated with purchase over the entire life cycle of a vehicle or product in general [6].

Vehicle ownership costs include the costs of buying and owning a vehicle, the variable costs of using and operating the vehicle [7]. In summary, total vehicle ownership costs include (Fig. 1): depreciation costs (which make up the cost of purchasing vehicles), fuel, insurance, maintenance, repairs, and government fees.

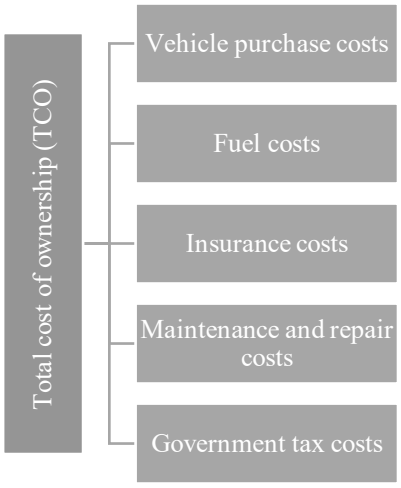

Fig. 1. Total cost of ownership (TCO)

The distribution of ownership costs varies from vehicle to vehicle and from state to state. Chart 1 displays the share of individual vehicle ownership costs for the US market, for 5 years of vehicle ownership. The diagram clearly shows the importance of the analysis of total costs when deciding on the purchase of a vehicle.

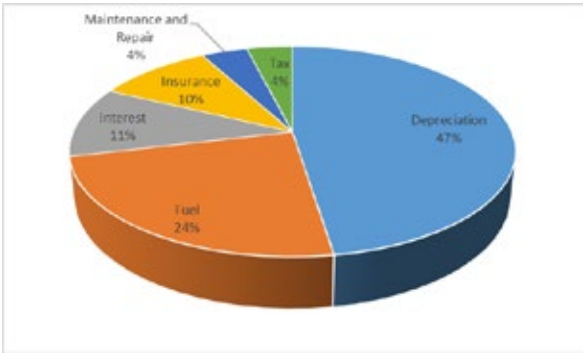

Chart 1. Total cost of ownership for a new vehicle for a period of 5 years (US market) **[6]**

Total cost of ownership can be determined with a equation (1).

$$TCO = (PR - RP) + FC + TIC + IC + MR + T - S \quad (1)$$

where: TCO is total cost to owner; PR purchase price; RP sales price of the vehicle after use; FC fuel costs; TIC total interest expenses; IC insurance costs; MR maintenance and repair costs; T government fees and S government subsidies. All parameters in the equation (1) are in the monetary units [6].

It is important to note that the difference between the purchase and sale price actually forms the total depreciation cost. So in equation (1) instead of (PR-RP) can be included the total depreciation cost DR.

Total interest costs (TIC) are optional, and can be included in the case of the purchase of vehicles in installments. TIC can be determined via equation (2).

$$TIC = \frac{r * P}{1 - (1 + r)^N} * N - P \quad (2)$$

where: r is monthly interest rate; P amount of loan for which interest is calculated; N number of months during which the refund is made.

2.2 Eco score fleet rating

The Eco Score is a methodological procedure developed in Brussels, which the Belgian government uses as an official tool for forming a policy of subsidizing transport companies. This procedure is based on the environmental assessment of the vehicle, taking into account the most important pollutants. The eco score includes emissions during driving (exhaust emissions) and emissions during the production and distribution phases of fuel. This approach is known as the well-to-wheel approach [8].

The Eco score rating range is from 0 to 100. The Eco score rating has been transformed from the total environmental impact (TI), with a rating of 100 representing a totaly clean and silent vehicle. The benchmark for a clean vehicle corresponds to an Eco score rating of 70 [9]. The transformation is based on an exponential function (Fig. 2) to avoid negative results.

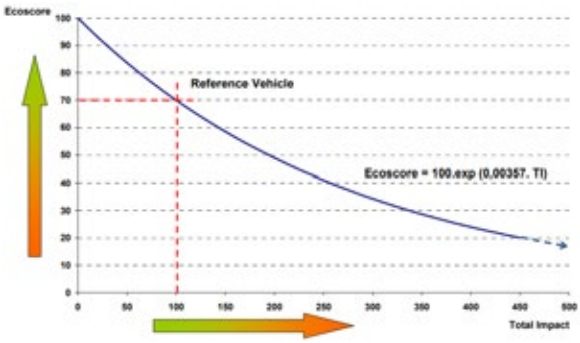

Fig. 2. Transformation Total Impact to Eco score and referent value [10]

It is important to note that this methodology does not include pollution during the vehicle production and recycling phases. There are two key reasons, it is complicated to obtain input data, and the impact in these phases is lower (about 10% of total pollution). However, the Eco score methodology include the difference between new and used vehicles [11].

Eco score methodology in vehicle assessment includes three types of emissions:

1. Emissions with an impact on global warming (Carbon dioxide CO2, Methane CH4, and Nitrogen dioxide N2O);
2. Emissions with an impact on air pollution (Carbon monoxide CO, Carbohydrates HC, Nitrogen oxides NOx, Particles PM and Sulfur dioxide SO2) and
3. Emissions with noise impact (Engine noise dB (A))

The values of the first set of emissions are most influential on the Eco score rating (50% of the impact), followed by the values of air pollutants (40% of the impact), while the remaining 10% of the impact is formed based on vehicle noise.

Eco score is determined for passenger cars and light goods vehicles using equation (3).

$$ES = 100 * [-0{,}00357 * (A * CO_2 + B * HC + C * NO_X + D * CO + E * PM + F * FC + G * dB(A) + H]^2 \quad (3)$$

where: CO_2, HC, NOx, CO, PM are standard designations for individual pollutants expressed in (g/km); FC average fuel combined consumption in (l/100km) for petrol, diesel and LPG engines, in (kg/100km) for CNG engines and in (kWh/100km) for electric engines; A, B, C, D, E, F, H coefficients whose values depend on the fuel type and Emission standards (values of coefficients see in [12]).

The calculation of the Eco score rating for Euro 6 passenger cars and light commercial vehicles, for vehicles with a built-in PHEV engine, and heavy vehicles differs from the equation (3) [13] - [14].

Since the calculation requires a large number of pollutants, which are often difficult to measure or unknown, their values defined by Euro standards are taken [15]. If values can be measured, the obtained results will be entered into the equation.

Chart 2 shows the Eco score rating for the assessment of the total rolling stock in Belgium. The diagram shows the Eco score grade as a function of the type of fuel and the usability of the vehicle (new or second-hand vehicle). Also, the diagram shows the average overall condition of the vehicle fleet. Eco score rating of new vehicles is higher than the rating of used vehicles. Also, electric vehicles do not change their Eco score grade as they age, which is not the case with diesel and petrol engines.

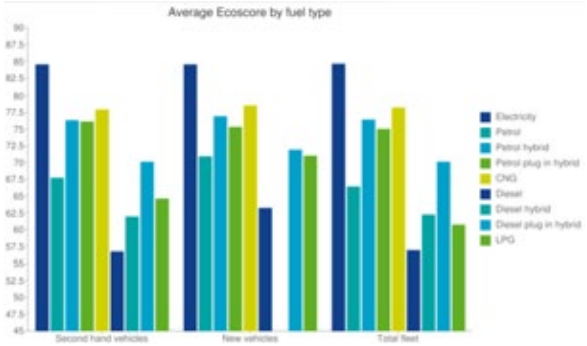

Chart 2. Eco score fleets grade **[16]**

Comparing the values from Chart 2 with the benchmark value of the Eco score (Fig. 2), it is concluded that vehicles powered by petrol, diesel, hybrid diesel, or LPG do not meet the overall environmental impact threshold.

2.3 Range and supply of vehicles

Important parameters in the execution of logistics operations are the range of the vehicle and the time required to supply the vehicle with fuel. Vehicle range refers to the distance traveled by a vehicle with one full tank/battery. The time required to supply vehicles with fuels refers to the time of charging the tank/battery.

These two parameters are the key disadvantages of electric vehicles, and they are a challenge for all logistics operators. The range of a conventional vehicle is practically unlimited with the minimum time required to fill the tank. The range of electric vehicles is limited, with significant vehicle battery charging times. The key trends in the development of electric vehicles are based on increasing the distance traveled and reducing the charging time. Currently, due to these limits, the use of electric vehicles is not possible to meet all transport needs.

Vehicle range will be considered as the total distance traveled by the vehicle during the observed time with one full tank/battery. The range of the vehicle differs for each type of vehicle and is in function from:

- average consumption per 100 kilometers;
- total capacity of the tank/battery and
- correction factors that depend on operating conditions and environmental conditions.

For the calculation of the range of a conventional vehicle, the standardized fuel consumption model can be used [17], which after conversion looks like equation (4).

$$K = \frac{FC * 100}{P_g * f_i} \ (km) \quad (4)$$

where: FC is tank capacity (l); Pg average combined fuel consumption (l/100km); fi correction factors consumption depending on the operating conditions (-).

Analogous to the calculation of the range of a conventional vehicle, the range of electric vehicles can be calculated with equation (5).

$$K = \frac{EC * 100}{P_E * f_i} \ (km) \qquad (5)$$

where: EC is battery capacity (kWh); PE average combined electricity consumption (kWh/100km); fi corrective factors consumption that depend on the conditions of exploitation and environmental conditions (-).

3 Comparison of defined criteria on example of Logistic company

The previously explained theory is the basis for analysis justification of electric vehicle introduction in the logistics operators fleet. A multi-criteria approach, in this case, is inevitable, due to the different values of the criteria. The case analysis was performed for a logistics company with 98 vehicles. The vehicles are powered by a diesel engine with an average Eco score of 43 (-) which is determined by applying the Eco score model (Eq. 3). The fleet includes 34 Euro 3 vehicles, 38 Euro 4 vehicles, 24 Euro 5 vehicles, and 2 Euro 6 vehicles.

Based on the data of company fleet, a representative vehicle was determined that meets the requirements of the company, and it is a vehicle with a mass of 1900 (kg). The characteristics of this vehicle were used for comparison evaluations criteria. It is important to note that the new, Euro 6 diesel vehicle with a power of 100 (kW) is compared with an electric vehicle with the same characteristics according to previously defined criteria.

For the application of the multi-criteria evaluation method TOPSIS [18], a basic evaluation matrix was formed (Table 2). Eco score and tank/battery filling time are obtained directly from the references, while the total cost of ownership and range of the vehicle is obtained indirectly using the equations (1, 4, 5).

After adopting the ponders of the criteria ($w_1 = w_2 = w_3 = w_4 = 0.25$ (-)), setting the maximization goal for eco-score assessment and vehicle range, the minimization goal for the total cost of ownership and filling time of the tank/battery and multi-criteria evaluation procedures it turns out that the diesel vehicle currently has a greater justification for its application in the logistics sector, as shown by the obtained results of multi-criteria evaluation (Table 3).

Table 2. Basic evaluation matrix

Evaluation criterion	Vehicle type		Ref.
	Diesel	Electric	
TCO (€/km)	0,443	0,513	[6], [19]
Eco score rating (-)	45	81	[20]
Range (km)	900	130	[21]
Supply (min)	8	30	[21]

Note: changing the ponders of the criteria the results will change, but in this case for any values w_i diesel vehicle is the best option.

Table 3. Ranking of variants

Position	Variants	Evaluation
I rank	Diesel vehicle	0,891
II rank	Electric vehicle	0,109

4 Conclusion

Converting conventional vehicles to electric is not an easy process. This paper showed that the analysis of the introduction of electric vehicles in the fleet should be approached thoroughly. All criteria that influence the final selection should be taken into account in the analysis.

For this paper, define three evaluation criteria:

- Total cost of ownership (TCO);
- Eco score fleet rating and
- Range and supply of vehicles.

The first criterion includes the financial expenses that the company needs to provide for owning a vehicle. The second criterion shows the impact of the vehicle on the environment, and the third shows the possibility of exploitation in certain conditions.

Based on the analysis, we conclude that the key advantage of electric vehicles is environmental protection. Key challenges are related to the high cost of purchasing vehicles, and relatively short range and long battery charging.

The cost of purchasing an electric vehicle is high, but maintenance is cheaper than conventional vehicles. Nevertheless, it is not profitable to procure these types of vehicles without government subsidies. In addition to subsidizing, the total cost over a longer time is equated with the cost of conventional vehicles.

The challenges of long charging and short range can be resolved if the vehicle operates in one shift, with the average daily vehicle travel being no more than cc 150 (km/day), depending on the vehicle type.

Replacement of conventional vehicles with electric ones is possible, in cases of government subsidies, shorter daily routes and good coverage of charging stations for electric vehicles.

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Preconditions and requirements for the development and quality assurance of logistics services

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Abstract

All processes in the production and distribution of material goods, which include material and interactive information flows, are united by the term "Logistics" and are realized within the logistics processes. Logistics processes hide large technological and economic reserves that need to be identified, located and used. At the EU level, a new philosophy of realization of quality logistics processes has been created in the past decades, and it is increasingly including the environmental aspect by introducing the term Green Logistics, which highlights the demand for a healthy environment. The level of logistics process technology is still far below the level of development of material production technology, which is the main reason for giving strategic importance to the rationalization and optimization of logistics processes at the global level in order at reducing the costs of all participants in the implementation of the process, and especially in the direction of raising the quality of services and meeting the increasingly stringent requirements of service users.

Keywords: *Logistics system, Logistics processes, Quality of logistics services*

1 Introduction

World trends of dynamic technological development and integration of the economic space raise the dynamics of the whole society and impose flexible behaviour as a condition for the survival of a modern transport company. The possibilities of further rationalization, i.e., the potential of success in the process of production of the transport service, are realized today in minimal positive developments.

Logistics, as a function of spatial-time transformation of material goods, energy, information, and knowledge according to the needs of users and the goals of companies, is imposed simply as an area of research into the possibility of increasing the success in the business of a modern transport company.

Many companies with highly developed economic systems base their business on the general legalities of logistics, i.e., logistics management. Focusing attention on this issue proves entirely justified since in the price structure.

logistical direct and indirect costs participate with more than 25%. For this reason, logistical management problems should be thoroughly investigated, diagnosed, and appropriately addressed. The fact is, however, that in modern business, quality is one of the important factors that, in addition to price, affect the position of companies in the market.

2 Logistics systems, logistics processes, and logistics services

By the basic definition, logistics represents a system of activities that are realized to devise, project, direct, manage and regulate the flow of goods, energy, people, and information within the system and between systems.

Logistical systems can be defined as systems of spatial-temporal transformation of goods and processes that flow in them as logistical processes

The main function of logistics systems is the spatial-temporal transformation of goods. Its fulfilment is related to the functions of changing the quantities and types of goods, and the functions of facilitating the transformation of

goods. Thus, these functions are performed in the following processes:

- transport, transhipments, and storage, where the processes of flows of goods are essential,
- packaging and insurance, where the processes of helping the flow of goods are essential,
- delivery and processing of orders, where information flow processes are essential.

For logistics to be adequately investigated, and to be able to define methods of planning logistics processes, it is necessary to define the holders of these logistical processes or elements of the logistics system (Transport, Storage, Stocks, Distribution, Manipulations, Factor - Man, Information, Communication and Control, Integration.

The trend in logistics systems is the development of formal quality processes. It is these processes that have enabled companies to operate safely. We can understand the development of quality processes as moving through four different stages with the following tasks:

- Quality control – determines basic procedural and statistical quality management;
- Quality assurance – emphasizes meeting the needs of customers;
- Quality management – this is not the task of superiors in logistical processes, but all subjects in the process;
- Meeting consumer needs – reflected in the procedures to be carried out to fully meet the needs of consumers.

Research in the world and our country says that within the framework of the usual procedures and processes in the field of movement of material goods, numerous and very expensive operations, procedures, processes, and systems are needed that result in losses of funds and time. These processes and systems can be optimized in a considerable scope by rationalization measures, increasing the degrees of efficiency, synchronization, and cooperation in transport chains.

Optimization carriers are usually large transport organizations, which organize transport chains in the field of transport in their direction or integration with other economic organizations, most often on a small and limited number of transport routes.

Taking advantage of existing evident rationalization reserves by combining certain functions and organizing rational transport chains becomes an obligation and imperative of the modern distribution of goods.

The requirements of the modern distribution can be systematized in four points:

1. That only what has been ordered is produced and distributed;
2. That the products are delivered as soon as possible;
3. To make the products as cheap as possible;
4. That the complete tied capital is reduced (located in the stock).

The formation of continuous transport chains ensures the above requirements (from the place of manufacture to the place of consumption). In doing so, commodity flows should be linked to information flows. Whereby we replace the term 'transport chain' with the term 'logistics chain'

Today, users of transportation services are looking for the offer of a rational conception of homogeneous logistic services. Homogeneous logistics service can best be represented by defining its associated components in a three-dimensional system. This definition of logistics service is clear, complete, and transparent, as can be seen in the following scheme (Fig.1).

With the help of defined components, a homogeneous logistics service can be described with a single sentence that reads:

To realize the distribution of the right goods at the right time, in the appropriate state, and in the right place (wasp Z) we need technique and technology (wasp X), as well as the organization and management of this process (wasp Y).

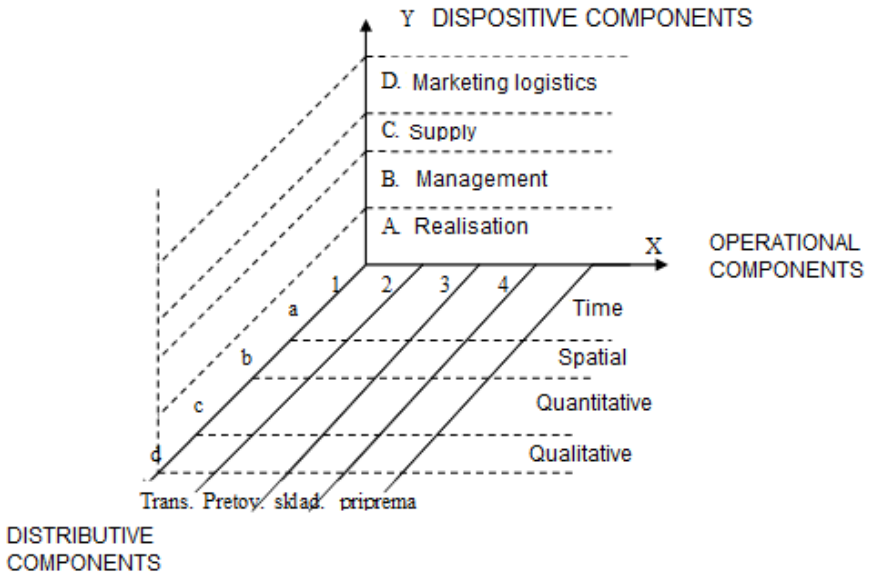

Fig. 1. Components of a homogeneous logistics service [8]

3 Logistics system performance and quality of services

Logistical performance is different parameters, surveyors, coefficients, and indicators in logistics. In a broader sense, logistical performance can be viewed as a subset of all the characteristics of (business or organizational) work of the company.

Logistical performances are part of the company's general performance, with which it performs on the market. With its business strategy, the company wants to achieve the best possible position in the market, that is, to achieve the best possible performance

To achieve this goal, the company must plan, monitor, manage and control its performance. Logistical performances are the result of business strategy, organization of work, and applied level of technique, technology, and informatics in the company.

The term **"performance"** in technique in general, quite often is met as a term that describes certain characteristics (characteristics) of elements and systems.

The terms "logistical performance" is used here as well as "logistical surveyors' performance", which include different parameters and indicators of the "success" of the functioning of logistics systems.

3.1 Display the basic performance of the logistics system

As basic logistical performance can be singled out:

- Logistical expenses;
- Quality of service;
- Techno-exploited performance and
- The security of logistical processes.

All these performances are due to the organization of work, and technical and technological solutions applied in the company. The method of functioning of technical and technological systems can be presented by a set of technological and exploitation indicators, which describe resources. This category of performance is often called logistical productivity, but the term techno-exploitation performance of logistics systems will be used here since productivity is only one of these performances. As a special category of performance, recently environmental factors have been singled out, as well as the safety of work processes, which can be seen in the block diagram (Fig.2)

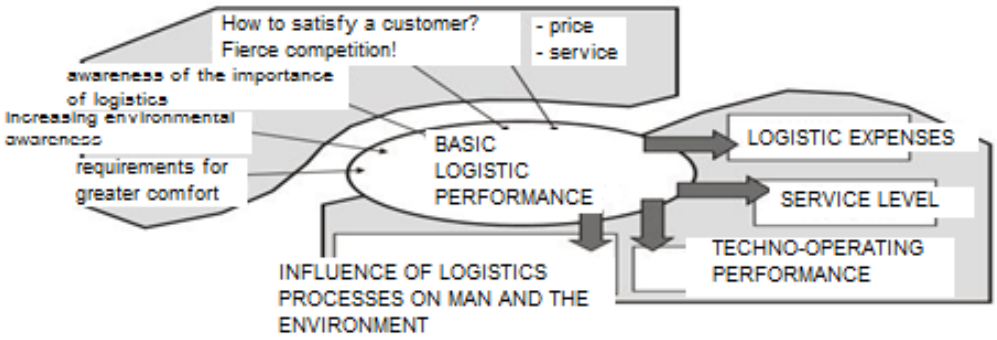

Fig. 2. Structure of basic logistics performance [10]

From the point of view of logistical performance grouping, there are:

- "hard" surveyors,
- "soft" surveyors.

The group of "hard" surveys includes costs, profits, and economic and financial indicators. These indicators can be quantified relatively easily [2]." Soft" indicators are the level of satisfied users, quality of service, delivery delay, and others. Soft indicators most often represent the user's perception of the realized service [2]. In the research so far, there are a large number of different approaches to defining logistical performance and its surveyors. Differences in approaches can be [2]: Performance set selection; Defining a surveyor for each performance; Defining dependencies measure performance and its surveyors; Different approaches to the performance surveyor's budget.

3.2 Measurement and monitoring of logistical performance

Measuring and monitoring logistical performance is the cornerstone of quality management in logistics because if something cannot be measured it cannot be improved. The creation of performance measures is directly related to the set vision and goals of the company. The metric must be clear, and precise, with defined methods, data sources, and periods [3]. It is necessary to define at the strategic level: performance plan, quantitative and qualitative methods of determination, in the function of concretization and realization of the set goals.

However, measurement is not only an end in itself but as an instrument for more effective management. Often, the results of the performance measurement show only what happened, but not why, or what to do next. To achieve the transition from measurement to performance management, it is essential that there is a conceptual framework and methodology and that top management is involved in the design and application of performance measurement systems. Also, open and effective communication with employed partners and customers is needed to exchange and share information, results, and initiatives.

To improve performance, it is desirable to establish the responsibility of individuals for measurement results, as well as a system of rewards related to output, but also to measure performance. The performance measurement system must be affirmative, and by no means restrictive. If the goals set are realistic, then the measurement can be stimulating.

The ability to use measurement results implies an intelligent mechanism for decision-making, where the results of measurements provide understandable, reliable, purposeful, and up-to-date information. The results of measurements can be used for: managing the differences between the set and the achieved goals, self-diagnosis (locating problems in the very beginning), the effect of feedback and learning, the recognition of omissions and errors, and risk management and continual improvement of quality.

4 Links between service quality and cost

Logistical costs, cover the costs of all activities that are realized to design, design, direct, manage and regulate the flow of goods,

energy, and information within the system and between systems. Logistical costs appear as the basic criterion in modern conditions when optimizing activities within the process of placing the final product on the market and meeting the customer's requirements. By investing in lowering them, as a rule, the most favourable effects are achieved, hence the constant interest in their study.

4.1 Determining the number of logistical costs

The next scheme (Fig.3) presents the process of determining, the type and structure of logistical costs.

The profitability of the company is a direct function of logistical costs because logistics costs account for a significant part of the total operating costs. The participation of logistical costs in total costs varies in production and trading companies and ranges in the interval from 15% to 50% and is observed over a wider period as a growing trend.

The link between the level of quality of the service and the costs achieved within the logistical process, as well as the logistics system, is not linear.

Logistical costs cover activities arising from the definition itself and logistics function. They represent a measure of the success of the functioning of logistics systems, i.e., logistics chains.

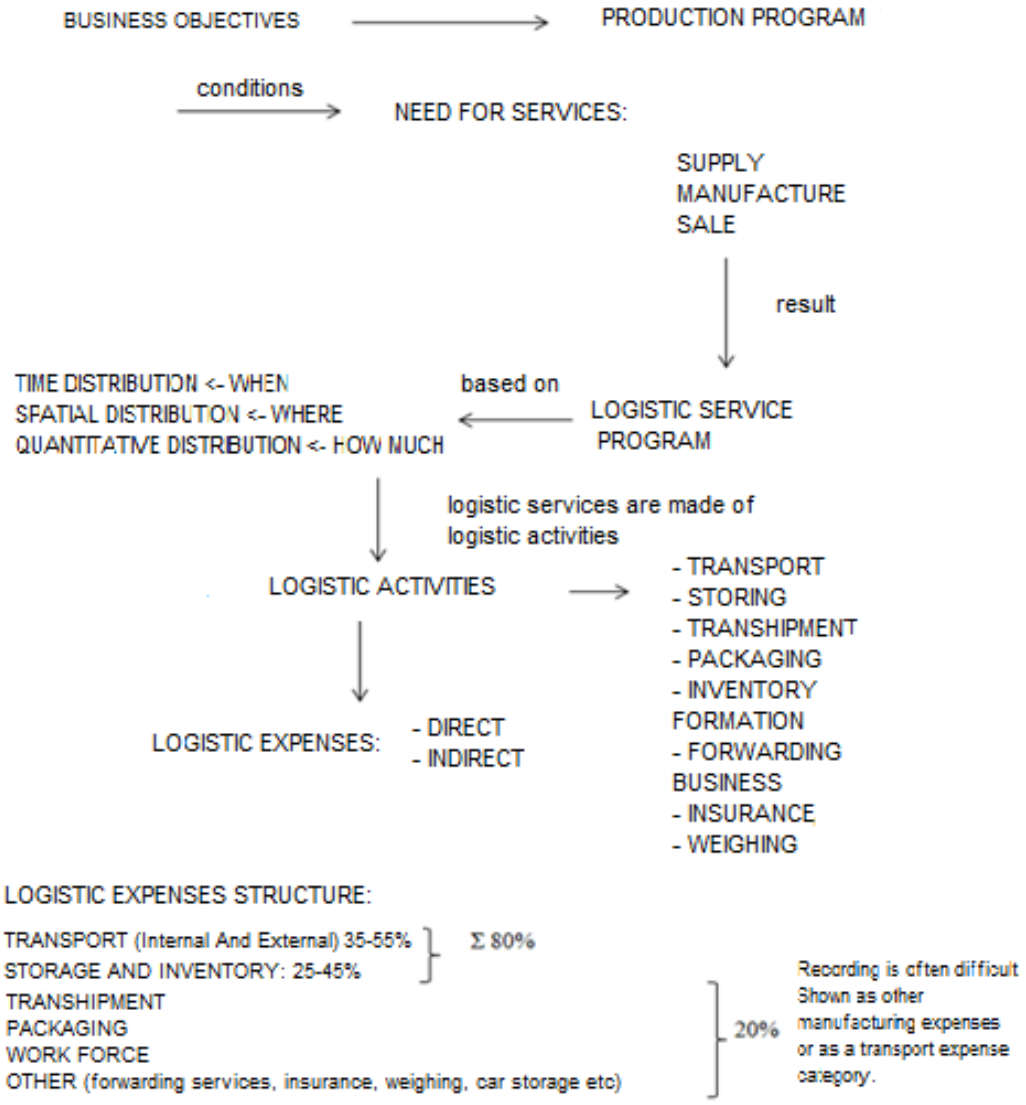

Fig. 3. The process of determining and structure of logistical costs

Logistical costs, cover the costs of all activities that are realized to design, design, direct, manage and regulate the flow of goods, energy, and information within the system and between systems [8].

Determining logistical costs is a very attractive and complex task and depends on a large number of factors. The main factors in determining logistical costs are:

- The necessity of parsing logistical costs;
- Determination of business stages and processes, which generate logistical costs;
- Determining the interdependence between different cost generators.

The main causes of problems when determining logistical costs are:

- Logistics is a service function, which is present in different subsystems of the company, so costs are much more difficult to determine than in some other areas.
- The existing cost calculation method is not adapted to the needs of logistics.
- Costs are very difficult to delineate, whereby they are not defined completely.
- Individual costs are not identifiable or delimited to each other.

The determination of the value of logistical costs can be realized in two ways:

- Calculation of logistical expenses, and
- Estimated logistical costs.

The calculation of logistical costs implies the definition of a set of surveyors and budget models, based on which the value of costs will be determined. In this case, it is necessary to define all individual logistical activities that generate costs and for each activity to determine the value of unit costs. The estimate of logistical costs is realized based on regression equations for individual categories of logistical costs.

Analysis of the structure of logistical costs can be viewed from the point of view of standstill and the point of view of movements of goods in the logistics chain, i.e., static and dynamic segments of the chain. The costs of indulgence of goods are divided into storage costs, preparation and control costs, inventory costs, and handling of goods. The costs of movement of goods include transport costs, loading and unloading costs, and the costs of serving goods after transport. To determine these costs, the unit costs of storage (per unit of quantity and time unit) must be known, the unit costs of transport and manipulation, the costs of transport on a specific or average dissolution per tonne, etc. for a specific vision and form of transport.

Viewed from a functional and technical and technological point of view, logistical costs can be analysed at the level of logistics subsystems and business and functional systems in the company.

The basic structure of logistical costs can be determined by analysing basic logistics operations. Commonly, the basic classification of logistical costs implies the formation of the following groups of theirs:

1. the cost of owning stocks,
2. costs of lack of stock,
3. storage costs,
4. transport costs,
5. Product design costs and administrative costs

4.2 Costs of ensuring the quality of services

Recently, as a special category of costs that is gaining more importance in the field of logistics, certainly the costs of ensuring logistical quality - costs associated with the realization of the appropriate level of quality of logistics service. This category of costs is derived from the TQM (total quality management) concept and represents an attempt to demonstrate the cost of the "quality ideal". The very concept of qualities has become, without a doubt, one of the key weapons of competitive struggle in the global world market. From a logistics point of view, these costs cannot be viewed separately from the quality of logistics processes, hence they should be associated with elements of the quality of logistics service.

In a conclusion, it is imposed that the way of determining logistical costs, i.e., the cost of realization of transport, manipulative, and storage processes is always due to the set goal,

the applied technology, and the relevant characteristics of the logistical process under consideration, as well as knowledge of the behaviours of static and dynamic elements of the concrete transport and logistics chain.

There is a very different time and cost structure for small ones (e.g.,100 km) and larger (e.g., 300-500 km) transport disposals per unit of transport. Essentially, both the logistical costs and the quality of the process affect the profits of the company. The reduction of logistical costs directly affects the increase in profits, and the increase in the quality of logistics services affects the increase in the number of service users, thereby affecting the growth of revenues and therefore the increase in profits. This connection can perhaps be most graphically presented through the consequences of the influence that the level of quality of service has on the profits of the company [5].

From the numerous considerations so far, it can be concluded that the logistical costs and the length of the delivery cycle are the most significant sizes that decide the performance of the business of any service provider company. Hey are directly incorporated into the price of the final product placed on the market and therefore affect the income that the production company can generate. Lowering these costs provides higher revenue either through generating higher earnings per unit of product or by creating opportunities to lower the price of the final product and therefore increase turnover and expand the market. However, in addition to acting on logistical costs and the length of the delivery cycle, there is another, very significant instrument that can be used in the process of generating higher revenues. This instrument is defined as the quality of logistics services. The consumer of the final products, when opting for one of the offered, alternative products, in addition to its price and quality, also recognizes the quality of service achieved in the purchase.

It may happen that despite the satisfactory quality and price of the product concerning the requirements of the specific consumer, the consumption of the final product is absent due to the low quality of service. For these reasons, it can be said that the quality of service in the realization of final results acts similarly to the logistical cost.

By increasing the quality of service, increased turnover can be expected and of course, therefore higher revenues from the consumption of the final product. From the numerous considerations so far, it can be concluded that the logistical costs and the length of the delivery cycle are the most significant sizes that decide the performance of the business of any service provider company. They are directly incorporated into the price of the final product placed on the market and therefore affect the income that the production company can generate.

5 Modern requirements in the design and development of logistics systems in the function of ensuring quality of service

The consequences of complex and dynamic changes in the market are increasingly felt nowadays, both from the changeability of clients' wishes, from the life cycles of products and their delivery time, as well as through increased requirements regarding time and quality factors. Companies are being forced to adjust to changes more quickly due to increasing market developments. It is in this part and these conditions that the importance and role of logistics on the market are felt, which ensures the optimal connection of transport chains on the principle of "door to door" and at the same time the distribution of goods to certain areas with short delivery deadlines (principle: JIT), all to raise the quality of the complete service.

Changes in the logistical structure, both industry, and trade, are created by the formation of a common European market and an increase in its economic power. These changes are primarily reflected in the increasing concentration, i.e., in the declining number of suppliers (reducing the number of sources of goods flows) and grouping of customers (reducing the number of confluences of commodity flows) with a strong tendency to streamline flows between production and turnover - consumption. In doing so, it is sought to production and distribution are part of a single common network with a tendency to encourage cooperation between suppliers, service performers, and customers.

The modern integrated logistical concept, in response to the changes, is based precisely on the mutual connection of production and sales with distribution to connect customers and suppliers into a unique logistics concept, that is, a logistics chain.

The integration of transport chains on large distances, especially in international transport, occurs by eliminating internal borders in the European area. The tendency is to create conditions for integrating all system elements to ensure a complete logistics service that covers all segments of the logistics chain, following the wishes and requirements of the customer. This is also called "individually integrated service packages according to the customer's request".

For closer interconnection of physical and information flows to optimally form information logistics as the basis for the realization of the adopted logistical strategy, a modern logistical demand in both industry and trade. Modern logistics as a discipline is manifested in increasing competitive ability, reducing costs, and increasing the quality of service, that is, meeting the requirements of the customer.

5.1 Definition and basic functions of logistical controlling

Definition and basic functions of logistical controlling Modern changes and turbulence in the market for the purchase of raw materials and the placement of goods require one proactive way of managing quality in logistics. Practice in the field of business of logistics providers has shown that it is not enough to be flexible and adaptable to the requirements of the market, but it is necessary to anticipate future needs and prepare promptly for the realization of the expected requirements of users. On the other hand, quality system management in logistics is based on a systemic approach and continual monitoring of all processes, activities, subsystems and resources, which requires an efficient process of managing various external and internal variable sizes and performance. *In other words, quality management in logistics requires timely, accurate and reliable information about logistics processes and systems.*

Data and parameters collected and processed based on classical information systems, legally adopted procedures and regulations, various accounting forms and reports, and analytical and synthetic contingency plans, are not sufficient for efficient decision-making. Instead of classical procedures that are mainly focused on partial subsystems and processes, with poorly usable parameters and data, it is necessary to have one comprehensive methodologically designed and elaborate system of identification, collection, processing, distribution and presentation of relevant information and data.

It is, therefore, necessary to consider the need and possibilities of applying the concept of logistical controlling, which can be defined as integrated support for quality management in logistics

5.1.1 Basic logistical controlling functions the concept of logistical controlling

Appears in the 1980s, and different authors interpret the goals, significance and functions of controlling differently in different periods. However, they all point out that the concept of logistical controlling cannot be identified with the concept of control of logistical processes and subsystems, which were some interpretations in the beginning stages of development. Controlling is much more than standard control of logistical processes and systems, and it can be said that it represents integrated support for logistical management. Likewise, in literature, and especially logistical practice, there are different formulations of the basic functions of logistical controlling, but most authors agree that these are functions: Planning, Management, Control and Informing (Fig.4)

Through the planning function logistical controlling ensures that the operations of the logistics system are based not on the reaction to market and other changes, but the prediction and anticipation of future events and phenomena. Research, prediction and planning of logistical performances are the cornerstones for defining the vision, mission and strategy of the logistics system.

Logistical control provides a proactive way of deciding, where the logistics system through the anticipation of the future can build different business scenarios and be prepared for each situation.

Logistic controlling has the function of active performance and business performance management. The basic principle is that business results are not expected, but managed. The reaction time for "signals" from the environment or the system itself should be maximally shortened. Instead of spending 90% of the time collecting and processing data, which was present in the past, it is necessary to spend 90% of the time on the analysis of causes and consequences, that is, the adoption of measures to improve the process and activities.

The control function involves measuring, monitoring and processing realized logistical performance values, i.e., determining deviations achieved from planned and projected values. Through analytical statistical processing of data, it is possible to monitor the degree of achievement of the strategic and operational goals set, i.e., the projected and projected performance values. However, the control function implies not only a literal identification of these differences but an analytical view of causal links and possible corrective measures and improvement proposals. The rapid advancement of IT theologies makes it possible to "data mine" the analysis of large amounts of data while detecting the causes of certain phenomena and understanding the behaviour of clients.

The information function implies an orderly and transparent way of processing, presenting and distracting information, to different levels of decision-making and management, from top management to direct executioners of logistical processes and activities. The impression is that today's companies are cluttered with data, but essentially there is a lack of usable and useful information.

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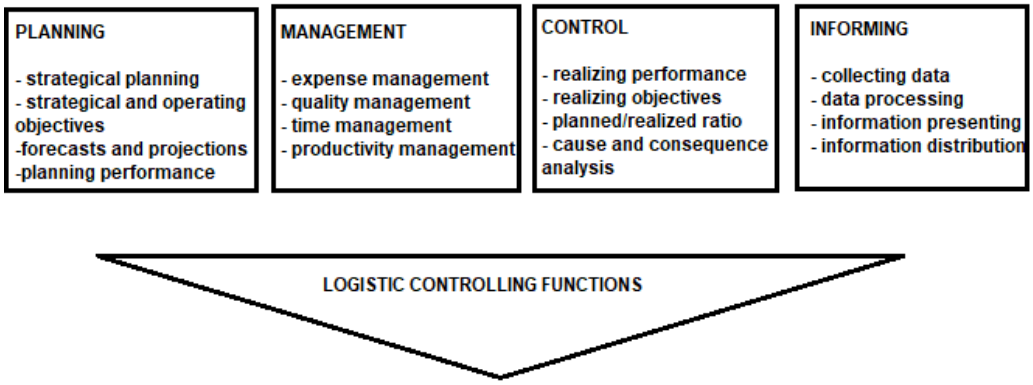

Fig. 4. Functions of logistical control

5.1.2 Logistical control in the quality wash in logistics

Quality management in logistics is a comprehensive concept, which is based on scientific methods and techniques for managing and improving quality, but also on adequate substrates and data. The application of certain approaches and models of quality management implies system collection and processing of data on logistics systems, processes and services. Various quantitative and qualitative techniques and methods are used for the collection and processing of data. A significant part of the parameters can be provided through logistical controlling, which is based on various methods, tools and applications related to the collection, processing and distribution of relevant information and variable sizes.

Through the analysis of collected and processed data, it is possible to assess the achieved performance concerning the project values and the set plans and goals. In this way, non-compliances are identified and potential areas of quality improvement are defined. Data

collected through a logistical controlling system enables multi-dimensional performance analysis, where multidimensional reports can be observed and analysed concerning different business perspectives. Logistical control gives a view of the entire logistics chain, whereby each participant can get exactly the information they need. Through the decomposition of the chain to logistical processes and activities, preconditions are created for the successful identification and measurement of performance by different dimensions.

The necessary data and parameters are determined by individual logistical processes and activities, but in no case do they represent partial and individual information, but in correlation with other parameters from the unique databases of logistical performance indicators. It can also be said that the greatest merit of logistical control is that it ensures the interconnection of different variable sizes, which describe logistics systems, processes and activities. Logistical performance, in essence, represents the sizes through which relationships of one or more functions or activities are expressed.

Logistic performance indicators enable accurate monitoring of certain processes and processes, their evaluation, editing and connection with other processes and activities in the logistics chain. For integrated quality management in logistics, performance describing the interdependence and connectivity of partial logistics areas is of particular importance. However, to describe the complex and changing structure of logistics systems and processes, a large number of logistical performance indicators are often necessary, the identification, processing and use of which is a serious problem in real systems. Out of a huge number of possible, key logistical performance indicators must be selected and an efficient method of measurement and monitoring must be defined for them.

In other words, it is necessary to define one relevant set of quality indicators, according to the needs and requirements of the quality management system. When talking about performances that support quality management in logistics, two groups of questions need to be answered:

- What are the logistical performance data for, i.e., what indicators, who, when, how, in what form and in what management place it uses and whether they need to be determined and monitored at all.
- How to identify, collect, quantify, process and present data on selected performance

The first group of questions concerns the selection and definition of key logistical performance indicators, and the second group concerns the problem of measuring and monitoring the selected performance.

Selection and definition of key indicators of logistical performance, is not at all as easy a task, as it can, be at first glance, to look. The problem is to separate the key from the ordinary indicators, that is, from several hundred, or even thousands of indicators, 15-20 key ones are selected for the quality management process in logistics. It is necessary to ensure that the selected indicators lead to an integrated quality management system and that the achievement of the strategic and operational goals of the logistics system can be measured through them. Choosing the wrong performance indicator can significantly jeopardize the quality management process itself in logistics. The selected performance qualities must be related to the strategic pyramid of quality management, where the realization of the company's vision, strategy and goals is measured through key performance indicators.

6 Conclusion

Quality management systems and logistical control have a common feature, manifested through the fact that there are no ready-made and universal solutions that can be used regardless of realistic conditions. The decision-making models themselves are similar, but with different strategies, environments, markets, processes, technologies, etc. Heterogeneous are sources of data that "feed" these systems.

The introduction of the quality system is a project that has no end. The same statement applies to logistical control. As competition becomes more aggressive, the environment becomes more unstable and the future more uncertain, the demands in front of the systems of analysis and forecasting become more complex.

However, in real systems, there are significant problems related to the introduction and development of logistical control and the model of quality management. The biggest

obstacles are the uncertainties brought by the new system. The reason employees usually resist change is because they do not know what will happen in the new "balance of power". Preparing employees for a new system is the task of those who introduce the system. It is necessary to manage the resistance to change. Resistances most often occur as a consequence: lack of vision and strategic thinking in the company, absence of understanding and support by the manatee, fear of change and unknown, constant organizational and structural changes, the resistance of IT professionals and existing "distributors of information", struggles of employees for status and position, lack of credibility of the project team that introduces the concept, etc.

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European digital guidelines as a basis for the digitalization process in Bosnia and Herzegovina - a review of current state

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Abstract

The development of information society and broadband Internet is key indicators of social and economic change. They transform the way companies, political systems, and citizens communicate with each other. Today, we talk about various regional and national initiatives to first stabilize and then improve the economies of countries through the development of the Internet and information society. The European Union has recognized information technology as a major factor influencing economic growth and innovation. Among the seven flagship initiatives of the Europe 2020 economic strategy is the Digital Agenda for Europe. This shows the importance that information technologies have in the development of the modern economy. In this paper, we analyze the current state of development of the information society and broadband Internet access in Bosnia and Herzegovina. We highlight the necessity of considering mechanisms for the development of broadband access. We analyzed the current situation and progress in the implementation of the Digital Agenda guidelines in EU countries. The aim of this research is to highlight the advantages of using EU strategic guidelines to improve and develop the current situation in the field of broadband Internet in Bosnia and Herzegovina

***Keywords**: Digital Agenda, broadband Internet, guidelines, strategy*

1 Introduction

New technologies based on artificial intelligence, large data spaces, and the development of digital service platforms are affecting all areas of society. Today, we talk about a “fully connected” society. Internet technology has evolved in ways that are difficult to predict. Therefore, digital infrastructure is the backbone of the digitization process. Owing to the close connection of the Internet with economic and social development, it is necessary to strategically plan the development of a more powerful, mobile, intuitive, and accessible Internet. Broadband internet access is no longer an exclusive measure of a society's technological development. This shows social development as a whole. The term "basic broadband internet" or "basic broadband networks" means networks with basic functions based on technological platforms. These networks include (A)symmetric (D)igital (S)ubscriber (L)ines (up to ADSL2 + networks), mobile networks, and satellite systems. Under fast and ultrafast access, universal broadband access is considered at speeds of 30 Mbps and 100 Mbps, respectively [1].

This paper aims to identify priority steps for the integrated and effective implementation of broadband Internet development strategies in Bosnia and Herzegovina (B&H). Some previous studies have investigated the process of digitalization in this area [2], [3]. However, to the best of our knowledge, the process of digitization process has not been systematically investigated in the calculated domain in the B&H space. The rest of the paper is structured as follows. We first analyze European standardization for the Internet and the guidelines necessary for the digitization process. Second, we analyze the current situation in B&H from the aspect of strategies and policies for digitalization, that is broadband Internet, which is its basis. In the third part, we critically compare and present the results of the state of broadband Internet in B&H s and the EU, followed by a discussion of what they mean for decision-making. The last section concludes the study and suggests pathways for future research.

2 EU digital single market: EU strategic guidelines, recommendations, and policies

The digital economy is growing seven times faster than the rest of the economy [4]. Traditional networks connect and converge allowing access from all devices and in all places using mobile and smart devices sensor networks are increasingly present. Cities are equipped with various communication and information technologies and thus become smart cities. Research and innovation in this field will certainly be a fundamental driver of Europe's future prosperity and quality of life. However, policy inconsistencies at the European level are a factor that slows down and impedes development to its full potential. Therefore, it was necessary to create a coherent and advanced framework for action within the digital economy.

Efforts in the digitalization process of the EU and its Member States are largely shaped by three, partly overlapping areas: the integration agenda, the regional agenda, and the digital agenda [5]. In this paper, we will focus on the digital agenda and its guidelines.

The period of digital development in Europe can be observed in two parts:

- The first digital period (2010. – 2020) – Digital Agenda for the first period.
- Second digital period (2020. – 2030.) – Digital Agenda for the second period.

In response to the global economic crisis, following the 2010 Lisbon Strategy, Europe presents a strategy for economic growth and development. Among the seven flagship initiatives of the Europe 2020 economic strategy is the Digital Agenda for Europe [6]. The Digital Agenda for Europe flagship initiative aims to help the EU and its Member States reap the benefits of a competitive digital single market. Digital potential needed to be unleashed and digital culture expanded across the EU. To achieve such a goal, seven pillars were identified around which 101 measures have been deployed. Following a review of the initiative in December 2012, seven key new measures were adopted. These measures mainly emphasize the importance of fostering digital infrastructure, improving the regulatory environment, promoting digital skills and jobs, and implementing strategies focused on cybersecurity, cloud computing, and microelectronics. The Digital Agenda for Europe contains a plan to ensure broadband with internet access up to 30 Mbps and more [6]. Measures to encourage the European Commission to expand high-speed broadband networks are:

- ✓ adoption of new rules on cost reduction;
- ✓ recommendation on the next generation of access networks;
- ✓ revised guidelines on state aid for broadband networks;
- ✓ proposal to complete the single market for telecommunications services – *Connected Continent.*

However, all these goals have not been achievable and the digital single market is not yet a reality and additional investments in high-speed infrastructure are needed.

In September 2015, the United Nations General Assembly launched the 2030 Agenda for Sustainable Development made up of 17 goals, 169 targets, and 232 indicators [7]. Building on these insights, the Commission sets out the direction of 'Europe's Digital Decade'. The European Digital Agenda for the Decade 2020-2030 aims to create secure digital spaces and services, a level playing field in digital markets with large platforms, and strengthen Europe's digital sovereignty [4]. At the same time, it will affect the ultimate European goal of climate neutrality by 2050. The four main goals of this idea are: [8]

a) Digitally skilled citizens and highly skilled digital professionals;
b) Secure, performant and sustainable digital infrastructures;
c) Digital transformation of businesses;
d) Digitalisation of public services.

To meet these EU targets, the Commission has defined two basic preconditions, namely: gigabit coverage for all households and 5G in all populated areas [9]. These targets are significantly higher for broadband, compared to 2020. As Fig. 1. shows, the EU still has a lot of work to do on the path to digitalization.

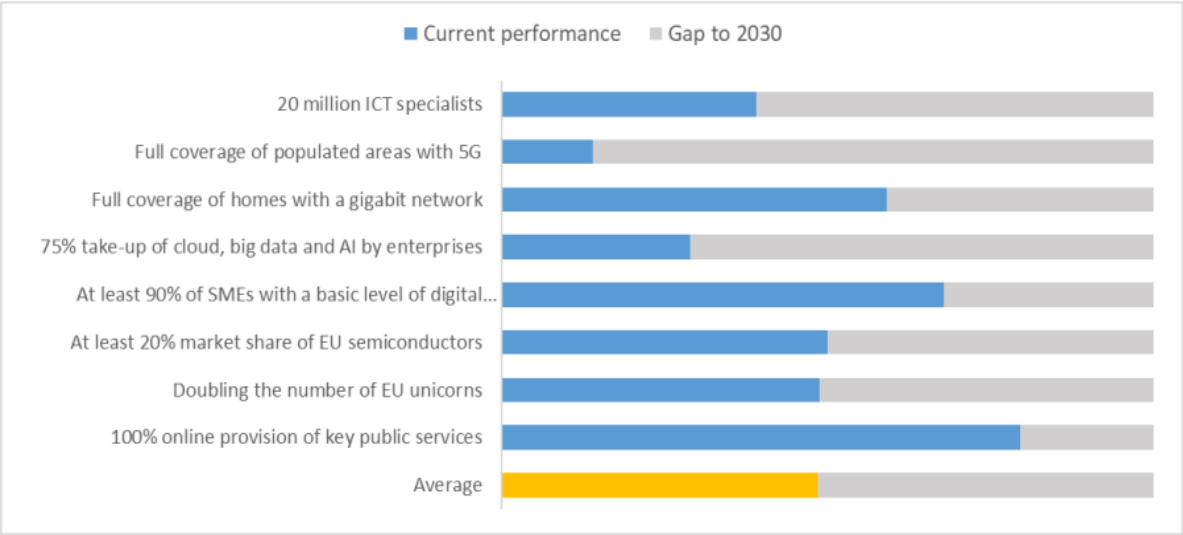

Fig. 2 Distance toward the digital decade targets [10]

EU allocates € 7.5 billion in strategic funds for 2021-2027 to support projects in five areas [4]: supercomputing, artificial intelligence, cybersecurity, advanced digital skills, and ensuring the widespread use of digital technologies throughout the economy and society, including through digital innovation centers. The EU has defined concrete objectives for each of the four cardinal points:

- ✓ Monitoring system - to measure the progress of the EU against the key targets for 2030;
- ✓ Assessing the areas with insufficient development at the level of Member States;
- ✓ An enhanced DESI report - the underlying indicators for monitoring the targets at the EU level and the digitalization trends at the national level;
- ✓ The European Commission will be responsible for the analysis and overall reporting on the progress to identify in which areas progress lags behind and how the identified gaps can be addressed through measures and recommendations at the European and/or the national level.

Progress in the implementation of digitalization at the EU level is monitored using the Digital Economy and Society Index (DESI). DESI provides insight into the economic and social challenges of the member states and monitors the national reform efforts carried out in the European Semester. The European Semester is a cycle of economic, fiscal, labor, and social policy coordination within the EU [10]. We analyzed the DESI 2021 report, which presents data from the first or second quarter of 2020, giving some insight into key developments in the digital economy and society during the first year of the COVID-19 pandemic. The impact of COVID-19 on the use and supply of digital services and the results of policies implemented since then are not covered by the data and will be more visible in 2022 [9]. According to DESI 2021, all EU Member States have made progress in the field of digitization. However, there are unequal levels of development in some Member States i.e Denmark has the highest score, followed by the Netherlands and Spain, while Greece and Bulgaria have the lowest performance [9]. This results in different priorities in the policies and activities of these countries. The Member States must work together to reach the 2030 targets.

The data on connectivity shows an improvement in very high-capacity networks (VHCN) available in 59% of the households in the EU [11]. This is an improvement up from 50% a year ago, but still far from universal coverage of Gigabit networks. The rural VHCN coverage went up from 22% in 2019 to 28% in 2020. Moreover, 25 Member States have assigned some 5G spectrum, compared to 16 one year ago. 5G has been launched commercially in 13 Member States, mainly covering urban areas.

The EU wants to reach the world market, so it voila budget of € 723.8 billion under the largest program under the Next Generation EU the Recovery and Resilience Facility (RRF) [8].

3 Bosnia and Herzegovina digital market: guidelines and policies

According to the ITU 2020 report, developing countries such as B&H should implement policies to maximize broadband, as a major digital technology that contributes to economic development [12]. B&H signed the Stabilization and Association Agreement back in 2008. Fourteen years later, B&H has still not met the conditions for applying for EU membership. The EU Council emphasizes the importance of improving and strengthening the efficiency of the functioning of the state and its institutions. This means that the country will have to be able to adopt and implement the laws and regulations of the European Union. These regulations apply to all branches of the economy, including telecommunications as the core of the development of modern society as a whole. To achieve a European perspective for B&H, it is necessary to reform the telecommunications sector.

To harmonize its political and regulatory framework for electronic communications with the EU, in 2016 the B&H Council of Ministers submitted to the Council of Ministers an initiative for the procedure of harmonization and adoption of the "Information Society Development Policy in Bosnia and Herzegovina". The policy is the basis for the development strategy of the information society of B&H. It was a key document for the development of information and communication technologies.

Relevant policies and procedures in the telecommunications sector in B&H include:

- Law on Communications in B&H (2003) (still in force),
- B&H Electronic Communications Sector Policy for the period 2017-2021,
- B&H Information Society Development Policy for the period 2017-2021.

These Policies are designed to encourage the investment process. This process should accelerate the development of electronic communication infrastructure, which would provide citizens with a more diverse and high-quality offer of services [13].

One of the leading problems for the digitization process is that there is no country-wide operational organization that coordinates the Internet and other communication infrastructures. In previous years, several government strategies and documents have been adopted, such as ICT infrastructure, ICT industry, e-business, e-education, e-healthcare, e-government, e-laws, 30 e-environment, Strategy, and action B&H Information Society Development Plan (based on the 2002 Information Society Development Program in Southeast Europe). The main drawback in the adoption of these documents is their practical implementation.

According to the Digital Quality of Life Index, which is calculated every year by Surfshark for 2020 [14], B&H is among the leading countries that do not have the will the government to take advantage of the technologies offered by artificial intelligence and their range of services provided.

The Draft Framework Strategy for the Development of Broadband Access in Bosnia and Herzegovina for the period 2019-2023 is currently in force. The strategy is based on the guidelines and priorities of the B&H Electronic Communications Sector Policy for the period 2017-2021. This strategy has set a goal of 75% coverage of the population in B&H by December 2023 with high-speed fixed broadband internet speeds higher than 30Mbps, which are also EU targets. In terms of mobile broadband, according to the draft strategy, the goal is to achieve coverage of the territory of B&H with 4G/LTE of 70%. The main task of this Strategy is to enable the elaboration of some of the previously defined goals in the Policy of the Electronic Communications Sector of B&H for the period 2017 – 2021 and to propose concrete measures for its implementation.

3. Analysis of digital development of Bosnia and Herzegovina according to EU guidelines

In recent years, the B&H telecommunications market has been characterized by uneven and unsystematic development at the state level. There is a decline in investment in this area [13]. Although certain private operators show slightly higher investment activity, this is insufficient. Most of the operators are mostly in public ownership, and the decline in investment activity on their part causes a decline in total investment in the telecommunications market in B&H in

recent years. As a broadband access strategy has not been adopted, the development of networks designed to access high-speed internet services in the fixed, mobile, and satellite networks is largely based on the entrepreneurship of the operators themselves. The whole process of progress further challenges the complex regulatory and legislative framework. The framework should be addressed in the form of harmonization of key laws, acts, and processes at different administrative levels. B&H is obliged to harmonize its regulations with the legislation of the European Union (EU), including the telecommunications sector. By adopting the Broadband Access Development Strategy in B&H for the period 2019-2023. meets one of the seven leading European economic strategy initiatives "Europe 2020".

The number of Internet users in B&H is growing (Fig. 3). The penetration of broadband subscribers in 2020 compared to 2013 is 21.39% [15]. However, B&H lags behind the EU in terms of basic broadband penetration, 61% versus 78%. Fast and ultra-fast broadband penetration is less than 0.1% [13].

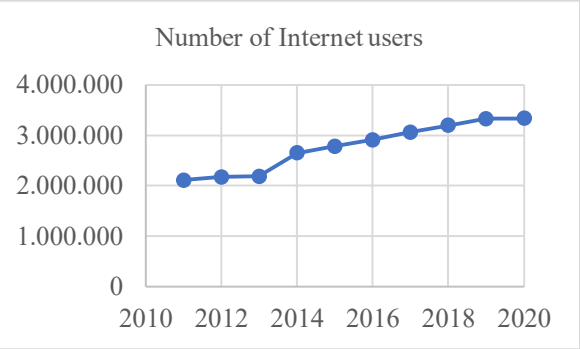

Fig. 2 Number of Internet users in B&H (2011-2020.) [15]

In the structure of broadband connections, ADSL (Asymmetric Digital Subscriber Line) access leads with 54.51% of the total number of broadband fixed connections (Fig. 3). There is an increase in cable and FTTx (Fiber to the x) Internet access compared to the previous year, and a decrease in FWA (Fixed wireless access) users. If we talk about access speed, 50% of subscribers have access to the Internet at speeds higher than 10 Mbit/s [15].

In the EU Internet access at home has a stable coverage of 97%. Among these technologies, xDSL continued to have the largest footprint (90%) followed by FWA (56%), DOCSIS 3.0 cable (45%) and FTTP (Fiber to the Premises) (42%) [11]. Coverage of Next-generation access (NGA) technologies capable of delivering download speeds of at least 30 Mbps reached 87% in 2020 [9].

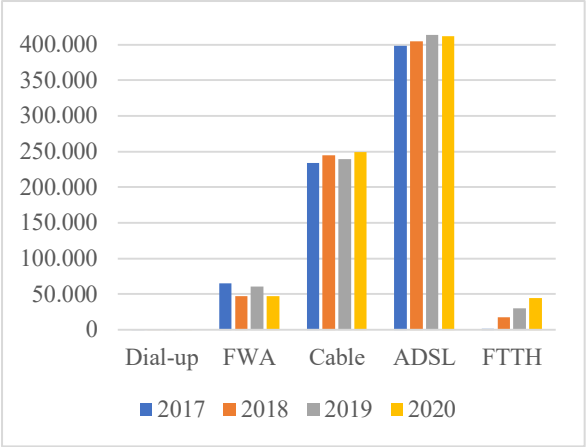

Fig. 3 Internet subscribers by types of access for the period 2011-2020. [15]

Now, if we look at mobile technologies, the level of penetration (number of mobile subscribers per 100 inhabitants) of mobile telephony at the end of 2020 was 99.39% [15]. As Fig. 4 - Fig. 6 show, the three mobile operators provide different types of coverage reports in [15]. There is no data on a single coverage of the entire B&H territory.

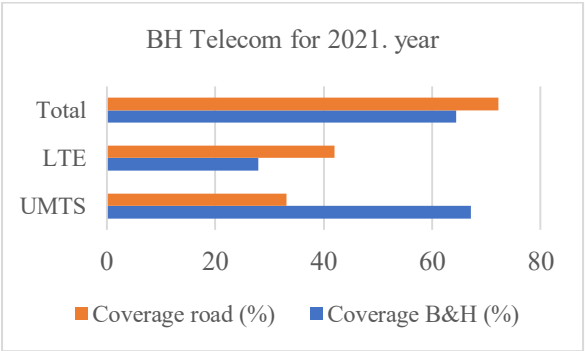

Fig. 4 Coverage for mobile networks of operator BH Telecom

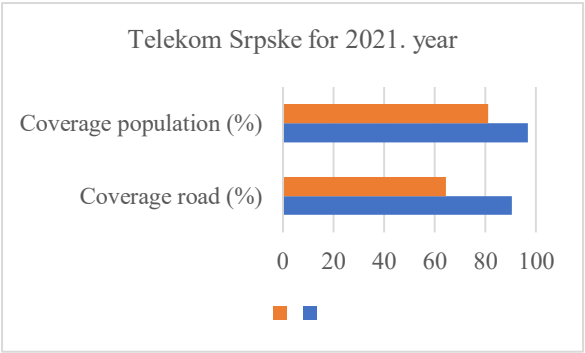

Fig. 5 Coverage for mobile networks of operator Telekom Srpska

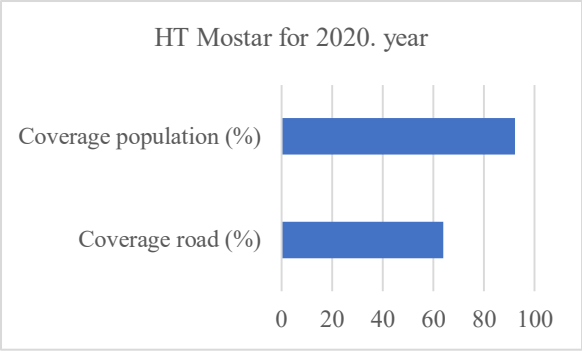

Fig. 6 Coverage for mobile networks of operator HT Eronet

In the EU 4G is almost universal reaching 99.7% of populated areas, and 5G commercial services were launched in about half of the member states by mid-2020 covering 14% of populated areas [9].

Analyzing this market situation of B&H, in the field of telecommunications, we notice the following problems:

- Uneven conditions for the establishment of new generation networks;
- Lack of awareness of the importance of broadband for society and the economy as a whole;
- difficult to obtain approval for the construction of telecommunications networks;
- Uneven construction and design standards;
- Inability to share infrastructure, which significantly slows down the replacement of obsolete and the establishment of new high-speed networks;
- Establishment of an orbital 5G network, thus entering into serious competition with ground-based services.

M2M (Machine to machine) services, smart vehicles, and communication with emergency services Internet access, and therefore all services available on it, including voice services, data transmission, and multimedia content require much greater investment in B&H. The latest EU report on B&H (2019) regarding information technologies emphasized that B&H:

- there is still no broadband strategy;
- the law enabling the liberalization of the telecommunications and electronic media sectors is not in force;
- does not have a single Strategy or Action Plan for the development of the information society throughout the country;
- must adopt a national strategy for the security of networks and information systems.

As the trend of increasing use of digital content is ubiquitous, there is a significant need to invest in infrastructure that will meet the needs of the digital age. B&H has some positive sides and evidence that digitalization is possible with a slightly more orderly political and legislative system. As Surfshark points out [14], a pleasant surprise is the functioning of the Internet in the Balkan countries during the pandemic, when many countries got a "jump" on the Internet. B&H remained in the first period of Europe's development and every effort should be made to catch up with Europe in its race for the digital decade.

Conclusion

The aim of the Digital Agenda is not just to keep every European online but to help people find their way into the digital world. Computers, mobile phones, and digital technologies are central parts of our daily lives. They can highlight many of the challenges we face, from road safety to healthy old age and from better public service to a stable and sustainable environment.

This paper emphasizes the theoretical potential as well as the practical challenges of implementing the goals of the Digital Agenda for Europe, which promotes broadband access in B&H. Bosnia and Herzegovina are in a difficult situation from the perspective of the systemic development of broadband Internet at the state level.

Realistic and achievable coverage and penetration targets in line with the Digital Agenda for Europe need to be adopted. These goals must be considered in the current situation. This is aggravated by the fact that B&H is still awaiting EU candidate status. As a result, B&H cannot access the funds made available by the EU. Funds for the development of networks in rural areas stand out, and the EU is happy to provide funding for good projects. Until they can use these funds, domestic operators will have to use their resources to cope with growing

competition and foreign private capital entering the domestic market. The future economy will be a network-based knowledge economy with the Internet at its center. Therefore, B&H s should follow the EU on their path to digitalization.

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5G Security Threats and Countermeasures: An Operator Perspective

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Abstract

The fifth generation of mobile telecommunications (5G) is one of the most important novelties of our times due to its influence on the economy and society. The advent of 5G networks and services expands the security threats landscape and requires the implementation of adequate countermeasures. This paper presents a brief overview of 5G security threats and countermeasures from operators' perspective. The aim is to contribute to the 5G cybersecurity knowledge collection and dissemination by summarizing the key findings and identifying next steps.

Keywords: *5G, Cybersecurity, Threats, Technical measures, Operators*

1 Introduction

The fifth generation of mobile telecommunications (5G) is an inevitable, next generation transformation of the role that technology plays in the economy and society. 5G is designed to provide an opportunity to move beyond connectivity in order to meet the different needs of citizens and economy. It is an opportunity to collaborate between various sectors, such as transport, health, finance, and provide rich, innovative services.

Thanks to technology improvement in various fields, commercial 5G networks are widely deployed from 2020. The Groupe Speciale Mobile Association (GSMA) has expected that 5G networks are likely to cover one-third of the population by 2025 [1]. The implementation of 5G network could add up to €1 trillion to European gross domestic product (GDP) between 2021 and 2025 and potentially create up to 20 million jobs across all sectors of the economy [2]. Ensuring the cybersecurity and resilience of 5G networks is thus essential.

Introducing a 5G technology makes changes to the security threat landscape due to the combination of new technology and different service models being introduced. These threats are usually unknown at the time of launch since attackers need live environment to develop new threats. Security threat landscape will expand with the exposure of new industries and services, such as industry 4.0, smart cities, connected vehicles, etc. [3].

Operators are responsible for the secure rollout of 5G using equipment sourced from technology vendors, i.e., deployment of 5G networks, investment and funding, and security of 5G networks. Recent research activities showed that 32% of operators reported an increased attack surface as key challenge here, whereas 48% admit that they do not have enough knowledge or tools to deal with security threats. In addition, 39% of operators point to limited pool of security experts which further reduce in-house cybersecurity knowledge [4].

In order to identify a common set of countermeasures which can mitigate the main 5G security risks, the European Union (EU) toolbox on 5G cybersecurity has been created. It contains non-binding measures to be implemented by various actors including operators. In addition, there are supporting actions that have potential to enable and assist the strategic and technical measures. In this context, one of the actions obligates the operators to review or develop guidelines and best practices on network security [5].

In order to contribute to this supporting action, this paper aims to summarize 5G security threats and countermeasures. All security threats

mentioned in this paper can be used by operators as a basis to develop security controls and to complement any in-house security threat materials. The specific measures are recommended to reduce various vulnerabilities and minimize the exposure to these threats. The intention is to decrease or even eliminate the impacts of these threats and better manage 5G cybersecurity risks.

The rest of the paper is organized as follows. After introduction, section 2 provides a brief overview of 5G security threats and corresponding countermeasures to be taken by operators. Section 3 discuss the key findings and provides an insight into the next steps.

2 Security of 5G Network

5G security threats and countermeasures described in this paper are categorized to map to generic 5G network domains, i.e., user equipment threats, radio access network threats, core network threats, cloud threats, service and application threats, and operation and management threats. Table 1 contains description of each identified 5G security threat, whereas Table 2 gives an insight into the suggested countermeasures that can be taken by operators to reduce or eliminate the threat impact.

2.1 Security Threats

Security threat is defined as "*the potential cause of an incident that may result in a breach of information security or compromise business operations*" [6]. Threats can be accidental and intentional. Accidental threats exist with no premediated intent. Intentional threats are result of a harmful decision.

Table 1 gives an overview of identified 5G security threats to provide practical guidance to technical staff.

2.2 Security Countermeasures

According to EU toolbox on 5G cybersecurity, security measures can be divided into two groups, i.e., strategic and technical [5]. Strategic measures include regulatory powers, third-party suppliers, diversification of suppliers, and sustainability and diversity of 5G supply and value chain. On the other side, technical measures refer to network security, requirements related to suppliers' process and equipment, and resilience and continuity. Here we focus on technical measures. Table 2 summarizes countermeasures for each of identified threats that can be taken by operators.

3 Kye findings, Conclusions and Next Steps

The security of 5G networks is identified as a critical issue. Operators strive to provide security assurance described by the security triad, i.e., confidentiality, integrity, and availability (CIA). Security threats summarized in Table 1 have potential influence on all three elements of CIA triad. User equipment threats potentially affect confidentiality. Radio access network and cloud threats have impact on both confidentiality and availability, while core network threats mainly affect confidentiality. Operation and management threats mainly have influence on integrity, while service and application threats primary affect confidentiality. Furthermore, security threats listed in Table 1 affect the following assets:user equipment, user data, system data, and telecom services. User equipment is only affected by the service and application threats. User data are affected by the threats associated with all 5G network domains, while system data are influenced by the core network, cloud, and operation and management threats. Telecom services are mainly affected by the radio access network, core network, and cloud threats.

Operators are expected to further discover new security threats and addressed them as 5G network and services are used commercially. In addition, they may implement standards, guidelines, and best practices to achieve security objectives for the safe use, deployment, and operation of 5G networks and services. In this context, this paper contributes to creation of technical guidance on best practices related to 5G network security which can increase in-house cybersecurity knowledge.

Table 1. Overview of 5G security threats

Domain	Threat	Description	References
User equipment	SIM credential theft	SIM credentials are accessed by unauthorized actors to monitor mobile user communication.	[7]
Radio access network	UE DoS attack	Fake base station is used by attacker to pretend to be legitimate base transceiver station to send false system information causing DoS attack.	[8]-[13]
	Network DoS attack	High amount of connection requests is generated by radio air-interface to exhaust network resources causing DoS attack.	
	5G authentication vulnerabilities	5G authentication vulnerabilities include billing fraud, implicit authentication, and privacy violation against active attackers.	
	5G user location tracking	Media access layer information about carrier aggregation is used to passively locate and track 5G users.	
	Radio jamming	Fake base station blocks users trying to access the network.	
	Hijacked TCP connection eavesdropping	Traffic between victim user equipment and remote TCP server can be eavesdropped by hijacking TCP connection to inject malicious TCP packets.	
Core network	Core network DoS attack	Attacker initiates DoS attack against the core network and make service unavailable.	[14]-[17]
	Voice call eavesdropping	Unauthorized actors compromise the mobile switching center with malware to spy voice content using lawful interception functionality.	
	SMS eavesdropping	Unauthorized actors infect operator's short message service center with malware.	
	5G NEF API exploitation	API software can have vulnerabilities which can lead to tampering, spoofing, data theft, and service unavailability.	
	CDR harvesting	Call detail records are harvested from mobile networks by malware usage.	
Cloud	VM abusing	Virtual resources are abused/controlled by attacker which results in information leakage, interception, eavesdropping, or system unavailability.	[3]
	MEC DDoS attacks	DDoS attacks against MEC are initiated in order to consume network resources and make services unavailable.	
	MEC APIs abusing	MEC APIs are abused to cause network congestion, data leakage, or resource exhaustion.	
	Unauthorized access to the NS management plane	Security control mechanisms of network virtualization may be bypassed resulting in unauthorized access to the slice management plane.	
	NS resource preemption	Security control mechanism of network virtualization may be bypassed causing slice resource preemption.	
	NS data theft and tampering	Security control mechanism of network virtualization may be bypassed causing slice data theft and tampering.	
Operation and management	Detect theft or fraud	A legal identity of the management plane is illegally obtained by attacker in order to intrude into the network.	[3]
	Exploitation of NC data weakness	Critical network assets can be accessed by threat actors during different phases of the solution implementation lifecycle.	
	Log tampering	Attackers tamper with system logs, security logs, and operation logs.	
Service and application	Malicious applications	Malicious applications may use phone credit, tamper with personal data, intercept user traffic or copy applications to commit fraud.	[18]-[21]
	UE compromise	Malicious actor may compromise or hack user equipment through a range of exploit methods.	
	Personal data theft	Improper use of security controls causes vulnerabilities exploitation by malicious actors.	

Legend: SIM (*Subscriber Identity Module*); DoS (*Denial of Service*); UE (*User Equipment*); IP (*Internet Protocol*); TCP (*Transmission Control Protocol*); NEF (*Network Exposure Function*); API (*Application Programming Interface*); SMS (*Short Message Service*); CDR (*Call Detail Records*); VM (*Virtual Machine*); MEC (*Multi-access Edge Computing*); NS (*Network Slice*); NC (*Network Configuration*).

Table 2. Overview of 5G security countermeasures

Domain	Threat	Countermeasures	References
User equipment	SIM credential theft	Store SIM credentials within hardware security module. Detect data exfiltration and identify abnormal processes. Identify compromised SIM cards and consider the chance of remotely changing the credentials.	[7]
Radio access network	UE DoS attack	Implement two-way authentication and SUPI encryption. Use signaling monitoring or network management system to identify the presence of false base station.	[8]-[13]
	Network DoS attack	Use network management system to monitor network key performance indicators and enable network access control.	
	5G authentication vulnerabilities	Deploy solution for fake base station detection.	
	5G user location tracking	Check configuration and frequently refresh temporary identifiers.	
	Radio jamming	Identify radio jamming equipment by using fake base station detection. Use measurement reports for identifying signatures of false base station.	
	Hijacked TCP connection eavesdropping	Establish network domain security. Implement IP-spoofing and replay protection, and TCP proxy in the network infrastructure.	
Core network	Core network DoS attack	Ensure equipment has a baseline security level. Deploy anti-DDoS devices, security edge protection proxies, signaling firewall.	[14]-[17]
	Voice call eavesdropping	Apply the latest security patches at the mobile switching center. Use privileged account monitoring to identify unauthorized access. Forward access logs to SIEM system and perform the root cause analysis.	
	SMS eavesdropping	Apply the latest security patches at short message service center. Review the privileges of network equipment users. End-point security solution and internal firewalls should raise alarms.	
	5G NEF API exploitation	Ensure network equipment has a baseline level of security. Ask vendors to provide test reports and have emergency response.	
	CDR harvesting	Apply the latest security patches at network and IT systems. Review the privileges of call data records database. Call data records databases and internal firewalls should raise alarms.	
Cloud	VM abusing	Develop virtualization security development policies for intrusion detection, security isolation, and security hardening. Coordinate security solutions included in all virtualized components.	[3]
	MEC DDoS attacks	Filter the packets heading for the target site under attack, restrict communication ports, reduce the operation of target facilities.	
	MEC APIs abusing	Develop security management specifications to prevent apps with security risks and deploy abuse prevention solution.	
	Unauthorized access to NS management plane	Enable authorization and authentication mechanisms. Implement domain and privilege management.	
	NS resource preemption	Enable proper network resource management mechanisms.	
	NS data theft and tampering	Delete residual data when slice resources are released. Enable network resource isolation and authorization mechanism.	
Operation and management	Detect theft or fraud	Deploy privileged access management and perform security audits. Improve the access control and authentication of accounts and permission. Deploy authentication, antimalware, and least privilege control.	[3]
	Exploitation of NC data weakness	Purchase tools for checking device security configurations. Improve the training of operation and maintenance personnel. Implement domain- and rights-based management.	
	Log tampering	Manage logs in a unified and centralized way. Protect the integrity of logs to prevent tampering. Use the situational awareness system to detect real-time/previous attacks.	
Service and application	Malicious applications	Not applicable.	[18]-[21]
	UE compromise	Provide DoS indicators and quick location for compromised UE.	
	Personal data theft	Not applicable.	

Legend: SIM (*Subscriber Identity Module*); DoS (*Denial of Service*); UE (*User Equipment*); IP (*Internet Protocol*); TCP (*Transmission Control Protocol*); NEF (*Network Exposure Function*); API (*Application Programming Interface*); SMS (*Short Message Service*); CDR (*Call Detail Records*); VM (*Virtual Machine*); MEC (*Multi-access Edge Computing*); NS (*Network Slice*); NC (*Network Configuration*); SIEM (*Security Information and Event Management*); IT (*Information Technology*); VM (*Virtual Machine*); SUPI (*Subscription Permanent Identifier*); DDoS (*Distributed Denial of Service*); MEC (*Multi-access Edge Computing*).

More detailed overview of challenges in the security of 5G networks is given in the ENISA report on threat landscape for 5G networks [22] and its update that encompasses all novelties introduced, captures developments in 5G architecture and summarizes information found in standardization documents [3]. In addition, there is specific report which focuses on 5G cybersecurity standardization from a technical and organizational perspective [23]. To ensure 5G network security, it is important that security requirements defined in the relevant 3GPP specifications are fully implemented and utilized [24]. In general, 5G should consider a more flexible security [25].

Based on security threats to date, the following next steps can be made on 5G networks [3][22]:

- Conduct a detailed gap analysis of the limitations for the protection of 5G network. In addition to organizational issues, such gap analysis will be required for migration/mitigation options;
- Develop good practices or guidelines for the secure implementation of 5G network, since they are an important step towards maintaining the final security level of 5G network;
- Perform a systematic analysis of operational and general-purpose models for security assurance processes to test their 5G adequacy and fill the identified gaps;
- Engage in discussions on 5G matters since experience in technical, organizational, and business issues of a 5G deployment are important for the generation of security guidance;
- Contribute to the 5G cybersecurity knowledge collection and dissemination.

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Modal shift ambitions and perspective of Bosnia and Herzegovina: QFD method analysis of quality combined transport

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Abstract

The modal shift represents one of the most important elements that participate in the creation of a sustainable transport system. Insurance of energy supply, climate change, and rising demand for transport services are some of the main issues that the world is encountering. Creating solutions for these challenges will request, in a couple of next decades, that railway transport overtake a big part of transport demand. The primary goal of this paper is to fundamentally change the way of understanding transport services, not just as a service of individual modes of transport but as a service in a continuous intermodal chain of transport supply. The perspective of the railway sector in B&H is to increase the quality of transport services through combined transport. Selecting the way of transport is a typical multi-attribute problem. In this paper, the House of Quality (HOQ) was used as a tool for analyzing relevant decisions that represent QFD (Quality Function Deployment) information. By raising the quality of service of combined transport with the usage of the QFD method, through quality houses, the railway sector in B&H will be able to ensure a bigger market position, supporting greening of transport and the Single European Railway Area.

Keywords*: Modal shift, Combine transport, Greening of transport, Sustainability, HOQ, QFD*

1 Introduction

The efficiency of intermodal transport is observed through the efficiency of the transport network, terminals, and the efficiency of freight transport services. The paper contributes to determining intermodality as a qualitative indicator of the level of use of economic efficiency of combined (road-rail-road) transport through a systematic approach to the problem where the reform processes in Bosnia and Herzegovina, ie the Federation of BiH and Republika Srpska in this area will be considered through the house of quality.

The aim is to analyze the quality of modes of transport by applying the method, which transmits the house of quality (HOQ-house of quality) in the approach to the quality function deployment (QFD). By identifying the possibilities that transport should have (internal variable "WHAT") in order to meet the needs of the customer of the transport service, certain criteria for evaluating service providers (external variables "HOW") are established in order to make the final ranking. The whole procedure is carried out by correlating the importance of "WHAT" due to the weight of "HOW" and the impact of each mode of transport. This paper shows that the analysis of the quality of combined transport is an essential step not only in defining the potential of the market but also in the formation of policies, technical operational strategies, and commercial approaches to realize this potential.

2 Concept of modal shift

The term we hear more and more often is "modal shift," which is one of the important elements that participate in creating a sustainable transport system. a transportation system that will benefit everyone. In its context, the term "modal shift" means a change from one mode of transport to another. Climate change as well as the energy crisis have led to the need for significant changes in the way we live, work, and travel if we want to embark on an environmentally sustainable path. This doesn't have to be a "doom" scenario. History tells us that we often develop our best innovations in times of greatest danger. Thus, the

thinking of transport users about changing the mode of transport in the current circumstances can lead to a more efficient, productive, and sustainable transport system.

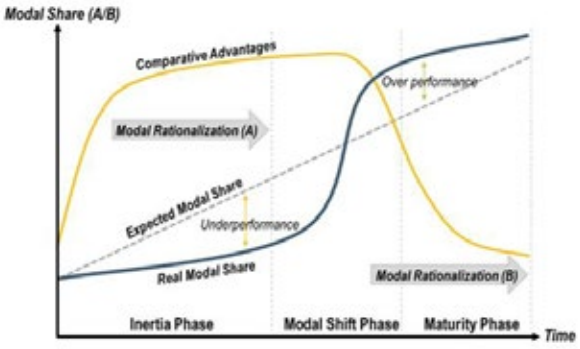

Fig. 1. Principles of modal shift [1]

The modal shift occurs when one mode of transport has a comparative advantage in a similar market over another. Comparative advantages can take many forms, such as price, capacity, time, flexibility, or reliability. Depending on what is being transported, the significance of each of these factors varies. Within the distribution chain in the book "The Geography of Transport Systems", Jean-Paul Rodrigue, Claude Comtois, and Brian Slack first edition 2006 [2] are identified four different cyclical phases of functional integration of different modes of transport (initial part, expansion, and interconnection, standardization and integration, integrated demand). Based on research [1], [2] the principles and theories of the modal shift are defined as three phases: inertia phase, modal shift phase, and maturity phase (Fig. 1).

1. ***Inertia phase***: Initially, a high level of inertia makes modal shift a slow process and is sometimes difficult to detect. Only a few beneficiaries can experience a modal shift, often as part of a government-subsidized initiative. Negotiating new procedures and new contracts are tasks that companies are reluctant to undertake if the benefits are not obvious
2. ***Modal shift phase***: This phase represents a rapid transition from one mode of operation to another as the industry recognizes its strengths. The new mode of transport is evolving from a situation of insufficient performance to a situation of progress.
3. ***Maturity phase:*** At this stage, the market potential is achieved by a new balance in modal shares. Their comparative advantages are less variation, which implies limited incentives to shift goods or passengers. The focus becomes more efficient use of modal means.

3 Road-Rail combined transport

The European Union as well as the European Conference of Ministers of Transport (ECMT) and the United Nations Economic Commission for Europe (UN/ECE) have accepted the following definition of Combined transport (CT) [3]:

"Intermodal transport where the major part of the journey, in Europe, is by rail, inland waterways or sea, and any initial and/or final legs carried out by road are as short as possible."

Union for Road-Rail Combined Transport (UIRR) actively promotes Combined Transport while also supporting the daily functioning of this ecologically and economically sustainable mode of long(er) distance freight transport. The combination of road and rail brings together the advantages of both rail and road in two concepts [3]:

- **unaccompanied CT**, the goods travel in swap bodies, standardized containers, or semi-trailers. These are efficiently transferred at transshipment sites, also called terminals, which are conceived to act as the link between these methods of transport.
- **accompanied CT**, the whole road vehicle is involved, i.e. the traction cabin too, which is driven onto a special wagon, and the driver accompanies it in a specially fitted couchette wagon.

4 The path to be followed

Current transportation systems come with a wide range of issues, including global warming, environmental degradation, health implications (physical, emotional, mental, spiritual), and greenhouse gas emissions. In fact, 23% of global greenhouse gas emissions from fossil fuel combustion are attributed to the transport sector [4]. Road transport has a share of 75% of total greenhouse gas emissions. All this puts a lot of pressure on national governments to develop policies to reduce greenhouse gas emissions. A specific solution is the greening of transport, which means the use of any type of transport

service that is environmentally friendly and has no negative impact on the immediate environment.

The European Commission's 2001 Transport White Paper [5] aims to shift 30% of road freight over 300 km to other energy-efficient modes of transport, such as rail or waterborne transport by 2030. The increased demand for rail transport promoted by public authorities may be a challenging target for the rail freight sector due to the large volume of goods it entails. Moreover, the growth of rail freight transport could lead to the need to expand the railway network, which includes environmental effects. EU transport policy calls for standards to be defined to reduce the harmful effects of traffic on the environment. Fully in line with The European Commission's Transport White Paper, Bosnia and Herzegovina is working with all relevant actors to create a political environment that supports the following three pillars:

1) improving the infrastructure financing policy,

2) improving infrastructure capacity and

3) establishing fair conditions of competition between different modes of transport.

This was not an easy mission, but B&H adopted a long-term transport policy and strategy through its institutions (2016-2030) [6], [7] thus accepting the fact that railways are the cornerstone of todays and even more future European supply chains. through the development of combined transport.

5 Ambitions and perspective of modal shift in B&H

Practically in B&H, in combined transport, the flexibility achieved by road freight vehicles can be naturally and inseparably combined with the efficiency resulting from the transport of bulk cargo by rail over long distances. In order to effectively consolidate and develop the position of combined transport on the BiH market, various actors (carriers, freight forwarders, shippers...) will have to think in a more European way and act in accordance with market economy regulations.

The advantages of the combined transport system will not be fully realized until the competition between combined (rail-rail-road) and clean road transport becomes only a subject of the comparison of comparative conditions and without favoring one mode of transport over another. All previous experience has shown that the minimum requirements defined by the directive on the separation of infrastructure and transport into purely administrative parts are not enough. Only a complete institutional separation into two independent companies can guarantee equal conditions for all railway companies.

5.1 Problems with using combined transport

Combined transport in B&H is almost non-existent, however, container transport (especially maritime) has been growing rapidly in the world over the last 30 years (exponential function). Therefore, significant growth rates can be expected in the coming years. Thus, B&H must build a multimodal infrastructure in order not to be excluded from international transport flows and thus hinder its economic development. Earlier forecasts have shown that it is more dangerous to underestimate the increase in containerization than to overestimate it. The current situation in combined transport in B&H is characterized:

- low intensity and consolidation of goods flows on the main transport routes, which makes it impossible to establish regular block trains;
- transport flows are unbalanced and relate mainly to the import of goods, which is why containers are often returned empty;
- the organizational framework is complex and characterized by unclear relationships and undefined roles of participants in combined traffic,
- there are no financial incentives in favor of combined transport, which relate to the purchase of special vehicles, handling equipment, transport vessels, and containers.

Table 1. Container transport by ŽFBH

Year	CTR “20”	CTR “40”
2017	6044	216
2018	5995	1304
2019	5519	796
2020	4623	483
2021	4832	204

Source: ŽFBH

Republika Srpska (RS) railways do not have data on the transport of containers on its network, which is one of the major shortcomings for monitoring the participation of railways in combined transport. Data for the period 2017-2021. of container transport for ŽFBH are given in Table 1.

In order to achieve the goals of the development of combined transport, it is necessary to harmonize the integration between modes of transport, infrastructure, hardware (cargo units, vehicles, telecommunications), operations, and services, as well as the regulatory framework.

5.2 Perspectives for the development of combined transport

With the adoption of the Transport policy [6], and through the action plan given in the Transport Strategy for B&H [7], the emphasis was placed on the equal development of all modes of transport and equal participation in the transport chain through combined transport which will be shown in HOQ (House of Quality).

The following types of goods imported or exported from Bosnia and Herzegovina could be containerized in the future:

- steel and iron scrap (Mittal Steel) in part, depending on size and quantity,
- fertilizers (GIKIL Lukavac), 100%,
- hydrated alumina and zeolite (product of the company Birač from Zvornik and raw materials of the company Aluminij Mostar), partially,
- alumina (Aluminij Mostar) partially, depending on size and quantity,
- salt (Tuzla Saltworks), 100%,
- soda and derivatives mainly for export (Sisecam Lukavac), 100%,
- construction materials (except cement), in part,
- wood: untreated, partially sawn; wood products (wood-based panels, etc.), 100%,
- paper, mainly for bags (Natron Maglaj), 100%,
- cellulose (SHP Celex), 100%,
- metal processing products, including the automotive industry in part, depending on size and quantity
- miscellaneous, including consumer goods, one hundred percent.

Table 2. Combined transport routes

Combined transport routes for which the FBiH has expressed interest	
Brčko border	Čapljina border Lukavac
Semizovac	Čapljina border
Sarajevo Cargo	Čapljina border
Maglaj	Čapljina border
Čapljina border	Lukavac Konjic Visoko
Lukavac	Šamac border

Every year, the Government of the Federation of Bosnia and Herzegovina expresses the FBiH's interest in providing rail passenger and combined transport services [8]. The interest is determined that the ŽFBH provides passenger and combined rail transport services on certain routes (Table 2).

Based on that decision, the Federal Ministry of Transport and Communications concludes an agreement with the ŽFBH on co-financing the provision of public railway passenger and combined transport services on these routes.

The development of the transport network and combined transport infrastructure in B&H takes place through active participation in the work of The Transport Community as an international organization in the field of mobility and transport, consisting of 33 participants - the EU and six Western Balkan countries. It is very important that the transport network of B&H is part of the unique transport network of Southeast Europe.

According to the positive example of air transport and the European telecommunications sector, only free access to the network for all qualified candidates is the key to the liberalization and revitalization of rail freight.

6 QFD method analysis of quality

The choice of individual forms of transport or combinations of modes of transport for the transport of goods in BiH is a limited number of factors related to transport infrastructure, nature of transported products, transport decision-makers, transport service providers, and the

prevailing environmental factor (greening transport).

Quality Control (QC) tool for continuous quality management with Quality Function Deployment (QFD) method to define the "voice of the customer" will establish a quality relationship between transport users, carriers, and the community, which will affect the success of the service combined transport market. An example of the application of the QFD method in intermodal transport is given in [9] and takes place through three "quality houses" where they are defined:

1. through the first "quality house", the requirements of intermodal service users;

2. through another "house of quality", important features of intermodal service;

3. through the third "house of quality", the way of providing intermodal service.

In this paper, we will focus only on the presentation of the first quality house, where the input variables of the question "WHAT" will be the strategic goals set in [7], and the answers "HOW" will be the action plan for railways given in [7].

6.1 House of quality

The basic tool of the QFD method is the House of Quality (HOQ). It consists of the whole concept of developing a new product or service starting from the needs of the customer, determining the relative importance of each of these requirements. The result is a network of matrices that allows a clear view of the design process and its outcome (Fig. 2). Matrix construction vertically represents customer/user expectations and horizontally specifications.

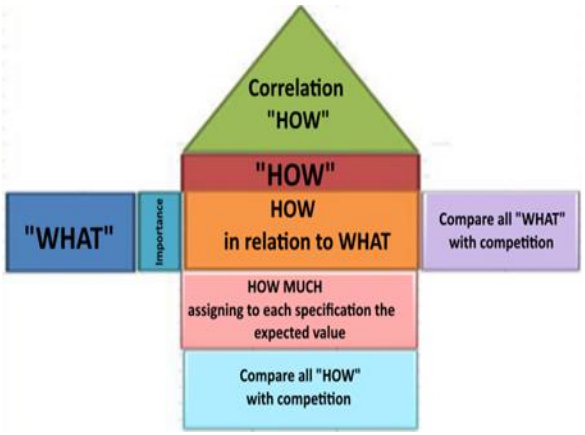

Fig. 2. "HOQ" construction

The QFD method takes place in two phases: step-by-step construction of the "quality house" and development of the "quality house" (Fig.3).

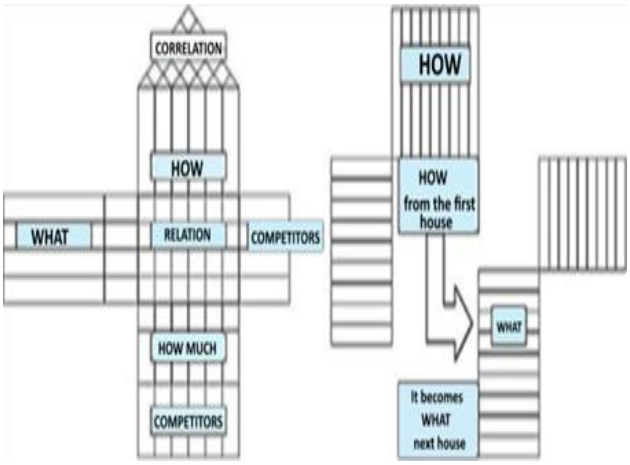

Fig. 3. Develompent of "HOQ"

6.2 Application of QFD method in combined transport

Combined transport is a concept that has been applied with greater or lesser success for years. The story and idea of combined transport have two segments:

- users and their desire to transport goods;
- the ability of combined transport to satisfy the wishes of users.

The point is to satisfy these two sides, and that can be achieved by the function of quality distribution, ie the QFD method that allows this connection to be in the function of the requirements of both the individual and society and service providers in combined transport. A method that can help to establish a link between users, carriers, and society in order to develop combined transport is the quality function deployment (QFD).

6.3 "WHAT" requirements

User requests can be stated and not expressed, ie there are conditions that are implied even though they are not expressed by the user. Using data from [7], the basic requirements of "WHAT" are:

WHAT-1: Adapted transport pricing system;

WHAT-2: Financial Sustainability: define stable sources of funding for the maintenance of railway infrastructure;

WHAT-3: Compliance with EU standards and laws: these are legislative interventions;

WHAT-4: Minimum allowable impact on the environment;

WHAT-5: Security and Information: Meeting security and information needs;

WHAT-6: Meeting the needs in terms of maintenance, improvement, and development of transport infrastructure;

WHAT-7: Service Integrality.

The price of transport is not explicitly a parameter of quality, but it is an important parameter when choosing a carrier for users of transport services. There must be a user-friendly pricing system with respect to external traffic costs.

From the Pareto diagram of the “WHAT” requirements (Fig. 4) it can be seen that the basic user requirements are arranged according to their importance as follows:

WHAT-3: compliance with EU standards (21%),

WHAT-7: service integrity (19%).

WHAT-4: minimum environmental impact (19%)

6.4 Answers "HOW"

On the one hand, there are users of transport services and their basic requirements, and on the other hand, the ability of combined, road, conventional rail to meet the requirements of users.

The function of quality distribution, ie the QFD method, enables this connection to be in the function of the requirements of the individual, the company, and the service provider. To the defined requirements of "WHAT" users of transport services, the quality matrix gives the answer "HOW":

HOW-1: Number and structure of cargo handling units: Sufficient number of containers of different sizes (small, medium, large) and appropriate purposes (universal and special);

HOW-2: Technical improvement and modernization of railway infrastructure, existing infrastructure to increase speed and safety in order to EN and TSI;

HOW-3: Defining models for financing railway infrastructure;

HOW-4: Complete implementation of the Law on Financing of Railway Infrastructure by allocating total maintenance costs from the budget;

HOW-5: Introduction of excise taxes on fuel or tobacco products to finance railway maintenance;

HOW-6: Business modeling of a railway company, restructuring;

HOW-7: Defining a long-term scenario for opening the railway market;

HOW-8: Adoption of EU directives on interoperability and security (2016/797, 2016/798);

HOW-9: Align existing legislation with EU legislation; EU acquis

HOW-10: Commitment to greening transport;

HOW-11: Development of a railway terminal/intermodal freight terminal (combined and conventional);

HOW-12: Define incentive schemes for CT.

Analyzing the results of the "house of quality" (Fig. 4), we notice that there is not a single request "WHAT" that does not have the answer "HOW", which is one of the prerequisites for the construction of the "house of quality".

Also, the roof of the "house of quality" or the correlation "HOW-HOW" shows that there are no answers "HOW" that are in contradiction with each other, ie the execution of one would prevent the execution of the other.

The Pareto “HOW” response diagram (Fig. 4) set out the priorities that need to be improved in order to increase the quality of the combined transport service:

HOW-1: number and structure of cargo handling units (16%),

HOW-8: adoption of the EU Directive on Interoperability and Security (15%),

HOW-2 and HOW-5: technical improvement and modernization of infrastructure as well as the introduction of excise taxes (10%)

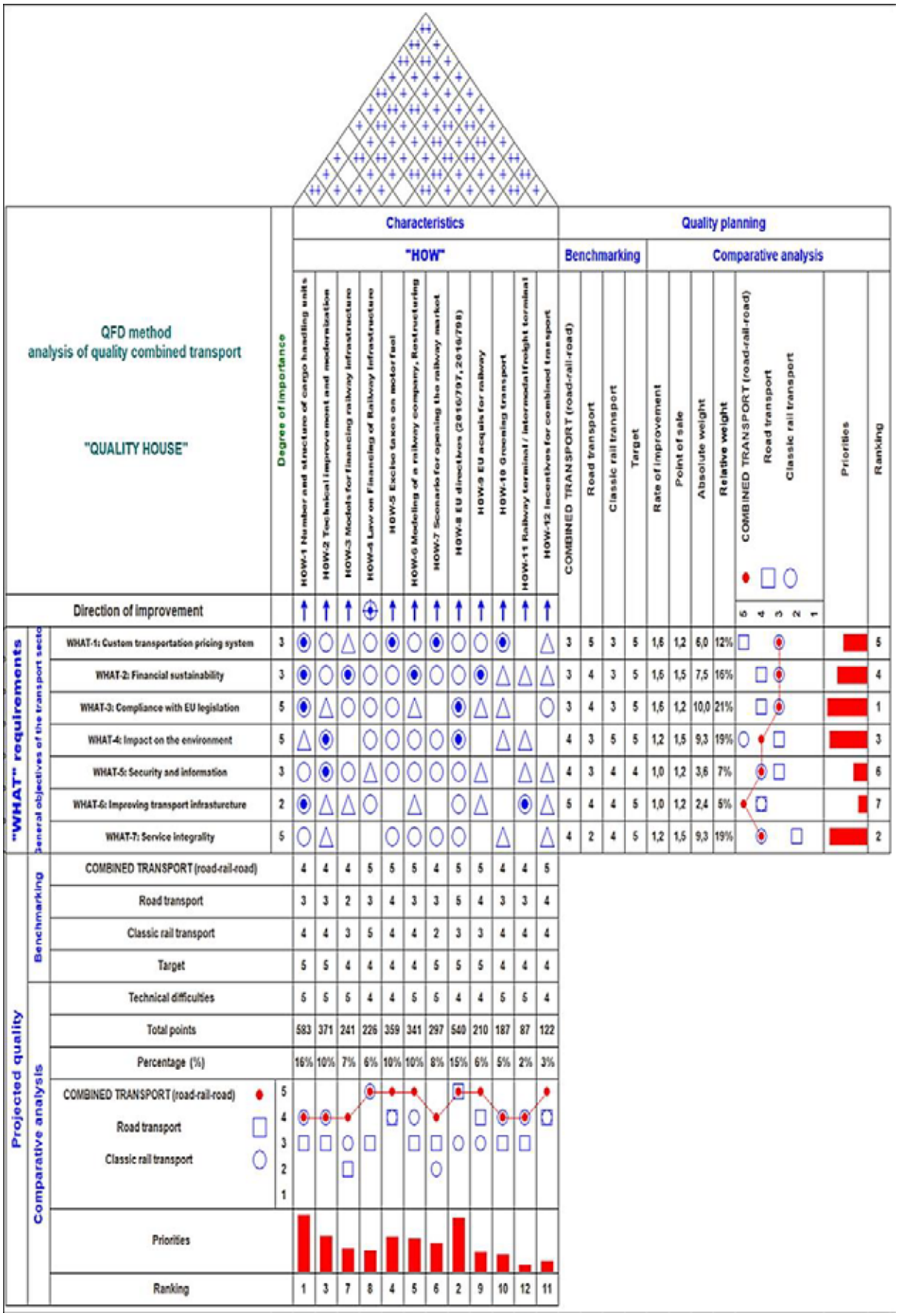

Fig. 4. House of Quality "HOQ" (Program "QFD - Quality Function Deployment Versao 1.1 - Free"

7 Conclusion

There is no absolute superiority of some modes of transport, but based on the given guidelines and through the growing awareness of public opinion regarding environmental protection, renewing the commitment and efforts of state governments to develop intermodal transport through certain subsidies is a clear sign that priority is given to combined transport. Combined (road-rail-road) transport maintains a balance between road and rail transport by ensuring regular competition and linking the development goals of these two modes of transport. It is necessary to control the growth of road transport and fight for the development of rail transport and other ecological modes of transport in order to enable them to be a competitive alternative in the development of combined transport services.

The quality of combined transport is the key in its competition with different modes of transport. Quality is considered a very important factor of competition as it has been recognized that the lack of quality is a clear source of costs in performing combined transport, which cannot be accepted by users or operators. Questions: what constitutes the quality of combined transport; demand-side quality requirements and supply-side quality indicators; how the quality of combined transport can be improved, were the subject of analysis of this paper using the QFD method. The "HOW" answers in the quality house showed that a sufficient number and appropriate structure of freight handling units, modernization of railway infrastructure, the introduction of excise taxes on fuel to finance railway infrastructure, and commitment to greening transport can increase the quality of combined transport services.

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Comparative performance analysis of an OTTO engine equipped for petrol or liquefied petroleum gas propulsion

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Abstract

Today, in the development of engines for the propulsion of motor vehicles, the greatest importance is given to the environmental aspect in terms of finding the ideal fuel. In solving this problem, it can be said with certainty that liquefied petroleum gas (LPG) has emerged as an ideal alternative fuel because it is more environmentally friendly and currently available in sufficient quantities. After showing the basic physical and chemical characteristics of LPG, the elements that must be installed in a vehicle that uses this type of fuel are listed. The paper analyzes the performance of OTTO engines with a subsequently installed LPG system in one group of vehicles that consisted of vehicles of the same manufacturer and type of engine. Using a chassis dynamometer in the laboratory power measurements were performed. The basic technical characteristics of the measuring equipment used in the laboratory are also stated. Based on the obtained measurements, the results of the operation of the engine on both fuels, as well as their mutual comparison are given. Considering that quite good results of testing the power of LPG aggregates were obtained in the following research, the parameter of the ratio of consumption of this fuel in relation to gasoline should be investigated for economic reasons.

Keywords: *OTTO aggregate, Chassis dynamometer, LPG, Engine power.*

1 Introduction

There are strong tendencies in the world to develop motor vehicles that use environmentally friendly and sufficiently available fuels. One of the ways to solve the current tasks of the automotive industry is the use of alternative fuels, or alternative energy potentials. The paper is based on liquefied petroleum gas (LPG) as an alternative fuel of known basic physical and chemical characteristics, which will be briefly described in this paper. Previous research has been mainly based on the analysis of the basic indicators of the powertrain (power, economy and environmental characteristics) in the use of LPG, which confirmed that this fuel is more economical and environmentally friendly than gasoline and diesel fuel, while much less research was based on measuring the engine power when working on these fuels.

Traction characteristic is one of the most important parameters of a motor vehicle and previous tests have given very little data on the operational dynamic characteristics of OTTO aggregates when using LPG. Certain changes to the powertrain, such as the installation of a system to supply the powertrain with liquefied petroleum gas, may lead to a change in the traction characteristics of the motor vehicle (power and torque). Tests of traction characteristics can be performed on the test site or on dynamometers intended for testing the traction characteristics of motor vehicles (chassis dynamometers).

Using the *AVL Roadsim Chassis Dyno 48“ 4WD MiM´´* chassis dynamometer, laboratory testing of the dynamic characteristics (power and torque) of the OTTO aggregate powered by two different types of fuel (petrol or LPG) will be performed. This paper will present all the results of research and analysis of the results obtained from the standpoint of changes in the engine power.

Power research will be conducted on a number of passenger motor vehicles that have a factory-installed system for supplying the engine with gasoline fuel, and on which a system for supplying the engine with LPG was subsequently installed. The tests were performed when the vehicle was powered only by gasoline and then only by LPG. The paper will present the

components and the principle of operation of the built-in LPG system.

2 Methodological settings of the work

The subject of the research is a comparative analysis of the performance of OTTO aggregate equipped with gasoline or liquefied petroleum gas. The paper will investigate the performance of the OTTO aggregate when it is powered by gasoline or liquefied petroleum gas.

The paper will also present the applied system for propulsion on liquefied petroleum gas. The vehicles tested have a retrofitted LPG engine supply system.

For the purposes of the research, tests will be performed on several Volkswagen motor vehicles. These are Golf IV vehicles, the age range of the vehicle is from 1999 to 2003 with petrol engines, in which the LPG engine supply system is subsequently installed.

The power test of the vehicle and the propulsion aggregate powered by gasoline and liquefied petroleum gas will be performed in the laboratory using the *AVL Roadsim Chassis Dyno 48" 4WD MiM''* chassis dynamometer.

The aim of the research, within the paper, will be focused on:

- laboratory testing of dynamic characteristics (power and torque) of OTTO aggregate powered by two different types of fuel,
- Interpretation of laboratory test results and comparative analysis of the advantages of using fuels from the point of view of dynamic characteristics.

The motive for the choice of work refers to the research of generally accepted attitudes about the advantages of using liquefied petroleum gas as a fuel.

3 Liquefied petroleum gas (LPG)

During the distillation of oil, individual hydrocarbons (C_nH_m) of different structure and different ratio of carbon and hydrogen are released, starting from the lightest fractions (with one to two carbon atoms C in the hydrocarbon molecule - such as methane CH_4 and ethane C_2H_6), through medium (such as heptane C_7H_{16} and octane C_8H_{18}) and heavy fractions (such as cetane $C_{16}H_{32}$), to the heaviest (such as hydrocarbons that make up fuel oil). Hydrocarbons between light and medium fractions (such as propane C_3H_8 and butane C_4H_{10}), at atmospheric pressure and normal temperature of about 20 [°C], are in the gaseous state, but at slightly lower temperature or at slightly higher pressure in the tank remain in the liquid state. Mixtures of these fractions form the so-called. liquefied petroleum gases.

Liquefied Petroleum Gas (LPG), or auto gas, is a mixture of saturated hydrocarbons (so-called paraffin) and impurities of other hydrocarbons, primarily unsaturated hydrocarbons (so-called olefins) and isomers of these hydrocarbons. Therefore, liquefied petroleum gas is a mixture of hydrocarbons with 3 and 4 carbon atoms (propane - C_3H_8, butane - C_4H_{10}, ethane, pentane, propene, butene, isobutane...). Propane and butane are colorless and odorless gases, but they are added the compound ethanethiol (CH_3CH_2SH), ethyl mercaptan, dimethyl sulfide, which contains sulfur to facilitate the detection of possible leaks.

Table 1. Properties of propane and butane

Properties	Propane	Butane
Chemical sign	C_3H_8	C_4H_{10}
Molar mass (M)	44,1 [g mol^{-1}]	58,12 [g mol^{-1}]
Density 0 [°C] and at 101,3 [kPa]	2,0098 [kg/m^3]	2,480 [kg/m^3]
Boiling temperature at 1 [bar]	-42 [°C]	-0,5 [°C]
Critical temperature	95,7 [°C]	152,8 [°C]
Critical pressure	43,6 [bar]	32,8 [bar]
Specific gravity in the liquid state	0,510 [kg/dm^3]	0,575 [kg/dm^3]
Lower caloric value	11070 [Kcal/kg]	10921 [Kcal/kg]
Spontaneous ignition temperature	540 [°C]	500 [°C]
Flammability limits in the air	2,1 – 9,5 %	1,9 – 8,5 %
Maximum combustion temperature	1925 [°C]	1897 [°C]

One of the most important characteristics of liquefied petroleum gas is high resistance to self-ignition, which means that LPG has a high octane number. This makes it particularly suitable for use in OTTO aggregates. A vehicle that uses liquefied petroleum gas for propulsion less pollutes the environment, has better

operating economy with a relatively small reduction in the traction characteristics of the vehicle. Research shows (Rakić, 2008) that the increase in fuel consumption in engines that have a built-in sequence system (direct gas acceleration system) is a maximum of 15%.

4 Application of LPG on OTTO aggregates

Application on OTTO aggregates is also known as bi-fuel conversion of gasoline engines, where the engine is powered by either gasoline or LPG.

In order to use LPG on an OTTO aggregate (ie those that normally use gasoline), it is necessary to install an additional LPG system. The LPG system must be adapted to the engine operation technology and the design features of the engine. Since LPG can be used on petrol engines with virtually no intervention on the engine itself, LPG systems in principle only provide storage and evaporation of LPG.

There are several different LPG systems that basically followed the technological development of engines and vehicles (they differ in the way the mixture of fuel and air is prepared), so that today there are mainly the following LPG systems:

- carburetor system,
- system for indirect injection without catalytic converter,
- system for indirect injection with catalytic converter,
- direct LPG injection system.

4.1 Direct LPG injection system

The system with direct injection of LPG is also called sequential system or system with multipoint injection.

The sequence system is intended for use in vehicles that use direct injection to prepare a mixture of fuel and air. It works by using injectors for the injection of LPG, on the same principle as with gasoline, which at any time, depending on the mode of operation of the aggregate, dose the optimal amount of LPG directly into the intake manifold of the aggregate. A very efficient system with an excellent history of reliability, is the best solution for installation in all vehicles on which it is technically possible to install.

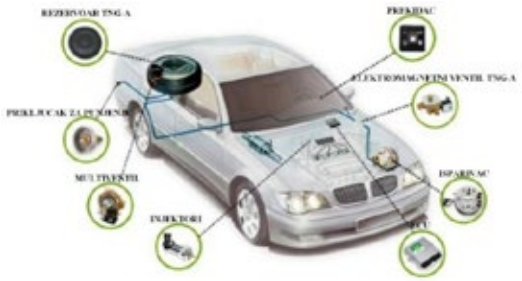

Fig. 1. Direct injection LPG system

The advantage of a system with direct injection of LPG is that it essentially has an ECU (Electronic Control Unit), atomizers, a large number of sensors and finally gas injectors. The system uses signals from the unit on which it is installed (speed, temperature, exhaust condition, injection time and injection torque for each cylinder separately) and its own parameters (temperature, pressure and amount of LPG in the tank). All input parameters are calculated by the ECU in real time and determines the amount of gas that will be injected into each cylinder of the unit. In this way, the best possible use of the engine power in relation to gas consumption is achieved.

The research examined vehicles that had new LPG equipment installed, and whose installation was performed in the same service workshop. Also, when choosing the vehicle, it was taken into account that the built-in LPG system has executive elements from the same manufacturer. The vehicles were equipped with STAG equipment, which was prescribed by the manufacturer for the given power and working volume of the propulsion aggregate.

Fig. 2. Embedded elements of sequential LPG system

4.2 Tested vehicles

As part of the research, tests were performed on five Volkswagen motor vehicles that have OTTO aggregate with a factory-installed system for supplying the propulsion aggregate with gasoline fuel, and which were subsequently fitted with a system for supplying the propulsion aggregate with LPG.

The test covered vehicles with 2.0 aggregate. The test vehicles had a different unit code. Two test vehicles had the code number of aggregate the AZJ, while three vehicles had the code number AQY, whose technical data for aggregates are shown in Table 3. Technical data for the tested vehicles are given in Table 2.

Table 2. Data of test vehicles with 2.0 aggregate of 85 [kW]

Tested vehicle	Chassis number	Aggregate number	The year of production	Mileage	Tested date
Vehicle 1	WVWZZZ1JZ3W640883	AZJ070012	2003	264591 [km]	02.05.2020.
Vehicle 2	WVWZZZ1JZ3W639445	AZJ070177	2003	236769 [km]	08.10.2020.
Vehicle 3	WVWZZZ1JZYW648070	AQY047085	2000	229391 [km]	27.09.2020.
Vehicle 4	WVWZZZ1JZ1W670184	AQY201396	2001	207512 [km]	21.08.2020.
Vehicle 5	WVWZZZ1JZYW227642	AQY037748	1999	219537 [km]	09.06.2021.

Table 3. Data of AZJ and AQY aggregates

Description	Value	Value
Aggregate code	AZJ	AQY
Number of cylinders	4	4
Number of valves	8, OHC	8, OHC
Aggregate volume	1984 [cm^3]	1984 [cm^3]
Stroke/piston diameter ratio	82,5/92,8	82,5/92,8
Compression ratio	10,5:1	10,5:1
Maximum power	85 [kW] at 5400 [rpm]	85 [kW] at 5200 [rpm]
Maximum torque	175 [Nm] at 2400 [rpm]	170 [Nm] at 2400 [rpm]
Compression pressure	10 – 13 [bar]	10 – 13 [bar]
Oil pressure	Minimum 2,0 [bar] at 2000 [rpm] and temp. 80 [^{0}C]	Minimum 2,0 [bar] at 2000 [rpm] and temp. 80 [^{0}C]
Type of unit control	Bosch Motronic ME 7.5	Bosch Motronic M 5.9.2.
Spark plug type	NGK PZF R5 D-11	NGK BKUR 6ET-10
Permissible clearence between spark plug electrodes	1,0 - 1,1 [mm]	0,9 - 1,1 [mm]
Ignition schedule	1-3-4-2	1-3-4-2
Fuel supply pressure	2,5 – 3,0 [bar]	2,5 – 3,0 [bar]
Minimum vacuum pressure on the intake manifold	590 [mbar]	590 [mbar]

5 Experimental testing of the power of OTTO aggregates

The shape of the towing characteristics of the car is influenced by the external characteristics of the installed aggregate, but also the applied transmission, as well as the dimensions of the drive tires. The external characteristic of the aggregate includes all its most important parameters, ie. it represents a form of obtained mechanical energy that has reached the flywheel of the aggregate and which represents the display of available energy at the entrance to the transmission [1].

In transmission, the unacceptable form of energy received from the powertrain (too many revolutions and insufficient torque) is transformed into the shape needed on the car's drive wheels. During this transformation, part of the available energy will be converted into an unwanted form (heating of the transmission, noise ...), resulting in a smaller or larger loss of energy obtained from the aggregate. Part of the total energy produced that reaches the drive

wheels in an acceptable form will be used to perform the basic function of the motor vehicle, its movement.

Some of the parameters that determine the obtained available energy for driving a motor vehicle on its wheels can be calculated, ie. to predict, but some of them are not always simply predictable. That is why it is very important, in certain situations, to perform tests on a specific vehicle, in order to determine its actual performance, which gives the motor vehicle user a clear picture of what he really has at his disposal [1].

Tests of traction characteristics of the vehicle, ie its performance can be performed on the road (polygon) or can be tested in stationary conditions. Since stationary test conditions provide much greater benefits, as well as greater comfort, solutions have been found that enable this, primarily through devices for testing traction characteristics in stationary conditions, or devices called dynamometers.

A chassis dynamometer is most often used for such tests, because it is very suitable for testing the performance of vehicles for different road load conditions, control operating modes, as well as checking the legally prescribed technical characteristics of vehicles.

The research presented in this paper was performed at the Technical Laboratory Center of the Faculty of Traffic and Transport Engineering Doboj, using a chassis dynamometer *AVL Roadsim Chassis Dyno 48 "4WD MiM´´* manufactured by AVL Austria, which belongs to the class of very precise meters for measuring vehicle traction and belongs to the group of active dynamometers . This chassis dynamometer is equipped with roller sets on which vehicles with front, rear and all four wheel drive can be tested. The device is primarily designed and intended for testing motor vehicles in various road load conditions at different speeds (from 0 to 200 [km/h]). It enables very precise measurement of: vehicle speed and acceleration, traction force on the roller surface, power on the drive wheels, power of the aggregate, torque of the aggregate, rolling resistance of the vehicle. With the use of additional equipment, it can be used to measure vehicle exhaust emissions, fuel consumption, noise, etc.

Figure 3 shows one tested vehicle on the chassis dynamometer *AVL Roadsim Chassis Dyno 48 "4WD MiM´´* in the laboratory for testing motor vehicles of the Faculty of Traffic and Transport Engineering Doboj.

Fig. 3. Tested vehicle on chassis dynamometer

6 Test results

The measured engine power was performed by laboratory testing when the propulsion aggregate, ie the vehicle, was powered by gasoline or liquefied petroleum gas. Six measurements were performed for all vehicles, three measurements when the propulsion aggregate was supplied with liquefied petroleum gas and three tests when the propulsion aggregate was supplied with gasoline. The test was repeated in order to check the repeatability of the measurement results and obtain the most accurate results.

Table 4 shows the measured engine power for each tested vehicle with propulsion of the gasoline and LPG.

Tabela 4. Power of tested vehicles

Tested vehicle	Chassis number	Power on gasoline	Power on LPG
Vehicle 1	WVWZZZ1JZ3W640883	83,475 [kW]	80,345 [kW]
Vehicle 2	WVWZZZ1JZ3W639445	84,138 [kW]	81,849 [kW]
Vehicle 3	WVWZZZ1JZYW648070	82,576 [kW]	79,603 [kW]
Vehicle 4	WVWZZZ1JZ1W670184	81,972 [kW]	79,013 [kW]
Vehicle 5	WVWZZZ1JZYW227642	84,358 [kW]	81,136 [kW]

Here it is very important to note that in all measurements, the correction of the net power of the aggregate was performed depending on the atmospheric conditions. The power factor includes a correction factor that takes into account air temperature, humidity and air pressure, so that accurate test data are obtained that are considered physically relevant regardless of weather conditions. After testing the power of aggregate on the chassis dynamometer, the measured net power of the aggregate is corrected depending on the type of tested aggregate. Correction of net power of aggregates depending on atmospheric conditions is performed in accordance with the directive EC 80/1269/ISO 1585.

Then, the analysis of the obtained laboratory measurements was performed using the comparative method. Table 5 shows the percentage of power drop for each of the tested vehicles running on LPG in relation to running on gasoline. Based on the presented results, it can be seen that in all tested vehicles, the power of the aggregate decreased when running on liquefied petroleum gas. The largest decrease in power was obtained in the test vehicle number five and it is 3.82%, and the smallest decrease in power is in the test vehicle number two and it is 2.72%.

Table 5. Percentage of aggregate power drop during LPG operation

Data	Vehicle 1	Vehicle 2	Vehicle 3	Vehicle 4	Vehicle 5
Vehicle power on LPG [kW]	80,345	81,849	79,603	79,013	81,136
Vehicle power on gasoline [kW]	83,475	84,138	82,576	81,972	84,358
The decrease in the power of the aggregate on LPG in relation to gasoline (%)	**3,75**	**2,72**	**3,60**	**3,61**	**3,82**

Figure 4 shows the results of measuring the power and torque of one of the tested vehicles during its operation on gasoline.

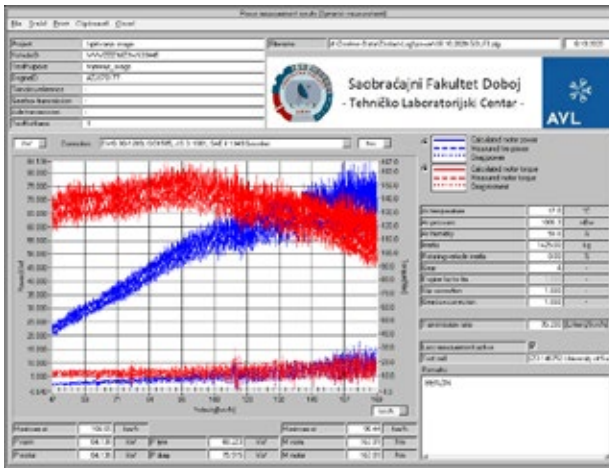

Fig. 4. Measurement results of one of the tested petrol-powered vehicles

The diagram in Figure 4 shows the different measurement results obtained, and within this research the most important are:

- the maximum power of the vehicle's aggregate is 84,138 [kW],
- the maximum torque of the aggregate is 167.01 [Nm].

Also, Figure 5 shows the results of measuring the power and torque of one of the tested vehicles during its operation on liquefied petroleum gas. This is the same vehicle for which the measurement results are shown in Figure 4.

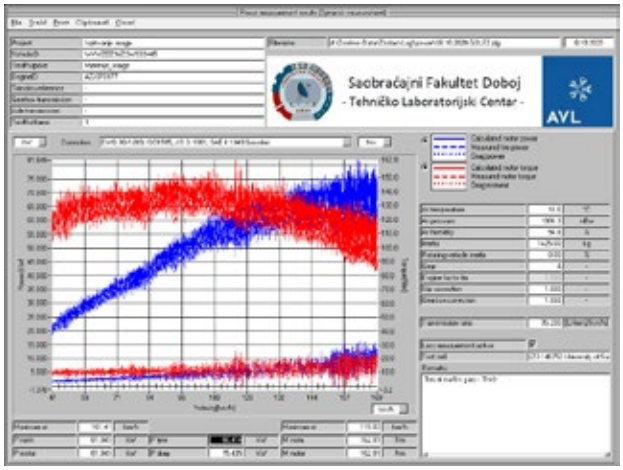

Fig. 5. Measurement results of one of the tested vehicles with LPG system

The diagram in Figure 5 shows the different measurement results obtained, and within this research the most important are:

- the maximum power of the vehicle's aggregate is 81,849 [kW],

- the maximum torque of the aggregate is 162.81 [Nm].

For a given aggregate whose measurement results are given in Figures 4 and 5, a decrease in the power of the aggregate when working on liquefied petroleum gas by 2.72% compared to its work on gasoline. Figure 5 shows that the torque diagram of the propulsion aggregate has slightly lower values compared to the torque diagram of the same propulsion aggregate in Figure 4. The reason for the lower torque is operation on liquefied petroleum gas, which resulted in lower traction. drive wheels. The end result was lower power of the propulsion aggregate when working on liquefied petroleum gas. As with this aggregate, this was the case with all other tested aggregates.

When the power ratio of gasoline and liquefied petroleum gas was determined, the search for average values was performed for all tested vehicles, and the obtained result of the average power drop when working on LPG is 3.50%.

The lack of research is that when measuring the power of propulsion aggregate, the analysis of the quality of propellant fuels used to supply the aggregate was not performed. In order to eliminate this shortcoming, the certificates of quality control of fuels used during the research were obtained from the authorized distributor, ie from the gas station where the fuel was poured. Based on these certificates, it was stated that the quality of fuel meets the prescribed standards for used fuels.

7 Conclusion

Power measurements were performed on an *AVL Roadsim Chassis Dyno 48“ 4WD MiM´´* chassis dynamometer. These measurements gave the results of the power of the aggregate for five Volkswagen vehicles running on gasoline and LPG. It is characteristic that all tested vehicles had lower power of the aggregate when working on LPG in relation to the power when working on gasoline. The smallest percentage drop in power of the aggregate when working on LPG was measured at 2.72%, and the largest percentage drop in power was 3.82%. The mean value of the percentage power drop for all tested vehicles is 3.50%.

Most of the research has been based on tests of exhaust emissions from the operation of LPG motor vehicles in relation to petrol and /or diesel fuel operation. These studies have proven that LPG is a much more environmentally friendly fuel compared to the aforementioned fossil fuels.

As part of this work, research has shown that the performance (power and torque) of the aggregate during its operation on LPG compared to gasoline is slightly worse. From the point of view of the average driver, this drop in power in real operating conditions is extremely difficult to notice.

In some future research, should be tested more vehicles of different types and manufacturers in order to make the results more relevant. Also, in addition to examining the already mentioned performance and environmental characteristics of the research, it should also focus on the consumption of LPG in order to obtain economic indicators of the justification of driving on this fuel.

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The impact of decarbonization on IC engine performance

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Abstract

Measurement of vehicle parameters before and after the decarbonization process is the main subject of research of this paper. Before the decarbonization process, a laboratory test of the passenger vehicle was performed, after the laboratory test, the decarbonization process was performed with a device based on water and electricity, without the use of chemicals to avoid harmful by-products, after which the laboratory test of the vehicle was performed again. The paper presents the results of vehicle performance testing in terms of exhaust emissions, engine power and fuel consumption before and after the decarbonization process. After the obtained results, a comparative analysis was performed, which aims to show the extent to which the decarbonization process contributes to the reduction of harmful gas emissions, as well as the impact of decarbonization on the power of the propulsion engine and fuel consumption. The obtained results indicate the possibility of further research in this field, due to the benefits that this process brings to vehicles, owners and the environment.

Keywords: *IC engine, decarbonization, exhaust emissions, engine power, fuel consumption.*

1 Introduction

The accelerating economic growth and development in the world is causing a rapid growth of road traffic, which leaves undesirable and unpredictable consequences for man and the environment. According to research, the largest and most toxic pollutant from motor vehicles is carbon monoxide (CO), which creates air pollution of more than 60%, followed by hydrocarbons (CH) 17%, sulfur oxide 14% and other oxides 5-8% [3]. The most obvious negative health impact of car emissions is on the respiratory system. It is estimated that air pollution, of which vehicle emissions are the main exponent, is responsible for 24000 premature deaths in the UK each year [3]. Many of these deaths are due to asthma, bronchitis and other diseases of the respiratory system - all of which are known to be aggravated by exposure to harmful gases from cars. In order to reduce exhaust emissions, the European Union is introducing standards that set limits on exhaust emissions. Also, the use of alternative fuels is becoming popular, and procedures are being used to reduce harmful emissions of diesel engines, such as measures on the engine itself and subsequent treatment of exhaust gases.

Speed characteristics represent the dependence of power, torque, consumption and other parameters on the speed of rotation. Speed characteristics are of general importance because they show the behavior of the number of revolutions and loads, and they are especially important for motor vehicles [1].

The economy of engine operation is driven by the specific effective fuel consumption. The specific effective fuel consumption is inversely proportional to the effective efficiency.

According to the above, all further research in the field of motor vehicles is aimed at reducing environmental pollution and economic viability. One of the factors that enables these theses, both in terms of reducing environmental pollution and reducing fuel consumption, and in extending the service life of IC engines is the process of decarbonization of engines [2].

In this paper, a test was performed on a passenger vehicle in terms of exhaust emissions, fuel consumption and engine power. The testing of the mentioned performances was initially performed in the Technical-Laboratory Center, after which the process of decarbonization of the engine was performed. Then a re-measurement was performed based on the mentioned performances.

2 Research methodology

The test process was performed on a Renualt passenger car. Initially, the exhaust emission test was performed on a device that is part of the installation of the technical inspection station, it is a test to which all vehicles are subject to regular technical inspection. The obtained results indicate the amount of CO_2 emissions as well as other gases. Then, the vehicle was placed on the installation within the Technical-Laboratory Center, where the test regarding the power and fuel consumption of the motor vehicle was performed. The laboratory in which the testing was performed is one of the three laboratories within the Technical-Laboratory Center. It is a laboratory for testing vehicles, in addition to which there is also a laboratory for testing engines, as well as a laboratory for combustion and environmental protection.

The laboratory for testing motor vehicles is equipped with a chassis dynamometer "AVL Roadsim Chassis Dyno 48" manufactured by AVL Austria. Some of the parameters that determine the obtained available energy for driving a motor vehicle on its wheels can be calculated, ie. to predict, but some of them are not always predictable in a simple way, for this reason an executive laboratory test is necessary. Tests of the traction characteristics of the vehicle, ie. its performance, can be performed on the road (polygon), or they can be tested in stationary conditions. Devices that enable tests of traction characteristics in stationary conditions are called dynamometers. The main purpose of testing motor vehicles on a chassis dynamometer is to accurately map the load conditions of the vehicle, as in real driving conditions on the road.

After testing the performance of vehicle in terms of exhaust emissions, fuel consumption and engine power, the process of decarbonization of the engine was performed. Engine decarbonization is based on the principle of filter cleaning. Particles generated during the combustion process of diesel engines can be efficiently removed by a particle filter that is placed in the exhaust manifold. As the filter becomes increasingly saturated with particles, a layer of particles forms on the surface of the walls on the opposite side from the inlet. This provides greater efficiency for the next phase of filtering. The DPF filter can become clogged for a variety of reasons, such as constant city driving and short distances where the DPF filter is unable to reach the desired particle combustion temperature inside, a injector failure where combustion is incomplete, and too rich a mixture of fuel and air. Also an example, if the air flow meter is dirty or damaged, which injects too much fuel, the nozzles can be damaged and inject excess fuel, which causes the engine and engine oil to overheat. If the filter is partially dirty, decarbonization of the engine can help. The introduction of HHO gas (oxy-hydrogen gas) affects the decomposition of carbon deposits that are emitted from the engine in the gaseous state through the exhaust system.

Carbon dioxide deposits, which form on parts of internal combustion engines, are present in every vehicle in traffic. Oil, too much enriched fuel mixture or of poorer quality, the city's 'start-stop' way of driving, all this causes faster carbon accumulation. A thin layer of carbon should not pose major problems, but its accumulation can cause them. Carbon deposits can significantly affect vehicle performance such as reduced power and torque, engine tremors, frequent stagnation in cold weather, increased exhaust gas concentrations, and fuel consumption.

The decarbonization process was performed using a nonCarbon device. NonCarbon devices work by electrolyzing water to create oxygen and hydrogen gases, which are then combined into a new fuel. By using HHO gas, the risks of storage and transport are eliminated because the gas mixture is created on demand, currently on site.

Oxy-hydrogen gas can be used to clean carbon deposits in the engine and thus improve the performance of the vehicle's engine. The only by-product in oxy-hydrogen combustion is water vapor. Neither carbon nor any other toxic substance is produced in the process. Oxy-hydrogen energy can be used as an additive to standard fuels such as gasoline, petroleum, oil, heating oil, acetylene, propane or liquefied petroleum gas. The process of decarbonization on the passenger vehicle lasted 60 minutes.

Finally, after the decarbonization process, a new measurement of exhaust gases was performed at the technical inspection station. Then, the performance of the vehicle in terms of power and exhaust emissions was measured within the Technical-Laboratory Center.

3 Results

Motor vehicles are the largest single source of air pollution. The exhaust gas of a gasoline engine contains a whole range of gases that result from combustion, and can be roughly divided into harmful and non-harmful gases. When emitting harmful gases from motor vehicles, there are two types of gases: motor exhaust gases - combustion products and emission of easily volatile components from fuel.

In order to contribute to the reduction of environmental pollution from the aspect of motor vehicles, one of the factors is the decarbonization of engines.

Therefore, a laboratory test of exhaust emissions was performed in this paper.

The obtained results in terms of exhaust emissions indicate that the decarbonization process has contributed to the reduction of the exhaust content of the motor vehicle. Table 1 shows the data of the degree of blackening before the decarbonization process.

Table 1. Results of degree of blackening before decarbonization

Acceleration N°	Blackening (m^{-1})	Rpm min.	Rpm max.
1	0.17	1110	2020
2	0.19	1200	2400
3	0.13	1150	2830

The results obtained during the first measurement indicate an average degree of blackness in the amount of 0.16 [m^{-1}].

Table 2 shows the results of the degree of blackening after the decarbonization process.

Table 2. Results of degree of blackening after decarbonization

Acceleration N°	Blackening (m^{-1})	Rpm min.	Rpm max.
1	0.05	1010	1710
2	0.01	940	1670
3	0.00	850	1650

The average degree of blackness during repeated measurement (measurement after decarbonization) is 0.02 [m^{-1}].

Comparing the obtained results in terms of the degree of blackening before and after the decarbonization process, they indicate that the degree of blackening was reduced by 0.14 [m^{-1}]. Fuel consumption is a factor that defines the economic viability of the decarbonization process. Fuel consumption testing was performed by road load simulation in real operating conditions at a speed of 80 [km/h] and at 1500 [rpm]. The results of fuel consumption before the decarbonization process are shown in Figure 1.

Fig. 1. Fuel consumption before decarbonization

Fuel consumption in the mentioned operating conditions is 5.00 [l/100km] (Figure 1).

Figure 2 shows the results of fuel consumption after the decarbonization process.

Fig. 2. Fuel consumption after decarbonization

Repeated measurement, under identical operating conditions, indicates a fuel consumption of 4.40 [l/100km] (Figure 2).

Conducted tests in terms of fuel consumption before and after the decarbonization process indicate that the decarbonization process has reduced fuel consumption by 9%.

In addition to the test regarding the emission of exhaust gases and the reduction of fuel consumption, a test was performed regarding the

power at the drive wheels before and after the decarbonization process.

Power tests at the drive wheels were performed during the simulation of real working conditions within the Technical-Laboratory Center. During the test, the air temperature was 4.10 [°C], the atmospheric pressure 1013.60 [mBar], while the humidity was 50%

The test results before the decarbonization process are shown in Figure 3, where the power obtained is 100.018 [kw].

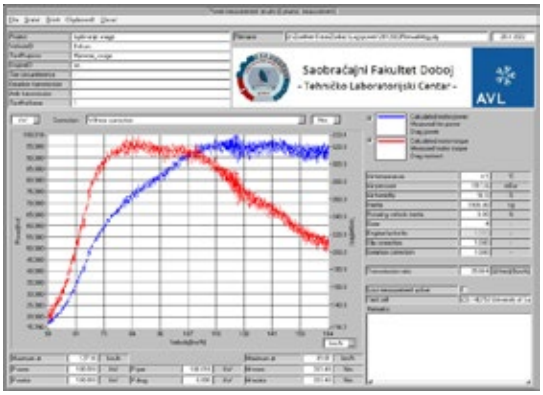

Fig. 3. Engine speed characteristic before decarbonization process

Then a new measurement was performed after the decarbonization process, simulating identical operating conditions as in the first case. The obtained results are shown in Figure 4. The results after the decrabonization process in terms of power indicate an increase in power from 100.018 [kw] to 105.240 [kw].

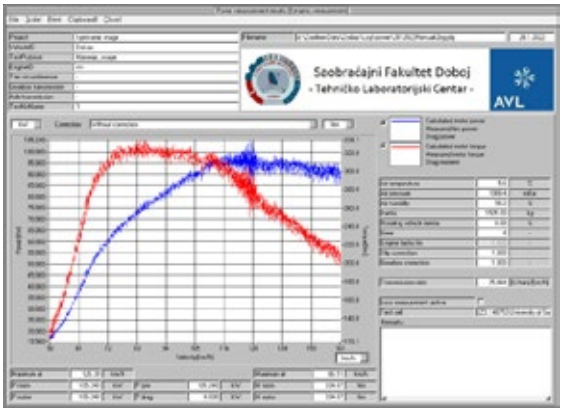

Fig. 4. Engine speed characteristic after decarbonization process

The obtained results also confirm the third thesis that dearbonization based on distilled water, in addition to contributing to the reduction of environmental pollution and reducing fuel consumption, also increases the power of the propulsion engine.

4 Conclusion

Road traffic largely affects the environment, in a way that pollutes the air with exhaust gases. Each liter of combustible fuel causes the release into the atmosphere of about 100 [g] of carbon monoxide, 20 [g] of various organic compounds, 30 [g] of nitrogen oxides, 2500 [g] of carbon dioxide and a number of other compounds [3].

Due to the huge increase in the number of motor vehicles that use internal combustion engines, legislation has long been introduced that limits the level of toxic components of exhaust emissions. One of the measures to reduce environmental pollution and emissions from internal combustion engines is decarbonization of the engine, which leads to a reduction in emissions and the degree of blackening. According to the obtained results, the degree of blackening decreases by 87.50%. In addition to testing the emission of harmful gases during vehicle operation, the basic engine quantities also play an important role: effective power, torque, crankshaft speed, hourly fuel consumption and specific effective fuel consumption. These values are a function of the engine mode, so the characteristics of the engine are the dependence of these values on the engine mode. Based on the conducted research, it can be concluded that the decarbonization process, in addition to reducing fuel consumption, also leads to an increase in some of the vehicle performance, such as fuel consumption and power of the engine. In addition, decarbonization contributes to extending the service life of internal combustion engines.

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Shipment delivery challenges using unmanned aerial vehicles

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Abstract

A UAV (Unmanned Aerial Vehicle) is an unmanned aerial vehicle or aircraft that can be monitored remotely or flown independently using a pre-programmed flight plan. Simply, a drone is a self-propelled vehicle heavier than air. From their beginnings and first forms to modern drones as we know them today, people have discovered many areas for their application. As the power and carrying capacity of drones has grown, so does the possibility of using them for different purposes such as logistics and postal services. The main advantage of drones in urban areas is the independence from road infrastructure and fast delivery, but several challenges need to be addressed for this type of delivery to be competitive with other modes. Many projects have dealt with this topic, but none of them has widespread use to this day. In this paper, we will present the basic challenges that arise in the use of drones for shipment delivery. The paper will present activities that should be prioritized to make a competitive type of service. The paper will present also the advantages over other types of shipment delivery and the current limitation with a future possible research area.

***Keywords**: Unmanned Aerial Vehicle, logistic, shipping, challenges*

1 Introduction

The emergence of modern technologies has conditioned the development of new, modern concepts around the world. These concepts are the answers to today's growing challenges, such as reducing environmental pollution and traffic congestion, increasing accuracy and reliability in the delivery of products/services, and automating all aspects of everyday life, all to facilitate and improve quality of life.

Logistics, as one of the special areas of business that contributes to positive economic results, has long been the subject of research and analysis of opportunities for improvement and modernization. Development of new techniques and technologies has contributed to the emergence of smart tools for overcoming numerous challenges in the supply chain.

Increasing demands for logistics services are also contributing to increased environmental pollution. Precisely for these reasons, in the realization of such growing demands, special attention should be paid to finding solutions for the provision of logistics services under more favorable conditions for the environment, as well as human health and life.

The daily increase in demand for e-commerce requires efficient and effective logistical support. In order to respond to the growing demands of the market, it is necessary to modify existing logistics methods and introduce new, more modern, efficient and effective working principles on which logistics processes will be based.

In everyday speech, the term "drone" is mostly used for drones, although there are essentially some differences between the two. In this paper, the focus will be on drones that are autonomous, because only an autonomous system in terms of costs is an advantage over other types of logistic delivery.

Only in very special situations, drones will be able to replace traditional urban delivery methods, but they emerge also as an option to complement existing delivery networks [1]. Within the e-commerce business, delivery time is paramount when choosing a carrier. Drones would enable a fast delivery to a predetermined point, without much human activity and other resources required for transport [2]. In particular, Amazon claims that in the case of e-commerce, 86% of the packages weighed less than 5 pounds

[3]. In terms of distance, Walmart claims that 70% of the customers were located within 5 miles of a center [1]. The transformation of the logistics sector that has taken place in the past decade has been significantly marked by the introduction of drones into the logistics system, more precisely: the involvement of drones in logistics processes has become a noticeable and significant element of these processes.

2 Research review

Article [1] states that drones will be used for special situations, especially for inaccessible areas, but they will also be used as an additional activity to classic types of delivery. It is also stated that their advantage is in urban areas and that they can be used in combination with other vehicles. Also, a large percentage of respondents are not familiar with these technologies according to paper [4]. This paper critically examines the research on public acceptance of drones finding the conflation of a diverse range of drone applications has led to ambiguity in the prevailing concerns and that the absence of clear parameters for drone use in local transport environments limits scope to develop informed opinion [5]. The goal of this paper is to analyze four city logistics concepts that differ in consolidation type, transformation degree of flow of goods (direct and indirect, multi-echelon flows), and the role of drones [6].

Authors in paper [7] state that automation enables further growth of postal traffic and also the development of innovative technologies that reduce the cost of shipment delivery, which allows postal operators to create new and better services that ultimately lead to more satisfied users.

Article [2] analyzed the cost-effectiveness replacing motorized delivery with a drone - a case study showing the benefits and cost-effectiveness analysis of the use of drones making the comparison of delivery costs with a light delivery vehicle and a drone.

To compare these costs with the costs of a drone, it was necessary to show the cost of delivery of a light delivery vehicle over a length of 16 kilometers (given that the radius of the drone from the base station is 16 kilometers).

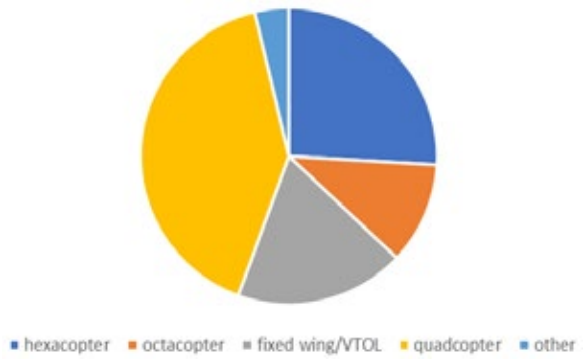

Fig. 1. The type of drones currently in use for logistics purposes

The obtained price per kilometer is divided by an average of 40 packages in the vehicle, which represents the final cost of delivery of one package within a radius of 16 kilometers, which is 4.8 HRK. For a drone, the cost per package is 8.11 HRK. The amount was obtained by putting it in a relationship; the price of the drone and its software increased by the number of required drones divided by the average number of packages shipped to city of Zadar.

Paper [8] presented a multimodal mode of transport where unmanned road robots are used in combination with unmanned aerial vehicles. This has been particularly significant in pandemic conditions where physical contact with humans has been reduced to a minimum.

A review of the literature revealed that there are many more review papers than case studies and classical research papers, which represents a great potential for future research. Paper [9] explores central issues to be addressed and briefly discusses and outlines a number of interesting new research pathways relevant to drone-based package delivery systems.

This study [10] reveals that regulations (R) and threats to privacy and security (Th) are the most critical barriers to drone implementation in the logistics sector. Other important obstacles are public perception (P), environmental issues (En), technical aspects (Te) and economic aspects (Ec), in descending order of their criticality. When we compare UAVs with road transport and if the road route has direct costs, such as tolls, and parking fees, then delivery by drone is better in terms of costs [2].

Paper [11] emphasizes insufficient research where the actual parameters of the drone are examined (battery, endurance, payload, and where the drone would operate in complex

trajectory conditions (congestion, meteorological situation, changing obstacles). There is also a lack of research where drone-based logistics models would be examined and to find under which circumstances they would really be more competitive than conventional types of shipment delivery. Most of the work examining drone performance took into account one drone or one pair of drone-vehicle. It is necessary to investigate the performance indicators of the system and how it will behave in relation to other types of delivery.

In addition to the academic community, a large number of shipping companies have launched their research programs and pilot programs where they have used different delivery methods as well as different types of drones as we can see in figure 2 and 3.

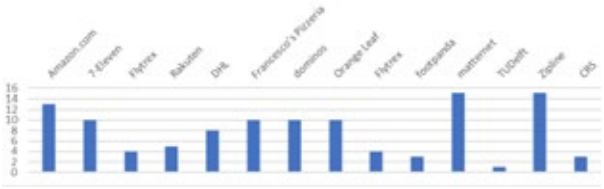

Fig. 2. Delivery time in logistics (minutes) [11]

We can see the drones already used to deliver shipments by different companies. Most of the drones are VTOL aircraft and have a relatively low speed. Fixed-wing aircraft have higher speeds but are not suitable in urban areas where high maneuverability is required. The following graph shows the range of individual aircraft.

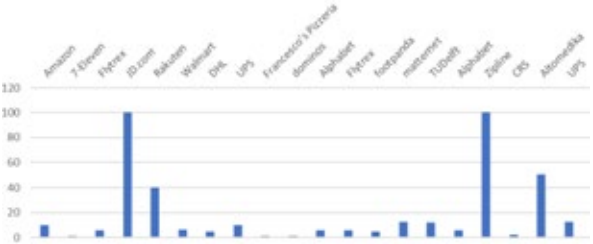

Fig. 3. Drone range for logistics purposes (miles) [11]

3 Type of drones used in logistics

The largest number of drones used in shipment delivery are fixed-wing drones. Fixed-wing and rotorcraft UAVs, classified based on the way lift is generated. Fixed-wing UAVs are similar to passenger carrier aircraft in which the wings are used to provide lift while a jet engine provides the forward thrust for take-off.

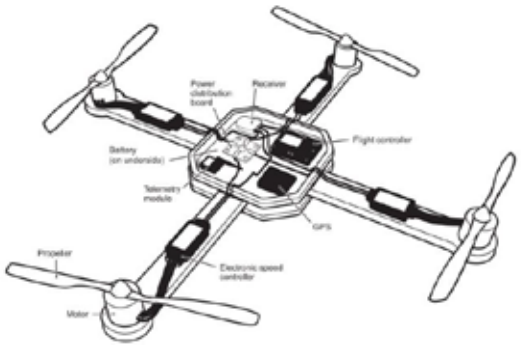

Fig. 4. Drone components

A drone system includes the airframe and propulsion system and a typical airframe includes a fuselage and a landing gear (Figure 4). The fuselage acts as the platform to carry all the equipment of a drone. For a well-designed drone, all factors including the scale, shape, material, strength, and weight should be carefully taken into consideration. The weight of the fuselage is mainly determined by its size and material. Propulsion system includes a propeller, motor, battery, and Electronic Speed Controller (ESC).

A propeller is a component that provide the thrust force and torque to control a drone. The propeller model is described by a four-digit number, such as a 1045 (or 10 × 45) propeller, among which the first two represents the diameter of the propeller, and the latter two represent the propeller pitch. [12].

Depending on the mission requirements, a rotorcraft aerial robot can have two, three, four, six, or more rotors (Figure 5), most commonly driven by electrical motors supplied by power from the electrical battery (somewhat less common, but still available, are fuel cells). For heavier payloads, 2-stroke small-scale internal combustion engines are used to drive rotors.

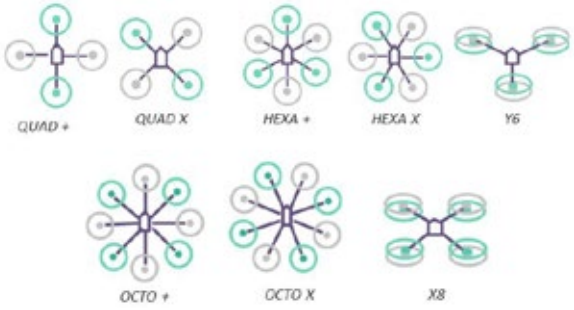

Fig. 2. Configurations of multicopters [13]

Choosing appropriate propellers is a direct way to improve the performance and efficiency of a drone (thrust vectoring).

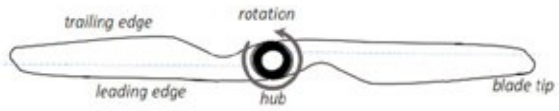

Fig. 3. Basic nomenclature of drone propellers

Drone motors are mainly brushless DC motors (Figure 7) for the various advantages such as high efficiency, potential to downsize, and low manufacturing costs. Brushless DC motors are used to convert electrical energy (stored in battery) into mechanical energy for propeller.

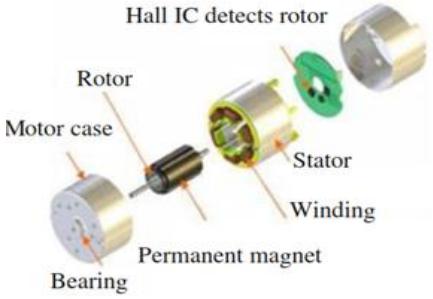

Fig. 4. Brushless drone DC motor

The overall performance of the propulsion system depends largely on a well-matched combination of motor (nominal voltage 10-24 V).

The drone would be able to be powered only with internal power in the form of batteries which limits the power received and the time in which it is able to fly, while at the same time being able to perform VTOL. There are many types of batteries, where the Lithium Polymer (LiPo) battery and Nickel Metal Hydride (NiMH) battery are the most commonly used ones because of superior performance. The basic parameters of the battery include voltage, discharge capacity, internal resistance, and discharge rate. The nominal voltage of a single cell of LiPo battery is 3.7 V

The basic function of Electronic Speed Controller (ESCs) is to control the speed of motors based on the signal that autopilots send, which is too weak to drive brushless DC motors directly.

The milliAmpere-hour (mAh) or is a technical index that how much electrical charge a particular battery has. The capacity of 5000 mAh for a LiPo battery means that the discharge of the battery will last for an hour with the current of 5000 mA when the voltage of a single cell is decreased from 4.2 to 3.0 V [12]. Energy density is the amount of energy stored in a given system or region of space per unit volume or mass named specific energy are (Watt × hour)/kg.

An RC transmitter is used to transmit commands from remote pilots to the corresponding receiver. Receiver, passes the commands to the autopilot after decoding them and multicopter flies according to the commands.

A drone autopilot is a flight control system used to control the attitude, position, and trajectory of a drone. It can be semi-automatically (needs commands from remote pilot) or fully automatically. Autopilots have a control framework which is often based on Proportional-Integral-Derivative (PID) controllers, leaving parameters to be tuned for different drones. GNSS receiver is used to obtain the location information of drone [12].

Radio telemetry refers to using Digital Signal Processing (DSP) technology, digital modulation and demodulation, radio technology to transmit data with high accuracy, and it is equipped with functions of forward error correction and balanced soft decision.

4 Results and discussion

Several problems still need to be addressed for this mode of transport to be competitive. In addition to the design and capabilities of the aircraft, it is necessary to develop aditional infrastructure in cities that would be favorable for drone operations. The introduction of drones into the existing distribution system requires major changes and adaptations. Some of these changes include the construction of take-off and landing facilities, battery charging sites, the assignment of drone truck adaptations, changes in surveillance systems and regulation of drone navigation capabilities. There are also currently very active services and expansion of e-commerce and some of the innovative solutions of city logistics are PUDO (Pick up and drop off), delivery technology in the last mile and is based on delivery using parcel machines. Systems that rely on small autonomous delivery robots are also in use. Delivery robots represent a new opportunity to improve last mile delivery concept in urban areas. Based on previous research, an overview of the advantages and disadvantages of using drones in logistics is given in the next table.

Table 1. Drone advantages and deficiencies

ADVANTAGES	DEFICIENCIES
Inaccessible and remote sites operation	Limited capacity, range, duration and weight of batteries
Autonomous unmanned systems	Limited operations in adverse weather conditions
Vertical takeoff and landing	Signal strength, loss of signals
Lower maintenance costs compared to conventional aircraft	Danger of injury or damage to property from drone falls, especially in urban areas
Adequate for last-mile delivery, especially in urban areas	Noise pollution
Low environmental impact	Privacy and security and distrust of people
High-speed delivery	Air traffic regulations/use of airspace
Advantages of multimodal delivery - the possibility of combining with other modes of transport	Limited infrastructure on the ground for safe and secure delivery of the shipment to the user
Suitable for cities where there is large urbanization on uneven terrain (easier access by drone from vehicles)	Obstacles in urban areas (power lines, trees, buildings)
Great development potential, especially in the field of artificial intelligence that will relieve the human need to manage this type of shipment.	Cyber security and package damage
Aircraft with vertical and horizontal flight capabilities (higher speed)	Drones need to be autonomous to be competitive with other types of transport, hence AI, but AI has not yet progressed to that level (drone does not differentiate between person and dog or terrain and pool)
Greater safety and relief of roads	Significant pilot training or development of autonomous systems is required
Substitutes vans and relieves traffic congestion	The cost of transporting drones per unit weight is much higher than many other solutions due to energy-intensive requirements.
	Great competition from traditional methods of shipment delivery

The development of technology and autonomous systems has enabled postal and logistics operators to reorganize and optimize their operations. In its history, drones have been mostly used for military purposes, but with the development of e-trading, it is increasingly used for civilian and logistics purposes.

Drones can provide a lot of advantages over traditional means of transport and ground based delivery. The most crucial factor is the reduced cost of operation and easy management. Delivery services and courier companies can take help of drones to resolve the pain points for last-mile delivery. Drones are set to become the future of logistics with their reduced cost, higher convenience and delivery times of less than 30 minutes. Last-mile delivery of goods is often carried out by vans, most of which have internal combustion engines. Drones may represent a helpful and innovative transport system to decrease environmental and noise pollution and congestion.

With the development of technology and intensive urbanization, the need for logistics services is becoming increasingly important. Drone shipment delivery is one of the innovative methods that has its advantages over classic types of shipments.

The traditional delivery system when it comes to variable and fixed costs is not more expensive than the modern way of delivery by drone. The introduction of this delivery method in Bosnia and Herzegovina would be of great importance, especially since most of the territory of BiH consists of very mountainous terrain as well as large urbanization. This urban first and last-mile use case is probably the most tangible and spectacular in the logistics industry.

5 Conclusion

This paper analyzes the challenges facing this system and provides insight into future needs and research and how to make this method of delivery competitive. The advantages and disadvantages of such type of shipping are given. We conclude that this type of transport still has many obstacles that need to be addressed in the future. Infrastructure and places where drones will move and operate need to be adapted and developed in parallel with drone technology.

Based on this paper, we conclude that drone technology will slowly replace and the human factor in certain jobs and activities in which until then only man was responsible. The use of drones will greatly improve living conditions, but also change the world we know.

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Basics of justification for the construction of the "Sarajevo West" business and logistics zone through the valorisation of the Sarajevo bypass lot 2a for the development of the transport system

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Abstract

Over the next decade, transport and logistics companies will have to adapt to a number of challenges, given the impact of global crises and wars, the impact of the Covid-19 pandemic, as well as the development of artificial intelligence and the rapid expansion of e-commerce. For a long time, business zones were considered a place of centralization of the manufacturing sector, but recently there have been more and more investments in the services and trade area. Today, the modern business zone contains all these branches of the economy and as such should be designed as multifunctional and with developed logistics to meet demands. It is crucial for a successful business logistics zone to choose a location and infrastructure which will make it attractive to the economy.

***Keywords**: Business logistics zone, GTC (Goods Transport Center), Industrial interchange, transhipment terminal*

1. Introduction

The formation of business zones in wider urban zones is an important contribution to the economic development of the city. Due to their non-existence, businessmen are forced to organize themselves, and this cannot induce wider economic development and the development of much-needed supporting logistics at full capacity. Usually, such spontaneous business zones are an obstacle to the proper development of the city and their adequate integration into a meaningful whole. Cities must plan to determine the location and development of regulatory plans with all the contents that form a business zone.

One of the basic preconditions for the formation of these zones are traffic connections and infrastructure. The conducted research and analysis of business zones in the Federation of B&H and the wider region, as well as the analysis of traffic flows and literature used in the subject area, we believe that Sarajevo Canton probably has an ideal opportunity to form a modern business and logistics zone in Butila, given that in a very small radius there is the Motorway on Corridor VC, a railway with a marshalling yard, and an airport. It is important to mention that the railway has a direct connection with the port of Ploče, and in the near future the motorway will also be directly connected to it.

Also, the e-commerce business is developing at an unstoppable rate even before the unexpected recent world events. The time of epidemics and global crisis that are currently happening in the world represent a historic turning point. The number of online orders is the clearest and surest indicator of a completely new way of purchasing goods, and companies operating in the transport and logistics sector cannot ignore it.

The aim of this paper is to emphasize the importance of adapting the transport infrastructure that would give full potential to the development of the business and logistics zone, putting it in the focus of businessmen, both those already operating in Bosnia and Herzegovina and new large entities, whose attention can only be attracted by a modern and affordable business zone. Also, the importance of forming a new modern business and logistics zone in order to develop the Canton and the economy was emphasized.

Today, there are over 130 registered economic zones in the Federation of B&H [1]. Most of these zones are only registered as such and listed in regulatory plans. Also, a large number of active zones were formed rather spontaneously and do not contain all the elements that a business zone should contain.

2. Logistics centres

Logistics centres are one of the most important parts of the logistics network. Commodity flows are inconceivable without a logistics centre, whether it is a space in an urban, national or global area.

The logistics centre can be defined as part of the transport infrastructure, i.e. the focus of material flow in the logistics chain [2]. In other words, the logistics centre is a place of gathering and concentration of goods in which the initial, final and transhipment operations are performed, i.e. the logistics centre is a link in the process of distribution of goods, where the transformation of goods and transport flows takes place.

Logistics centres differ in macro and micro location, organization, technology, development, etc., but they all have a common function – providing complex logistics services.

In modern times, the logistics centre is a technologically equipped facility where goods are not only stored, but also processed and prepared for further distribution to the end consumer. It developed from the traditional warehouse function by increasing the number of functions by applying new techniques and technology and enabling high concentration and fast flow of goods in an increasingly efficient and effective way. It is the new technique and technology that has enabled the continuous optimization of processes in logistics.

Logistics centres are formed with the aim of providing complete logistics services. Although logistics centres are not standardized, they all have some common features, such as receiving and shipping goods, transhipment, warehousing, preparation of supporting documents and more.

Some of the key features for their successful functioning are multimodality, multifunctionality, open access to the location, cargo handling, electronic exchange of information, connectivity of different sectors in order to implement logistics activities and cost savings.

A very important activity of logistics centres is the storage of goods, which includes [3]:

1) storage of goods and cargo units,
2) transhipment of goods within the boundaries of the warehouse area,
3) packing and unpacking of goods,
4) treatment of goods,
5) processing of goods,
6) commissioning,
7) storage of special goods (heavy objects, live animals, frozen goods, etc.).

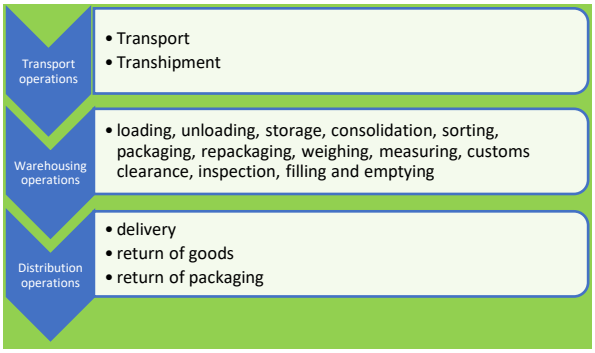

Fig. 1. Logistics centre operations

3. Criteria for choosing the location of the logistics centre

When choosing the location of the logistics centre, various complex procedures are applied. The criteria that need to be considered can be classified into different aspects [4]:

Table 1. Criteria for choosing the location of the logistics centre

TECHNOLOGICAL	ECONOMICAL	ORGANIZATIONAL
-intensity of goods and transport flows -availability of logistic centre -goods delivery time -availability of technologies and types of goods -connection to several modes of transport -availability of intermodal transport terminals, etc.	-logistics cost (transport, storage, supplies, etc.) -location activation costs; -investment in the construction of access roads and infrastructure, - net present value -payback period; -gravity of economically developed economy, etc.	-presence of logistics servers' providers -presence of intermodal transport operators; -possibility of organising line connections in railway/water transport -representative offices, associations, companies in the field of transport and logistics, etc.
TECHNICAL	**ENVIRONMENTAL**	**LEGISLATION**
- geological characteristics of the location -infrastructural network (electricity, water, sewerage, etc.) -technical possibilities of connection to transport infrastructure of railway, air, etc.	-pollution; -noise and vibration; -hazardous materials and goods; -the impact of the environment on the goods in the logistics centre; -the impact of goods and processes in the logistics centre on the environment, etc.	-inclusion and spatial and urban plans; -the possibility of ownership regulation of land and buildings; -harmonization with laws and regulations governing the presence, distance and protection of logistics centre, control and status of goods in the logistics centre; -dangerous goods, etc.

Determining the location of the logistics centre, as a place where services are performed in an optimal way, has a great impact on the

efficiency and cost-effectiveness of logistics services. Planning a new logistics centre is not a one-time process, but a long-term investment that needs to meet a number of different criteria, both at the macro and micro levels [5]. In determining the optimal location, among other things, future economic indicators should be used, but also historical factors. There is a great increase in economic activities at all levels, from local, through regional to international and intercontinental. A significant role in all this is played by supply chains that achieve service quality through their logistics centres. In this way, individual business systems do not have to be treated as competition, but through integration more favourable business results are achieved.

4. Construction and arrangement of business and logistics zone Sarajevo West

Today, there are over 130 registered economic zones in the Federation of B&H. Most of these zones are only registered as such and listed in regulatory plans. Also, a large number of active zones are more spontaneous and do not contain all the necessary elements.

4.1 Construction of business and logistics zone

The location selection of the business and logistics zone of Sarajevo Canton is not accidental. Analysing transport flows depending on the existing exploitation of transport infrastructure (table 2.) and taking into account the optimization of infrastructure exploitation for transport purposes, the proposed location was strategically chosen for the Sarajevo Canton and the Federation of B&H, or the whole of Bosnia and Herzegovina [6]. A location (figure 2) with plots of 55 and 28 hectares was proposed, which would be sufficient for the organization of a business zone. Both proposed plots are owned by CPC "PD Butmir" Ltd. Ilidža (KJP “PD Butmir” d.o.o.), which potentially facilitates the purchase, which would not be the case if it were private property or it had a larger number of owners. It should be noted that in the wider area of the selected location, there is a possibility to expand the business logistics zone up to 50%.

The proposed location, with minimal investment in the organization of transport, integrates road, rail and air transport in one place. The area along the Motorway Corridor Vc near the Rajlovac railway junction and the road connection with Sarajevo International Airport is an ideal area for establishing a business and logistics zone of importance for the capital of our country and our country as a whole. It is important to note that the expressway continues to be built towards the city centre. The City of Sarajevo, as the administrative centre of Bosnia and Herzegovina and Sarajevo Canton, must take over the function of optimizing, channelling and managing transport flows, using internationally defined standards and control criteria, strategic and proper storage of raw materials, semi-raw materials and goods, its distribution with the obligation to control the formation of objective market prices depending on quality. Ultimately, the proposed model must take precedence over the multimodal transport in our country, and it must regulate and optimize transport flows in B&H. Centralized and direct communication with international transport flows is another benefit of the proposed site.

The business and logistics zone "Sarajevo West" in its primary content should include the following:

- Customs terminal - A customs terminal for road traffic with all the necessary accompanying facilities was recently built near the location. The function of this terminal should be extended to rail and possibly air traffic.
- Storage space - For the needs of all three transport branches it is necessary to plan storage capacities depending on existing and future quantities and types of goods. Storage spaces with their capacities will take precedence in the territorial occupation of the proposed space, because storage spaces must receive the storage of all types of goods in all weather conditions, for a longer period of time under specially defined storage conditions.
- Logistic space for receiving, sorting and sending international letters and shipments.
- Oil terminals - Construction of oil terminals in capacities that will satisfy the need for daily needs of distributors of oil derivates and products, but also the creation of commodity reserves of this energy source. The positioning of oil terminals in the area

of the proposed location must be directed towards the exploitation of railway infrastructure and the transport of oil and oil derivatives. However, it should be pointed out that it may be more important to put into operation the existing oil terminal in Blažuj, which already has a very good traffic infrastructure and is very close to this business zone.

- Container storage / loading / unloading terminal - Adapt the function of the container terminal to the needs of road and rail traffic, based on the simple and efficient unloading, loading, reloading and storage of container transport.
- Free zone - Provide all entrepreneurs with a free zone, i.e. without a customs zone and enable storage of imported goods (raw materials, semi-finished products or products) without the obligation to pay taxes until the moment of use of stored goods for final purposes.

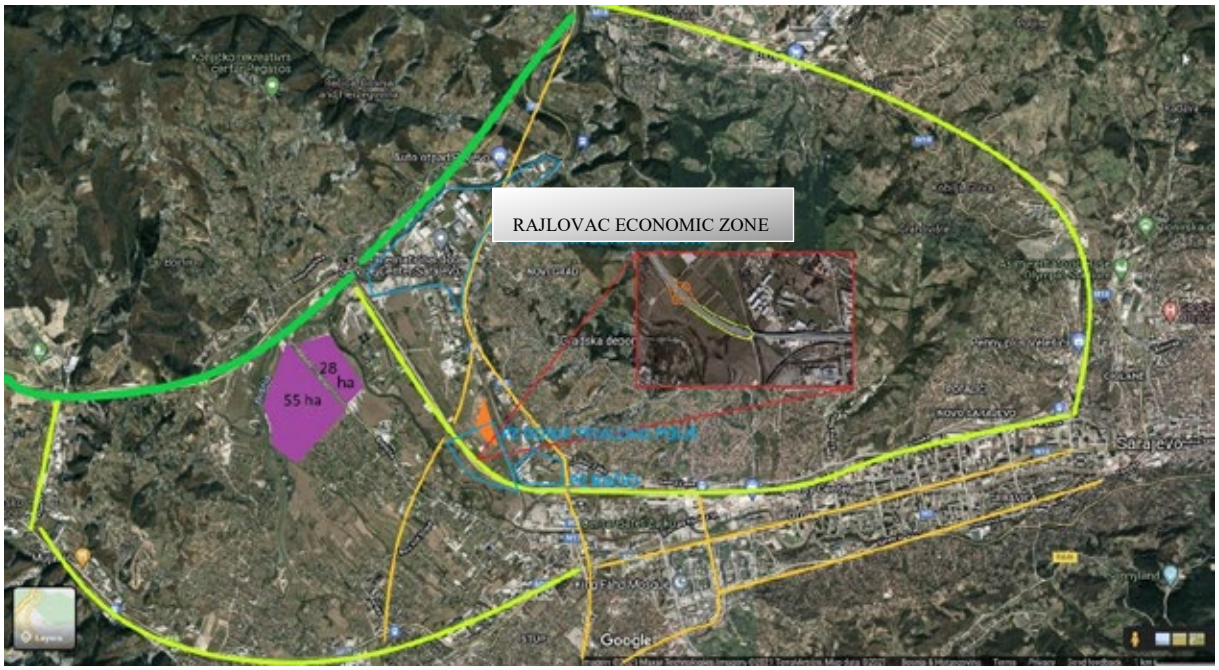

Fig. 2. Overview of the position of the planned business and logistics zone with an overview of existing and planned roads

Table 2. Traffic connection of existing and planned business zones of Sarajevo Canton

Road infrastructure	**Corridor Vc (E73)** as part of TE Corridor V : Kyiv (Ukraine) - Budapest (Hungary / EU) - Osijek (Croatia / EU) - Sarajevo (B&H) - Ploče (Croatia / EU) connecting Central and Eastern Europe with the Adriatic sea and the future Adriatic-Ionian Corridor, ie through Kyiv (Ukraine) and the connection to TE Corridor 9 connects the Black Sea and the Baltic with the Adriatic Sea. TE Corridor Vc also intersects with TE Corridor X, which connects Western Europe with Central and Southern Europe. **M-5 -** (border with Croatia / EU) - B&Hać - Bosanski Petrovac - Ključ – Mrkonjić grad - Jajce - Donji Vakuf - Travnik - Vitez - Lašva - Kakanj - Blažuj - Pale - Rogatica - Ustiprača - Višegrad (border with Serbia) **M-17** – (border with Croatia/EU) – Šamac – Modriča – Doboj – Maglaj – Žepče – Zenica – Kakanj – Sarajevo – Konjic – Mostar – Čapljina – Dračevo – (border with Croatia/EU) **M – 18** – (border with Serbia) – Rača – Bijeljina – Simin Han – Tuzla – Živinice – Kladanj – Olovo – Sarajevo – Trnovo – Foča – (border with Monte Negro)
Railway infrastructure	Railway 11 – Sarajevo – Čapljina Railway 12 – (border with Croatia/EU) Šamac – Sarajevo *Both railways are under category D4:* *- axle load 22.5 tons* *- load per running meter 8 t / m*
Airport	Sarajevo International Airport for passenger and cargo transport *Sarajevo International Airport with a traffic of more than one million passengers a year and a transport of more than two million kilograms of cargo.*
Seaports	Ploče (Croatia/EU) 197 km Bar (Monte Negro) 302 km
River ports	Šamac (Sava river) 212 km Brčko (Sava river) 184 km

4.2 Arrangement of the business logistics zone

The planning of the business and logistics zone of the Sarajevo Canton should be modelled on modern zones of this type in developed cities in

Western Europe. A very important detail in the preparation of the zone area is the continuation of the Miljacka and Bosna riverbeds arrangement due to the protection of the Sarajevo business and logistics zone (this would also protect populated areas in the danger zone from flooding).

When designing a modern business and logistics zone, in addition to the location, the following elements should be taken into account [7]- [9]:

- **Energy independence -** is achieved when the facility produces as much energy as it needs for overall operation. Logistics centres take up a lot of space, and therefore large roof areas are great locations for solar panels. It should be noted that along the zone there are large water capacities (rivers Bosna, Miljacka, Željeznica and Dobrinja), and the proximity of Sarajevogas and CNG Refuelling Stations.
- **Intelligent Building Management Systems** - the installation of various measuring devices and software for building management monitors the use of energy, electricity, gas, water, various utilities; the buildings themselves are getting smarter and enable comprehensive analysis and more efficient energy management, as well as fault detection and timely elimination.
- **Lighting -** lighting participates in the energy consumption of the building with over 30% of costs, and this factor is also taken into account in the design of modern logistics centres; In addition to savings, natural light has a very positive impact on employees, achieving greater efficiency and concentration of employees
- **Automation of warehousing operations** - it is getting more and more difficult nowadays to find a sufficient number of quality workers for this type of work. Duration of warehousing operations is not always predictable, so it is difficult to plan shifts and the required number of employees. In response to the growing shortage of manpower in logistics centres, the use of automation is necessary. Automated systems can perform their operations 24 hours a day, 7 days a week, without the cost of manual manipulation. This approach allows significant savings and a quick return on investment in this technology

4.3 Transhipment Terminal

A freight transport centre should be planned on the marked area, which can be smaller or larger, depending on the needs. This centre is of great importance for the Business and Logistics Zone, given that the location is in an ideal position, primarily in relation to the city, and then to the most important hub of road and railway infrastructure. The Sarajevo bypass on Corridor Vc, together with the proximity of the railway, are very important for the transport of goods from the north, west and south of the country, where the largest exchange of goods takes place. Sarajevo, primarily as the capital and due to its geographical position in the centre of B&H, is a significant hub and start and end destination for the transport of goods. Good traffic connection with the port of Ploče, especially after the construction of Corridor Vc, will make this GTC especially important.

Fig. 3. Location of the freight transport centre

This would significantly improve the competitiveness of RFB&H in the transport market and make a significant contribution to the development of the business and logistics zone, especially if newer multi-modal transport technologies were used.

The technical base of the GTC consists of the existing infrastructure, industrial tracks, roads, access roads, transhipment machinery, means of transport encountered in the GTC, storage systems, etc. Within the freight transport centre functions of receiving, preparing, handling

and shipping goods with all applicable transport technologies would be performed, such as:

- Palletizing
- Containerization
- Transport of road vehicles by rail

Fig. 4. GTC Operations

5. Construction of an industrial interchange for the business and logistics zone

The Butila interchange, as the largest intersection in FB&H on Corridor Vc, with its constructive elements does not allow connection to the motorway of the existing economic zone Rajlovac and the planned zone Donje Telalovo polje. The proximity of the motorway is largely responsible for their origin and development. The Rajlovac economic zone, and especially the customs terminal that moved to this zone from Halilovići, attracts trucks that supply logistics centres and provide transport for industry. In any case, they generate additional traffic, and in the future, with the growth of the business zone, it is to be expected that there will be more and more of it.

5.1 Description of traffic problems

The Briješće interchange, serves the existing business zone Bačići. However, due to the railway that passes under BC1 and intersects road flows, it cannot be used to serve the existing economic zones (Rajlovac and Telalovo polje) nor the proposed business logistics zone "Sarajevo West". The current traffic route for the existing Rajlovac economic zone is from the motorway and vice versa via the Briješće interchange, then via the M17 main road towards Rajlovac and local roads towards the economic zone.

This traffic is additionally congested by excessive traffic on the section Stup - Briješće - Rajlovac (especially in the morning and in the afternoon). According to the latest reports, on BC1 alone, AADT (Average Annual Daily Traffic) reached 22,500 vehicles per day with a growth tendency.

In the zone of the Butila and BC1 interchange, there are the settlements of Azići, Doglodi, Bojnik, Ahatovići, Dobroševići and potentially Otes, which are no longer as small as they used to be. After the war, these settlements experienced an expansion of growth. The reasons are the war migration of the population and the unstoppable growth of the city of Sarajevo, which was to be expected. The usage of motor vehicles and their supply by the population is currently solved by longer local roads towards these settlements, which are mostly connected in the Stupa zone. This additionally clogs up the congested traffic in this part of the city of Sarajevo.

Heavy goods vehicles and traffic from the motorway and these settlements, which is generated especially on the section M17 Stup - Briješće - Rajlovac, in addition to congestion, has a great impact on deteriorating traffic safety in this part of the city, both on the motor vehicle users and especially on the vulnerable users in traffic (pedestrians and cyclists), since these are populated places, with accesses to shopping malls and school zones.

5.2 Proposed solution

The construction of interchange (figure 2) for the business logistics zone on the BC 1 expressway on the Butila - Briješće section would have multiple benefits. The construction of this interchange would create one of the important preconditions for a modern, fast and efficient approach to the business and logistics zone "Sarajevo West".

In addition to this, the interchange would already make a significant contribution to the existing situation, connecting the existing, spontaneously formed economic zones, the existing settlements that gravitate to this part of the city.

The interchange would generate most of the traffic from populated areas around the Butila and BC1 interchanges (Azići, Doglodi, Bojnik, Ahatovići, Dobroševići and potentially Otes) and thus reduce congestion in the municipalities of Ilidža and Novi Grad (Stup interchange approaches).

The construction of the interchange would significantly reduce traffic at unsafe road crossings over the railway, which has been a problem since the construction of the railway. Through this project, they could also be fixed. The interchange itself would attract traffic to the expressway and relieve the area of Rajlovac.

6. Action plan

Given the complexity of the state system as well as the political situation, it would be desirable for as few institutions as possible to be involved in this project. With the necessary support of the competent institutions, this project could be implemented relatively quickly with the following holders:

- Sarajevo Canton
- PC Motorways of FB&H Ltd. Mostar
- Municipality of Novi Grad Sarajevo
- Municipality of Ilidža

Project financing:

- Given that this is a development project that should be sustainable and environmentally friendly, there is a great chance to receive a grant from international financial institutions (IFI)
- EBRD granting, EIB, European Commission, etc.
- Own funds

The BC 1 motorway project already had the construction of an industrial interchange on the Butila - Briješće sub-section in the project documentation. We do not know why it was abandoned and why it was not built. In any case, any existing project documentation should be reviewed. If it does not exist, the following is required [10]:

- Study documentation (traffic, environmental and feasibility study)
- Amendments to urban and regulatory plans
- Development of conceptual designs
- Development of major projects
- Execution of works

7. Conclusion

We live in a time of globalization which brings various challenges but also opportunities. Put simply, if you want to be a part of the global game, you have to play by the rules that have already been established, and if not, then someone else will do it. Bosnia and Herzegovina can finally start thinking about tackling the big players, given that in the near future the entire Motorway on Corridor Vc can be seen as one of the basic preconditions for bringing in large economic entities in the field of production, trade and services.

The corridor itself should not and must not be the end of a cycle, but the beginning of stronger economic development both in the country and abroad. With the formation of the business and logistics zone in Sarajevo as the capital and geographical centre of the country and the mentioned corridor, it has an ideal geostrategic position on the north-south section, connecting the Port of Ploče with Central Europe. It is inadmissible to leave one such geostrategic position and potential to the spontaneous creation of business zones that cannot create for themselves what the state, canton or municipality must create as a precondition for stronger economic development. The proposed location, with minimal investment in the organization of transport, integrates road, rail and air transport in one place. The area along the Motorway Corridor Vc near the Rajlovac railway junction and the road connection with Sarajevo International Airport is an ideal area for establishing a business and logistics zone of importance for the capital of our country and our country as a whole. The City of Sarajevo, as the administrative centre of Bosnia and Herzegovina and Sarajevo Canton, must take over the function of optimizing, channelling and managing transport flows using internationally defined standards and control criteria, strategic and proper storage of raw materials, semi-raw materials and goods, its distribution with the obligation to control the formation of objective market prices depending on quality.

A logistics centre is a system that represents a significant infrastructural element and an organizational and physical link from production to consumption. At the very centre of the system

is the supply chain, i.e. the optimal organization of the unhindered flow of goods from raw materials, through production, distribution to the final consumer, with as little delay and with all the necessary information. The creation of a business and logistics zone will improve the quality of services, reduce transport and storage costs, improve the efficiency of the entire distribution system, especially the city, and relieve the roads and integrate transport carriers (roads, railways, airports) [11].

The construction and establishment of the business and logistics zone "Sarajevo West" and the construction of an industrial interchange on BC1 Butila - Briješće are strategic steps for the development of Sarajevo Canton. This is primarily reflected in the infrastructural, traffic (multimodal), administrative and logistical arrangement of the business zone as a precondition for attracting business entities.

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Warehouse facility energy efficiency assessment model

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Abstract

The aim of this paper is to investigate the formal structural elements of the energy efficiency assessment system of a warehouse facility as part of a complex distribution system. The problem of work starts from the fact that there is still no single method of assessing the energy efficiency of warehouse facilities that would unequivocally evaluate the planned and taken corrective measures, given the lack of methods related to such intensive construction. In this paper, we determine the final consumption systems of the warehouse facility and the supply systems of the warehouse facilities. The goal of a successful assessment model is to look at the financial and environmental benefits of individual measures, point out the possibilities of reducing costs and the cost-effectiveness of investing in energy efficiency measures of warehouse facilities. A successful assessment model should create the preconditions for determining clear economic criteria when setting priorities for the implementation of energy efficiency measures. The research findings show that it is possible to significantly improve the procedure for assessing the energy efficiency of warehouse facilities.

Keywords: *Warehouse facility, Inspection, Energy efficiency, Consumption reduction*

1 Introduction

Warehouse facilities are fenced or unfenced spaces, covered or uncovered, which are used to store raw materials, semi-finished products, or finished products. The basic task of the warehouse is to preserve the value and quality of stored material or goods and to ensure the uninterrupted and uninterrupted flow of the supply chain. The warehouse facility is an arranged and equipped place for temporary and safe disposal, preparation and release of materials before, during and after their wear and use in the production process. The goal of warehouse facility operators and the necessary commitment of the entire logistics sector as one of the significant consumers of electricity with a noticeable item in the energy balance and infrastructure facilities dispersed in a wide area, is the design, construction and use of various high energy efficiency devices to save electricity consumption (LED lighting, energy efficient mechanical installations, energy efficient ventilation, etc.). Continuous improvement of energy efficiency is one of the most important pillars of modern energy policy and is the key and most cost-effective mechanism for achieving sustainable development goals [1]. In this process, the energy audit of the warehouse facility is a key step in the analysis of energy efficiency. Namely, the energy audit is an unavoidable step on the way to control costs and reduce energy consumption in the logistics system. As a result of the energy audit, there are recommendations for changes in the way of working or behaving, as well as recommendations for the implementation of interventions and the implementation of investments that improve energy efficiency without compromising working conditions in the warehouse facility. When the results of the inspection indicate the existence of significant space for improving energy efficiency, standard methods require that a detailed energy audit be conducted in order to confirm the identified potentials by on-site measurements. After the energy audit, a list of priority energy efficiency measures is created. The key parameters of the analysis of possible measures are the amount of savings in energy, water and money that will be achieved by implementing the proposed measure in the warehouse facility. Identification of measures to improve the energy efficiency of warehouse facilities and equipment is a key and unavoidable step in the analysis of energy and water efficiency, control of consumption and

reduction of costs and consumption of energy, energy and water in buildings. By implementing and improving energy efficiency measures in facilities within its competence, the warehouse system operator would set an excellent example of the fact that investing in energy efficiency measures has very positive effects on budgets and the common environment. Improving the efficiency of energy consumption in warehouse facilities reduces costs, thus contributing to the competitiveness of the sector.

2 Elements of warehouse system - structure of energy consumers

Warehouse facilities (systems) are an important but often neglected factor in energy efficiency assessments. Successful and sustainable warehouse design is a necessary condition for the success of the optimization process of the entire logistics chain. Each warehouse is part of a larger chain, and it needs to be viewed with a holistic approach. The specifics of warehouse systems are the need for different devices in the function of storing different goods and materials (Figure 1.). Various warehouses are equipped with complex equipment (electric carts, diesel, gas and electric forklifts, electric cranes, high-rack cranes, bar code readers, radio frequency technology, handheld scanners, magnetic strips, magnetic strips, sensors for the correctness of goods, etc.).

Fig. 1. Warehouse facility and equipment - consumers

On the other hand, we identified five groups in the warehouse facility supply system, and nine components in the warehouse facility final consumption system (Table 1.). Table 2. displays the main consumers of the warehouse facility.

Table 1. Warehouse facility energy consumption systems

	Final consumption systems of warehouse facilities	Warehouse supply systems
1.	KP_1 - Heating of auxiliary rooms	SO_1 - Power system
2.	KP_2 - Warehouse cooling	SO_2 - Heat production system
3.	KP_3 - Warehouse air conditioning	SO_3 - Cooling system
4.	KP_4 - Warehouse ventilation	SO_4 - Plumbing system
5.	KP_5 - Domestic hot water consumption	SO_5 - Fossil fuels (gas, fuel)
6.	KP_6 - Electric motor drives	
7.	KP_7 - Electric lighting	Losses - Q
8.	KP_8 - Diesel and gas drives	
9.	KP_9 - Other devices and equipment	

Table 2. The main consumers of the warehouse facility [2]

	Major consumers	Ancillary consumers
1.	Warehouse facilities (different types)	
2.	Material warehouse facilities	
3.	Material disposal agents	
4.	Means for shaping unit loads and transport	
5.	Auxiliary warehouse equipment	communication and information system
		means for assembling and disassembling unit loads
		means for determining measurements and weights
		means of transport over rails and other unevenness
		transhipment means and packaging equipment
		material capture means
		aids to connect with the environment
6.	Accessories	safety and protection devices
		air conditioning devices heating / cooling
		sanitary and hygienic devices
		cleanliness devices

3 Energy efficiency assessments of the warehouse facility

Energy efficiency in warehouse facilities means consuming less energy for the same amount of stored products or services provided. Clear objectives of energy efficiency assessment and implementation offer many benefits to the operator, depending on the type of intervention (Table 3.).

Table 3. Energy efficiency goals/warehouse facility

1.	Reduction of load in warehouse facilities with increasing energy prices.
2.	Increasing the energy security of the facility.
3.	Increase the necessary investments for the supply of alternative energy.
4.	Reducing air pollution and slowing climate change.
5.	Improving the employment of skilled and unskilled labor.
6.	Reducing the burden on the company's budget.
7.	Increasing economic competitiveness.

In order to assess the energy saving potential of a warehouse facility, the existing energy efficiency of different systems must be defined. In fact, it is necessary to establish what the current energy situation is. It is not possible to estimate the energy saving potential just by looking at the total energy bill (eg 60,000 kWh / year). The question is whether it is a large or small warehouse building, what are the auxiliary warehouse facilities, etc. The specific energy required gives a clearer picture of the energy efficiency of the warehouse facility. There are many other factors such as the type of warehouse building, climatic conditions, technical installations, etc. which affect the overall "energy needs" [3].

The aim of marking potential measures to improve the energy efficiency of warehouse facilities and equipment is to establish an energy management system. Considering the real state of sources and potentials for improving energy efficiency of warehouse facilities and equipment, and energy consumption in system elements, identifying the necessary energy efficiency measures, includes estimating the amount of investment required in the implementation of proposed energy efficiency measures and expected amounts of energy savings. and proposals for financing them. In the analysis, we identified four sectors that are potentially possible in the system of warehouse facilities and which are a priority for low-emission development strategies are shown in Table 4.

Table 4. Improvement sectors

	Sectors
1.	Electricity consumption of warehouse facilities from renewable sources.
2.	Energy efficiency in warehouse facilities.
3.	District heating system for auxiliary warehouse facilities.
4.	Electric warehouse transport

4 Analysis of the energy audit functions of the warehouse facility

Energy audit is the first step in all programs of rational energy management of facilities and equipment. Energy audit e.g. we analyze the thermal and cooling characteristics of the building envelope and the characteristics of technical systems in order to determine the efficiency / inefficiency of energy consumption and draw conclusions and recommendations for increasing efficiency. This procedure determines the manner of energy use and systems and places where large energy losses are present in order to determine measures for rational energy use and increase energy efficiency. Review of energy efficiency of warehouse facilities and equipment includes detailed analysis of technical and energy characteristics and analysis of all technical systems in facilities at the level of warehouse system that consume energy and water in order to determine efficiency / inefficiency of energy and water consumption and make conclusions and recommendations for energy efficiency. and equipment. The two main purposes of the energy audit are shown in Table 5.

Table 5. Purposes of energy audit

1.	Analysis of the state and possibilities of application of measures to improve the energy properties of the warehouse facility and increase energy efficiency.
2.	Determining the class of energy consumption in the energy certification of a warehouse facility.

Data accuracy is the key to a successful energy audit. This is most pronounced in existing buildings. Sometimes it is not possible to get all the necessary data, sometimes it is necessary to perform additional measurements. It is important

for the quality of the energy audit that the lack of data or inaccuracy of data is kept to a minimum.

The person conducting the energy audit must be professional and trained to inspect the existing condition, conduct measurements and the necessary calculations, to more accurately establish the existing energy status and make recommendations for improving the energy performance of the warehouse facility.

A key part of the energy audit of the warehouse facility is to identify recommendations for changes in plant and equipment or changes in user behavior and recommendations for the implementation of measures and implementation of measures to improve energy efficiency of facilities without compromising or improving working conditions, service process or service quality. object. The primary goal of the energy audit is to determine the energy properties for new or existing facilities, and to make recommendations for increasing energy efficiency. The energy audit must contain the information required for energy certification.

The primary goal of the energy audit of facilities and equipment is to collect and process detailed data on facilities and all technical systems in the facility and to determine the energy properties of the facility. The standard content of the energy audit of the facility includes eight phases (Table 6.).

Table 6. Stages of energy audit of the warehouse facility

	Phases
1.	Phase of analysis of technical specifications of the construction warehouse facility in terms of thermal protection (analysis of thermal characteristics of the casing).
2.	Phase of analysis of technical specifications of energy properties of ventilation systems.
3.	Phase of analysis of technical specifications of energy properties of domestic hot water systems in the main and auxiliary facilities.
4.	Phase of analysis of technical specifications of energy properties of energy consumption systems of transport and warehouse systems.
5.	Phase of analysis of technical specifications of energy properties of electricity consumption system - system of electrical installations, lighting in the warehouse and other subsystems of electricity consumption.
6.	Phase of analysis of facility technical system management specifications.
7.	Phase of analysis of the possibility of using renewable energy sources and efficient systems.
8.	Phase of introduction of proposals for economically favorable measures to improve the energy performance of the warehouse facility, achievable savings, investment assessment and payback period.

Based on the characteristics of individual warehouse facilities and equipment, it should be noted that certain steps of the energy audit are specific. The energy audit of warehouse facilities and equipment, in addition to identifying the possibility of applying energy efficiency improvement measures, must include all the necessary information for the implementation of the energy certification procedure.

5 Mathematical model for estimating the energy efficiency of a warehouse facility

The mathematical model of energy efficiency of all processes within the warehouse system can be defined as the ratio of utilized energy output (work and usable energy) and input energy consumed in the process (energy loss) (Figure 2).

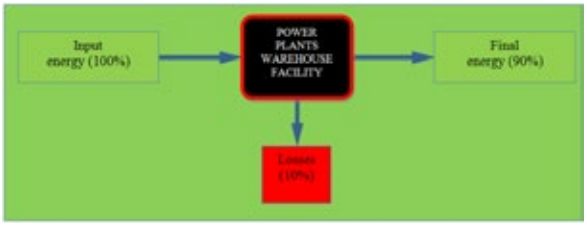

Fig. 2. The concept of energy efficiency of a warehouse facility

The energy efficiency of the warehouse facility system, ie the degree of efficiency (energy efficiency) is formally equal to the ratio of final energy and input energy:

Degree of efficiency of the warehouse facility system
=
Final energy / input energy

Formalized relationship is defined as:

$$SO_1+SO_2+SO_3+SO_4+SO_5 \rightarrow (KP_1+KP_2+KP_3+KP_4+KP_5+KP_6+KP_7+KP_8+KP_9) + Q \quad (1)$$

The main consumers or components of the warehouse system that are subject to energy audit are shown in Table 2.

The research should take into account the degree of efficiency of all warehouse facilities and the type of energy / fuel used.

The balance of energy consumption by main groups of consumers within the defined energy cost centers is prepared on the basis of information on working hours and habits of employees in the warehouse. Information on the operating hours of warehouse devices and equipment used during warehousing is obtained through interviews with on-site logisticians, review of available logs of individual devices (read directly from device memory or work logs) and personal experience related to the type of activity performed within the analyzed warehouse building [4].

6 Proposal of a three-phase model of energy efficiency analysis of warehouse facilities

For the analysis of facilities and equipment of the warehouse facility, we propose a three-phase model of energy audit. The first phase of the model consists of a preliminary review that does not include detailed calculations or measurements and modeling of energy consumption. In the first phase of the model, we perform an energy audit that includes a brief overview of the energy properties of warehouse facilities and equipment, in order to determine the potential for increasing energy efficiency, or determine the need for a detailed energy audit of all elements. The basic steps of the first phase of the energy audit are given in Table 7.

Table 7. Steps of the first phase of the three-phase energy audit model

1.	Preparation phase - collecting data on the characteristics of the warehouse facility and construction equipment, important energy systems and energy costs.
2.	Interview with the responsible person in the warehouse facility.
3.	Tour of the warehouse facility - visual determination of the energy state of the shell and all technical systems, recognition of the basic characteristics of energy consumption and places of large energy losses.

By visual inspection of the energy condition of the warehouse facility and its main characteristics (Table 8.) and all technical warehouse systems and a brief analysis of the collected data, we identify a key problem and compile a set of recommendations to increase energy efficiency.

Table 8. The main characteristics of the system

1.	Construction characteristics of thermal protection.
2.	Energy properties of ventilation, lighting, air conditioning, heating and cooling systems.
3.	Energy properties of warehouse transport.
4.	Representation and energy properties of individual groups of consumers.
5.	Object management structure.
6.	User access to energy issues - the so-called. human factor.

The main goal of the first phase of the energy audit is to determine the potential for rationalization of energy consumption and to make a decision on the need to conduct the second detailed phase of the energy audit.

The second phase of the model consists of a detailed energy audit in which we perform in-depth energy analysis of the warehouse facility and based on measurements we have a starting point to evaluate more complex energy efficiency improvement measures that are recommended for additional analysis.

The third phase of the model introduces an appropriate simulator (eg. Flexsim) to mimic the real state and processes in the warehouse facility (Figure 3.). Namely, in the analysis of the relationship between the activities in the warehouse facility and energy consumption, the human factor must not be neglected. Improvements in the efficiency of the warehouse facility should be sought on the side of technology (machinery and equipment) but also on the side of equipment management (human factor). That is why we use simulation to determine the impact of changes in the parameters of certain behaviors on other elements of the warehouse system.

Fig. 3. Elements of consumer simulation in Flexim environment

With the simulation method we try to solve the problem situation of complex warehouse processes that have the following characteristics:

1. Dynamics in energy consumption in the warehouse, which means that the phenomenon in which the problem occurs changes over time;
2. Excessive complexity of the logistics problem, ie the existence of complex interdependencies of consumption in the warehouse and the relationship between the elements of the problem;
3. Stochasticity of some elements of the consumption problem in the system.

The result of the three-phase model is the final document which suggests that the key output of the energy audit model is a list of measures to improve the energy efficiency of the warehouse facility that are proposed for implementation, ie. Investing.

7 Evaluation of energy efficiency measures of a warehouse facility

The purpose of the evaluation of energy efficiency measures of warehouse facilities and equipment consists of two main objectives (Table 9.).

Table 9. The purpose of identifying energy efficiency measures of warehouse facilities and equipment

1.	Analysis of the current state of measures taken for energy properties of warehouse facilities and equipment in the function of energy efficiency implementation.
2.	Identification of possibilities and justification for the application of additional measures to improve the energy efficiency of warehouse facilities and equipment with the ultimate goal of implementing the energy certification procedure and determining the energy class.

The purpose of evaluating the model of conducting energy audits of warehouse facilities and equipment and introducing measures is to provide tools for successful implementation of energy audits by prescribing a detailed procedure of all activities in this complex process, because the goal of the process is not only insight into the current energy condition of the warehouse facility and equipment with regard to the main characteristics and the successful implementation of the proposed measures.

Based on the analysis of the collected data, specific energy, economically and environmentally optimal additional energy efficiency measures for the observed warehouse facility and equipment are selected.

8 Proposal of the energy card model of the warehouse facility

Within the paper, we also define the proposal of the optimal model of the energy efficiency assessment card of the warehouse facility. The proposed card consists of nine interdependent elements: General data, basic technical data on the warehouse facility, energy needs of the warehouse facility, CO_2 emissions, costs, investment price, economic and financial indicators, savings in energy consumption after the measures and the potential for labor (Table 10.).

Table 10. Proposal of optimal cardboard model for energy efficiency assessment of warehouse facility

GENERAL INFORMATION ABOUT WAREHOUSE				
The name of the warehouse facility		Type of warehouse facility		
Location of the warehouse facility		Number of employees		
Municipality		Average daily number of users		
State		Object code		

BASIC TECHNICAL DATA ABOUT THE WAREHOUSE FACILITY				
CATEGORY	CONSTRUCTION FACILITIES WHICH ARE AN INTEGRAL PART OF THE WAREHOUSE FACILITY			TOTAL
	1	2	3	
Total area of heated space (m^2)				
Total volume of heated space (m^3)				
Total window area				

WAREHOUSE ENERGY NEEDS				
CATEGORY	CURRENT STATE	SITUATION AFTER THE MEASURE EE	THE DIFFERENCE	Unit of measure
Total for heating				kWh/year
Total for lighting				kWh /year
Total for other electrical appliances				kWh/year
For heating per m^2 of heated area				kWh/m^2 year
For heating per m^3 of heated space				kWh/m^3 year
Energy category				
Required amounts of energy for heating			Unit of measure	
Gas				m^3/ year
Heating oil				l/ year
Pellets				t/ year
District heating				kwh/ year
Electric heating				kwh/year

CO_2 EMISSIONS WAREHOUSE				
	CURRENT STATE	SITUATION AFTER THE MEASURE EE	THE DIFFERENCE	Unit of measure
From heating				t/year
From transport				t /year
From lighting				t/ year
From elec. devices				t/ year
Total				t/ year

COSTS				
	CURRENT STATE	SITUATION AFTER THE MEASURE EE	THE DIFFERENCE	Unit of measure
For heating				KM/ year
For lighting and elec. devices				KM/ year
Total				KM/ year

INVESTMENT PRICE			
MEASURE	Investment (KM)	Energy saving (kwh/year)	Energy saving (%)
MEASURE 1.			
MEASURE 2.			
MEASURE 3.			
MEASURE 4.			
MEASURE 5.			
TOTAL HEATING			
TOTAL TRANSPORT			
TOTAL LIGHTING			
TOTAL			

ECONOMIC AND FINANCIAL INDICATORS		
Evaluation method	Result	Eligibility of the investment
EASY RETURN PERIOD FOR INVESTMENT IN BUILDINGS (PP) (year)		
EASY RETURN PERIOD FOR LIGHTING INVESTMENTS (PP) (year)		

EASY RETURN PERIOD FOR INVESTMENT IN ENERGY EFFICIENT ELECTRONIC DEVICES (PP) (year)			
NET CURRENT VALUE FOR INVESTMENT IN BUILDING $NPV_{Building}$			
NET CURRENT VALUE FOR INVESTMENT IN LIGHTING $NPV_{Lighting}$			
NET CURRENT VALUE FOR INVESTMENTS IN ELECTRONIC DEVICES $NPV_{Electrical\ device}$			
INTERNAL RATE OF RETURN FOR INVESTMENT IN BUILDINGS $IRR_{Building}$			
INTERNAL RETURN RATE FOR INVESTMENT IN LIGHTING $IRR_{Lighting}$			
INTERNAL RETURN RATE FOR INVESTMENTS IN ELECTRONIC APPLIANCES $IRR_{Electrical\ device}$			
Savings in energy consumption after implemented measures			
	HEATING (%)	LIGHTING (%)	TOTAL (%)
ENERGY			
FINANCIAL			
CO_2 EMISSIONS			
Savings in energy consumption after implemented measures			
The potential of the project to create new jobs			man – months

9 Conclusion

The energy audit model of the warehouse facility is a framework for a systematic analysis of energy consumption in order to determine the efficiency of consumption, and to find and evaluate the potential for achieving overall savings. The results of the research showed that energy efficiency assessments of warehouse facilities have not been the focus of scientific research to date. The proposed three-phase model is a new approach to measuring the energy efficiency of warehouse facilities based on real data.

The existence of clear metrics for assessing the energy efficiency of warehouse systems and the need to quantify the consumption process in such a system, necessarily introduces us to the field of simulation models and associating numerical value with elements and processes of warehouse systems. Applying the system three-phase model, the consultant has the opportunity to analyze all segments of energy and water consumption of the warehouse facility, from inputs and energy transformations to direct consumption through activities that take place in the building. Based on all the above, we can conclude that the following is crucial for conducting an energy audit of the warehouse facility: systematic planning of all activities and timely communication with the logistics operator, systematic understanding of activities in warehouse facilities, correct reading of simulation results in the warehouse facility. energy efficiency improvements and systematic presentation of results and guidelines for the continuation of activities through a report submitted to the warehouse operator. Ignoring any of the above five key steps, an energy audit of a warehouse facility will not yield the expected results.

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ATCT 2022 - KEYNOTE SPEAKERS

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