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Implementation of Sustainability into Business Strategy

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Abstract Businesses play a key role in the ecosystem in terms of their impact on economic, social, and environmental aspects. Businesses should perceive these aspects equally and thus support the achievement of sustainable development goals. The paper aims to characterize and compare sustainable strategies in selected companies in terms of implementation of sustainable development goals and the concept of a triple bottom line.

Keywords sustainable strategy, corporate sustainability, triple bottom line, SDGs

JEL Q01, Q56

1. Introduction

Sustainability is attracting increasing interest and importance in business circles thanks to the promise that it will act as a source of competitive advantage. Gaining new sources of competitive advantage is important because of the intense competition in today's market, where companies are required to constantly innovate to create and meet the requirements and expectations of customers and society as a whole. With growing expectations for sustainability and business transparency, businesses are realizing the need to act on sustainability. [1][2]

As early as 1994, Stead and Stead argued that businesses in the 21st century would have to change the basic assumptions and values that underpin their relationships with stakeholders and have an impact on the environment. Environmental and social performance should be integrated into business processes and regular market research to capture changing consumer attitudes towards environmental issues, and business principles should be adapted. Kofi Annan unveiled the world's largest corporate sustainability initiative, known as the UN Global 6 Compact, to encourage businesses around the world to align their strategies and operations with universal principles in human rights, labor, the environment and the fight against corruption. steps that support societal goals. The sustainability of the company received considerable attention after the global crisis of 2007-2009, and was seen as a means of ensuring the long-term sustainability of companies and their accountability to various stakeholders. [1][3][4]

The global crisis was followed by a period of economic growth, which, however, had a negative impact on certain aspects, such as the deepening of social inequality, the deterioration of the environment, the reduction of diversity and inclusion, or unfair remuneration. It follows that the progress made is not the desired progress and there may be shortcomings in the development process that need to be eliminated through sustainable development. Sustainable development should involve all stakeholders in the ecosystem, with businesses being considered key stakeholder with the potential to make a significant contribution to sustainable development. In this context, this article focuses on the concept of business sustainability and the challenges of implementing a sustainability business case. [2][3][4]

2. Theoretical background

Business sustainability is a multidisciplinary function of accounting, economics, ethics, finance, management, marketing, law and supply chain management, among other things, with a strong focus on improving economic viability, ethical behavior, environmental health, management measures. and social justice. It can bring benefits in terms of risk management, cost savings, access to capital, customer relations, human resources management and innovation capacity. It also facilitates stakeholder involvement in sustainable growth and risk management in building trust in the company and achieving long-term investment goals with shareholders by increasing the effective allocation of capital. Business sustainability is also considered an ethical conduct of business activities with effective corporate governance to ensure business continuity and continuity. Business sustainability is a business approach to creating long-term value and is based on the premise that the development of such strategies supports the long-term prosperity of businesses and society. [4][5]

The sustainability of a company is, like sustainability in general, based on the so-called Triple Bottom Line (TBL).

The term Triple Bottom Line was coined in 1994 by John Elington. The TBL consists of three basic lines, which are also the basic pillars of sustainability and sustainable development - the environmental, economic and social pillars. Sometimes the name 3P is used instead of TBL, which consists of parts - People, Planet, Profit. The TBL represents the idea that companies and other entities should not only be assessed from an economic point of view, but based on three dimensions or pillars. [6]

Agenda 2030 is part of supporting the implementation of sustainability. Agenda 2030 is an action plan focused on people, the planet and prosperity. The agenda also includes the eradication of poverty in all its forms and dimensions, including extreme poverty, and is considered to be the greatest global challenge and a requirement for sustainable development. The scope and ambition of the Universal Agenda is demonstrated by 17 Sustainable Development Goals (SDGs) and 169 sub-goals. Some companies refer directly to SDGs in their sustainable strategies and link the individual sustainable goals of the company with the fulfillment of SDGs. According to Moriok, the sustainable development of the world and the future of future generations depends on current decisions and business activities. Business sustainability is a concept that drives organizations to improve their performance in all three pillars of TBL. Creating links between the three pillars of TBL and 17 SDGs can be useful for businesses. The TBL-SDGs framework can inspire businesses to actively participate in and contribute to SDGs. The integration of TBLs and SDGs can provide companies with internal and external incentives to contribute to the sustainable development of the world. [7][8][9][10]

3. Methodology

The main goal of the paper is the analysis of sustainability strategies in selected companies and their mutual comparison. The purpose of the paper is to identify how selected companies approach the implementation of sustainability and what aspects they focus on. Selected companies include PepsiCo, Ford, Continental Matador, Tesco and Patagonia. The companies were deliberately selected to be different in terms of focus and industry, for the potential identification of differences between the perceptions of sustainability of selected companies.

The analysis also includes identification of the implementation of sustainable development goals, all three pillars of sustainable development into business strategies, identification of key areas, specific goals, time frame of implementation, tools for meeting goals, ongoing evaluation of results and identification of sustainable strategy integration into the supply chain, resp. identification of the requirements or code that suppliers must meet. The secondary analysis was performed mainly by extracting data available on the websites of selected companies. Subsequently, the method of analysis was used to analyze the data obtained. In addition, the method of synthesis was used, which was used to unify the data obtained and the formulation of individual conclusions.

4. Results

The content of the following paragraphs is a description of the approaches of selected companies to building sustainable strategies with a focus on key elements and principles of strategy and goals of individual companies.

4.1 PepsiCo

PepsiCo is a multinational company engaged in the production of beverages and food. The company has created a strategic comprehensive transformation of pep +, in which sustainability is at the heart of how the company will develop and create value by acting responsibly and inspiring the company and other actors to make positive changes. Pep + aims to transform business operations, from sourcing ingredients, through production and sales in a sustainable way, to influencing more than a billion of its customers so that sustainability becomes part of the daily lives of all stakeholders. PepsiCo has been presenting its sustainability goals and annual reports since 2005. They cover three aspects - sustainability of people, talent and the environment. By 2025, PepsiCo plans to reduce the added sugar and fat in products, design packaging that is 100% recycled and can be further recycled, and reduce the amount of waste they produce by up to 50%. PepsiCo also continues to develop a diverse workforce and promote respect for human rights. The strategy includes activities aimed at regenerating utilized agricultural land, sustainable acquisition of key crops needed for production, improving the quality of life of more than 250,000 people working in the agricultural chain or achieving zero emissions by 2040. The company also aims to reduce plastic production via the SodaStream platform. Objectives also include the inclusion and replacement of existing ingredients, ingredients that are more sustainable and nutritionally effective. Elimination of the use of sugar and sodium is also part of product development. By the end of 2022, all products should be available in EU markets in only 100% recycled bottles, with the company reducing greenhouse gas emissions by around 30% per bottle. The paradox is that in the US, the company plans to fully implement this transition by 2030. [11][12]

4.2 Ford

Ford is the first automotive company to publish a sustainability report, specifically in 1999. The company invests millions in electrified vehicles, promotes volunteering, and supports minority, women and veterans. It promotes diversity and increases the positive impact on communities in the areas where society operates. One of the company's projects is SHE-MOVES, which aims to empower women in the field of mobility. In addition, the company has created several projects to support education or improve the quality of life of people in Africa and South America. The company's goals include the promotion of human progress, becoming the

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world's most inclusive and diverse enterprise, obtaining all the raw materials needed for production responsibly, and using such raw materials and materials that support sustainable production. It also includes the replacement of all plastics used in the manufacture of vehicles with recycled and renewable plastics. One of the goals is to use only renewable energy sources and reduce water consumption by 50% in all production plants by 2035, stop using disposable plastics in production by 2030, or to produce only emission-free vehicles by 2040. Examples of social pillar activities include supporting communities in Detroit, developing Corktown, or renovating historic buildings in and around Michigan. [13][14]

4.3 Patagonia

According to Rank and Brand, Patagonia is one of the most sustainable clothing brands in the sports and outdoor sector. Patagonia has been striving to be an environmentally friendly company for more than twenty years. The company's sustainable development strategy consists of three basic areas - product, activism, and giving. The company's mission is to create the best products with a minimal negative impact on the environment and the company's environment and use the business to inspire and support the implementation of environmental crisis solutions. The company has created the so-called Footprint Council, which deals with strategies in the field of sustainability and control and measurement of implemented activities. The company's programs include, for example, the Worn Wear E-shop program, where customers can purchase used products, the 1% For Planet program, within which the company dedicates 1% of its revenues to non-profit organizations or an environmental stakeholder network. [15]

The company plans to be carbon neutral by 2025, obtaining 100% of the required energy from renewable sources and increasing the share of recycled materials so that all products are made from 100% recycled materials. The aim is also to achieve a fully sustainable production cycle. The company supports the construction of modern resources for obtaining renewable energy, not only for use by the company itself but also within communities. The company has developed a code of ethics, a fair trade program, a fair remuneration system, social and health bonuses and programs that must be implemented, and adhered to by all Patagonia stakeholders. In addition, society is proactive in promoting environmental activism, promoting inclusion and equal opportunities for all, with an equal share of men and women in society. [15]

4.4 Tesco

Like previous companies, Tesco has implemented the concept of sustainability into its strategy, focusing on four core areas - people, product, planet and places. The company has so far managed to implement 8 sustainable development goals in its strategy. The strategy includes the promotion of good working conditions and a suitable work environment, tools for personal growth or programs aimed at the employment of high school and university graduates. In addition, the company provides all employees with courses, training and lectures that focus on mental health, digital skills acquisition, lifelong learning or other personal development of employees. The company seeks to positively influence all stakeholders in the supply chain, such as promoting gender equality, ethical audits, overseeing the quality of life of people involved in the supply chain, promoting the prosperity of people, farmers and communities, with the main goal of eliminating modern slavery or unfair pay. The company has developed a code of ethics that is valid for all suppliers. [16]

By 2025, the company plans to use only recycled plastics or other alternatives as packaging, to sell only those eggs that come from free range and 50% of suppliers should have implemented projects to support biodiversity. The goal by 2035 is to become a carbon-neutral company. The company has created programs to prevent deforestation in the supply chain, to use only renewable energy sources, to offer, for example, damaged but safe fruit or vegetables, and to distribute excessive unused stocks to communities and non-profit organizations. In the Slovak Republic alone, the company has distributed 15 million portions of food, redistributed 90% of unsold products, supported more than 1,600 projects, 800 tons of products or donated more than two million euros to implement local projects. [16]

4.5 Continental Matador

The company operates the largest tire plant in Europe in Púchov. The company has developed a sustainability strategy that focuses on four key areas - carbon neutrality by 2050, zero-mobility and industry by 2040, closed resource and product cycles, and responsible sourcing and business partnerships. The company has so far managed to reduce water consumption by 55% and energy by 17% per metric ton of tires produced. The company is also trying to use recycled plastic bottles in the production of tires and thus reduce rubber consumption. Within the environmental field, the company is committed to meeting the four goals of sustainable development. The company is working to transform the production cycle so ensure maximum use of materials and products without zero waste. The company has developed a code of ethics for suppliers, which contains specific requirements related to achieving the goals of sustainable development. It covers human rights, working conditions, environmental protection and the fight against corruption. The company also set up a department to monitor compliance and report violations. Business partners are evaluated based on generally accepted platforms EcoVadis and NQC, while 59% of suppliers have so far completed this evaluation. The company also provides dual education programs, internships, foreign language courses, motivational lectures and personal development programs. The goal is to reach a 25% share of women in management positions by 2025. The following table 1 compares the strategies in selected companies. [17]

A comparison of the strategies of the selected companies shows that the set elements are mostly met by Continental,

whose strategy contains all the elements, but the time frame for achieving the goals is not specified for all goals. PepsiCo's strategy, which implemented all of the above elements, came in the imaginary second place, but has not yet implemented any code or other requirements for its suppliers and their sustainable strategies in the area of the supply chain. The remaining companies have implemented most of the elements, but Patagonia and Tesco do not focus on the economic pillar of sustainability in their strategies, and Tesco does not publicly share the ongoing assessment of achieving sustainable goals and meeting the set strategy.

Table 1. Comparison of the strategies in selected companies

Elements	Businesses				
	PepsiCo	Ford	Patagonia	Tesco	Continental
Social	Y	Y	Y	Y	Y
Environmental	Y	Y	Y	Y	Y
Economic	Y	Y	N	N	Y
SDGs	Y	Y	Y	Y	Y
Key areas	Y	Y	Y	Y	Y
Objectives	Y	Y	/	/	Y
Time frame	Y	/	/	/	/
Tools	Y	/	/	/	Y
Ongoing evaluation	Y	/	/	N	Y
Suppliers	N	Y	Y	Y	Y
Y - contains N – do not contain / - partially					

Source: [12][13][15][16][17]

Insufficient elements include clear goal setting, except PepsiCo, all companies have indicated a timeframe for only some goals, companies only partially list the tools through which they want to meet the set goals, and Ford and Patagonia only provide a partial assessment of goal achievement and strategy. On the positive side, however, in all selected companies, the positive aspects significantly predominate over the negative ones, and the companies implement almost all of the set elements.

5. Conclusions

The sustainability of a company can be characterized as a strategy where the company delivers its goods and services in a way that is environmentally sustainable and at the same time supports its economic growth. While the sustainability of the company recognizes that the growth and profitability of the company are important, it also requires the need to meet social goals, respectively. pillars of sustainability - economic, social and environmental. These sustainability pillars are referred to as the Triple Bottom Line. The pillars of sustainability, which support companies' efforts to implement sustainable elements, must be seen equally, and none of the pillars must take precedence over the other. The implementation of a sustainable strategy has a positive impact not only on the environment but can also lead to improved brand image, reduced costs, more satisfied shareholders, increased productivity and the like. An analysis of publicly available data on the strategy of the selected companies shows that TBL is not only implemented by Tesco and Patagonia.

All selected companies implemented SDGs in their strategy and identified key areas of their strategies. All companies have clearly defined goals, but Tesco and Patagonia in some areas have only described what they would like to do, without a clear goal setting. The biggest problem is that four out of five companies do not state the time frame publicly, ie. as long as or in what time horizon they plan to meet the set goals. Only PepsciCo and Continental report on the interim evaluation for all the objectives set. Apart from PepsiCo, all companies ensure that the code is complied with by all suppliers, resp. require their suppliers to implement sustainability into their strategy. The sustainability of a company can be seen as a new and evolving paradigm of corporate governance, as it is an alternative to the traditional model of growth and profit maximization.

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Interoperability and Its Significance

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Abstract The purpose of this paper is to define interoperability, as well as to provide a theoretical overview of interoperability and legislation bound to this term, which affects its implementation in practice in Slovakia. Overview consists of categorizing interoperability and identifying its degrees, discerning its security aspects, analysing benefits and drawbacks of this concept in information systems. In the paper is also stated meaning of interoperability and application in the different areas of use. There is also stated the view of different authors about how to look at the interoperability, with explained meanings of its different types.

Keywords interoperability, information systems, types of interoperability

JEL O14

1. Introduction

Today's technologies operate on a networked basis, where one technology either supports another, builds on the outputs of the first, or interconnects these technologies. Such systems can communicate with each other, through information and communication technologies (ICT), as well as share resources, whether through local or large networks. This is called interoperability. The information shared by people and devices can already be seen as high value goods on the market. However, information sources are scattered, resulting in an increase in their exchange, creation, or use, with an emphasis on securing systems against possible misuse. As a means, to ensure interoperability, are used standards. [1], [2]

In order for interoperability to be put into practice, it is necessary to specify the conditions such as [1]:

- define the institutional framework,
- define the conditions for the possibility of using ICT in public administration,
- define rules and principles for mutual use of data and simplification of communication between public administration bodies internally and externally.

2. Interoperability and Its Meaning

The European Commission (represented by the IDA Working Group) defines interoperability as the ability of ICT systems to exchange data and ability to altogether utilize both data and information. [1]

For the purposes of the European Investment Fund, interoperability is understood as the competence of organizations to cooperate with the aim of mutually beneficial objectives, including the sharing of information and knowledge between cooperating organizations through business processes supported by those organisations, thanks to the exchange of data between their systems of ICT. [3]

For the purposes of the paper, interoperability will be further understood as the ability of ICT-based systems to operate finely with different institutions in exchanging data, information, and resources, through networks, without using the same ICT system.

Factors that are key to efficient IS interconnection and information exchange are shown in Figure 1.

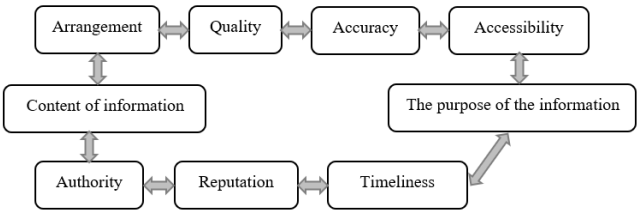

Figure 1. Factors affecting the exchange of information within the reciprocal IS interconnection. (Source: [1], own processing)

The importance of interoperability lies in the fact that the interconnection of different information systems (IS) enables faster and more efficient communication between individual institutions. However, it is necessary to distinguish whether it is an interconnection of standardized or non-standard information systems. In the case of non-standard systems, it is the interconnection of institutions on the basis of bilateral agreements, which can lead (ideally) to a "one-on-one" networking. However, this type of connection is expensive. Therefore, it seems to be more advantageous to apply the interconnection of standardized IS institutions. In this case,

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it is a link "from one central point (institution) to other institutions", with communication between the institutions taking place through a central point. An example of such a connection can be e-government (electronic form of public administration). [1]

The concept of interoperability can be found in different spheres of life [1], [4], [5], [6]:

- healthcare and public administration,
- digital identification systems and SW,
- transport and telecommunications,
- public security and the army,
- risk management.

2.1. Interoperability Legislation

Interoperability has been regulated within Europe, specifically by the Member States of the European Union (EU). The first common document amending it was Directive 2002/21 / EC of the European Parliament and of the Council (of 7 March 2002) on a common regulatory framework for electronic communications networks and services (Framework Directive). In the Framework Directive, interoperability is understood as interoperability of services. Subsequently, the European Interoperability Framework - Implementation Strategy (2017) was created by the European Commission (hereinafter the Framework). In this document, interoperability is a factor influencing the EU in the provision of digital public services, as well as legal issues in this area, organizational aspects, connectivity, and technical aspects. The first annex to this document is the Interoperability Action Plan (2017), which sets out the objectives, measures, timeframe for their implementation and delegates responsibility to the relevant legal authorities with the main aim of addressing the causes of interoperability problems. The second annex is the Strategy for the Implementation of this Framework (2017), which provides forty-seven recommendations for guidance to public administration bodies to streamline the management of interoperability activities, unification of procedures, etc. [7], [8], [9], [10]

In the conditions of the Slovak Republic (SR), this Framework was incorporated into the documents [11], [12], [13], [14]:

- What should be the Cybernetic and Information Security Policy for II. and III. ISVS category and how to develop it,
- to the Regulation of the Government of the Slovak Republic No. 594/2006 Coll. on technical requirements for interoperability of the trans-European high-speed rail system,
- Regulation of the Government of the Slovak Republic No. 61/2022 Coll., laying down details on the interoperability of car radios and terminal equipment intended for the reception of digital television signals,
- Interoperability is also discussed in the document EDPB's New Declarations on the Opening of Boundaries and Interoperability of COVID-19 Applications,
- and others.

3. Interoperability – Types, Security and Stages

Interoperability can be categorized differently according to different authors. Thus, security needs to be precise to suit the needs of each type of interoperability.

3.1. Types of Interoperability

Some divide it into 3 categories, others into four, and it is not always divided into categories in the same way. This differs mainly in the application of interoperability (medicine, public administration, information systems and others). Examples of such divisions are given in Table 1.

Table 1. Types of interoperability categorizations according to selected authors. (Source: author)

Authors	Number of types of groups	Types of groups of interoperability	Source
Adebesin, Foster, Kotzé, Van Greunen	4	organizational, semantic, syntactic, and technical	[15]
Hochmann	3	technical, organizational, and semantic	[1]
Open standards	3	business, information, and technical	[16]
Techopedia	2	syntactic and semantic	[2]
Ford, Colombi, Graham, Jacques	2	technical and non-technical	[17]

Syntactic interoperability is understood as the interconnection of two or more systems capable of communicating with each other and exchanging data, while enabling the cooperation of different software (SW) components even in the case of a different programming language. In **semantic interoperability**, the data exchanged between two or more systems is comprehensible to all systems, provided that the data exchanged makes sense (is useful) as it is defined by the users of the systems in the form of results. [2]

Another division of interoperability (Ford et al.) is for example into categories technical and non-technical interoperability. By **technical interoperability**, these authors understand interoperability: communication, electronic, application and multidatabase, while under **non-technical interoperability** they understand interoperability: organizational, operational, process, cultural and coalition interoperability. However, these authors state that the assignment of interoperability to one of these categories is subjective and depends, to a large extent, on the angle from which the aspect is viewed, while not all types of interoperability can be included in these two categories. [17]

The types of interoperability categories that we consider essential for business in the market are [16], [1]:

- **operational** or business **interoperability** - specifies how business processes should be shared,
- **information interoperability** - defines how information should be shared,
- technical interoperability - defines the interconnection of IS or sharing of technical services.

Organizational interoperability deals with the creation of conditions (in institutions considering legislation), which are based on the needs of implementation and technical, semantic, and technical interoperability. [1], [18]

3.2. Security in the Interoperability

Since the individual IS are interconnected, there is a risk of a potential risk of leakage, theft, or misuse of information sources. This danger occurs mainly in the network connection of individual institutions via the Internet. Therefore, it is necessary to encrypt sensitive data and secure it with an electronic signature. E-government provides a link between information security and interoperability in the Slovak Republic. This link in the field of security is legally enshrined in the National Information Security Framework and in the Information Security Rules and Guidelines. On the interoperability side, this interconnection is legally dependent on the National Interoperability Framework and the Interoperability and Safety Standards. To ensure the protection of information, it was necessary to establish legislation that would include both security standards and standards for electronic signatures, considering the security policy. [1]

3.3. Interoperability Degrees

Interoperability can also be specified using its levels (this is used, for example, by NATO). The information is shared between the institutions through the various stages [16]:

Degree 1: the exchange of unstructured data requires the mediation of unstructured data that can be interpreted by humans,

Degree 2: The exchange of structured data involves the interchange of structured data that can be interpreted, aimed for manual or automated manipulation, but require manual compilation, receipt or forwarding messages.

Degree 3: continuous data sharing entails automated data sharing between systems, where they are based on common exchange models.

Degree 4: Seamless information sharing is an addition to the previous stage to the universal interpretation of information via processing of data based on collaborating applications.

4. Interoperability Measurability and Literature Review

Interoperability as such does not have a uniform measurability model. Authors Ford. et al. (2007) evaluated in a survey of secondary resources that only eleven organizations were significantly involved in the development of models (in the military field) for the measurability of interoperability, its methodology or processes. In the field of e-commerce, was executed an analysis of secondary sources by Razaei et al. (2014) who analysed four models, while Leal et al. (2016) analysed these resources in the area of connected enterprises based on a central hub and connected spoke sites (using lines). They used eleven measurability models from different sectors in the analysis. Finally, this paper includes a systematic analysis of the literature by Jabin et al. (2019), in which they described the possibility of measurability of interoperability in the BIM environment (building information models) in connection with the conformational test. [17], [19]

To be able to measure something, we must be able to measure the attributes of such an entity, or we can measure it indirectly, by deriving from several attributes of the given entity. For indirect measurement, it is necessary to use a model in a certain form, which represents the relationships between the measured attributes. Some models use mechanisms such as qualitative measures to express themselves, these are highly subjective and evaluated mainly by words such as "good", "optimal" and "adaptive", or quantitative measures, which are expressed for example by scale 0-100%. [19], [20]

5. Objective and Methodology

The aim of the paper is to inform about the concept of interoperability, to compile a literature overview, as well as to identify approaches of exploring the concept. The methods used in the article were the analysis of secondary sources, the synthesis of the acquired resources, the analysis of the pros and cons of interoperability of information systems and the subsequent deduction of its following contribution.

6. Analysis of Advantages and Disadvantages of Interoperability of Information Systems

Due to the informative nature of the paper, it is possible to apply an empirical qualitative method of analysis of advantages and disadvantages to bring interoperability closer. This analysis is suitable for application to improve the decision-making process. This analysis is shown in Table 2.

Table 2. Analysis of advantages and disadvantages of interoperability in the field of information systems. (Source: [6], [21], [22] compiled by the authors)

Advantages of interoperability in the information systems	Disadvantages of interoperability in the information systems
increases productivity	data timeliness
better data protection	data consistency
reduces costs	data redundancy
reduces error rate	data security
reducing the time to obtain the right data	Implementing interoperability between systems is costly and time consuming

Table 2 lists the five main advantages and five main disadvantages (according to the authors of the paper) associated with the interoperability of information systems. Despite the disadvantages, which are primarily caused by the cost of putting this system into practice and the time of its creation, it also provides advantages, especially in the area of productivity of interconnected companies. In viewpoint of the disadvantages, when implementing interoperability

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between systems, maintenance must be taken to ensure that the entered data are up-to-date, consistent and do not duplicate in terms of where they are collected. On the contrary, the use of data stored in this way and shared with each other makes it possible to reduce the error rate in operating with these data, which increases productivity and leads to the efficient use of both time and resources. This ultimately diminishes the costs caused by downtime, error correction, or resolving data loss or theft.

7. Conclusions

Interoperability is a term that has been present in the literature for several decades and still discovers new areas of use in practice. However, its categorization is inconsistent, as it is necessary to consider the way in which the issue is perceived. Similarly, the models of its measurability are not completely uniform, and they take greater account of the conformational test, but it does not express the measure itself.

In addition, interoperability is relatively widespread and reaches several spheres of life. Therefore, it is questionable to what extent the interoperability of logistics companies as well as distribution logistics companies affects technologies as well as processes. However, this will be further examined in following research.

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The Most Preferred Portal for the Use of E-Government Services

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Abstract This Currently, Communication is important, citizens can communicate with the state through different means. One of the access points is Central Government Portal (CGP) that serves as access to e-government services. Primary survey was aimed on the most used access points of our e-Government. The results of the survey have shown that slovensko.sk is the most used portal. On the other, other portals are also frequently used what raises a question what way of identification is more citizen friendly and whether the current state of identification is appropriate for everyone.

Keywords Digitalization, Slovensko.sk, e-Government

JEL R50, R590, H540

1. Introduction

Slovak e-Government access points include Central Government Portal - slovensko.sk, specialized portal, Integrated citizen service point (IOMO) and client centers. These access point serve natural persons as well as legal persons, who are allow to use e-Government services. The aim of primary survey was to verified which portal is the most using and defined advantage and disadvantage e-Government services. Central Government Portal (CGP) is an information system which is used for electronic communication with particular authorizes and for access to all online services through a single-entry point, especially using internet and information and communication technology (ICT). The aim of CGP is to enable citizens to communicate with authorities by means of which ICT from one access single entry point only.

The main purpose of the portal is to guide users to particular public e-service along with the use of relevant information resources. Citizens are required to have their own electronic ID (eID), any of ICT devices such as, laptop or computer, reader for eID, internet, digital skills and central government portal software. CGPl is a portal providing information about e-Government, whose services in information can be shared among citizens. Electronic mailboxes are located at the CGP at slovensko.sk. There are loads of statistics there, which identify saving money such as sending, submitting and notifying sent electronically - see Table 1. [1,2,3]

Table 1. Financial saving by means of CGP

Year	Decision sent electronically	submissions sent electronically	notification sent electronically
	Savings in [€]	Savings in [€]	Savings in [€]
2019	57 913 022	6 826 858	8 456 325
2020	79 705 215	7 382 850	5 562 769
2021	79 891 383	6 219 816	4 265 345
Total for 3 years	217 509 620	20 429 524	14 445 439

Source: Slovensko.sk[online]. [cit. 2022-4-07]. Available on the internet:< https://lnk.sk/jwK8>, Own processing.

Among the main benefits that the e-services bring are saving time, financial savings, availability 24/7, all the services in single place and improving public access to open government data, streamlining and improving access to current, historical and future data, streamlining the provision of information and more.[1] Specialized public administration portals by means of which messages with one or more public administrations are possible include the following portals, such as: www.ejustice.gov.sk, finančná správa, www.eznamka.sk, www.portal.minv.sk, e-sluzby.zilina.sk, npz.sk and others. [4,5]

The client center is designed to provide comprehensive services to the public in one place, so that the services are equipped efficiently, quickly and increase the comfort of

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citizens. Client centers have been built in each district in Slovakia. [6]

Subsequently, IOMO serves for assisted electronic communication of legal entities and natural persons with public authorities. The Ministry of Finance of the Slovak Republic is the administrator of the IOMO information system and operation. Besides, IOMO provides assisted access to CGP and the use of e-Government services for citizens and businesses. [7]

In addition, the access points to eGovernment services consist mainly of virtual or physical. On the one hand, The Virtual access points are CGP, specialized portals, call center and so on. On the other and the physical access points are IOMO, client center and so forth. Access points are used by both natural and legal persons to use e-Government services. [6, 8]

Table 2. Access components of eGovernment architecture

Access points to eGovernment services in Slovakia
Central Government Portal – (CGP) (Including electronic mailbox)
Specialized portals - www.ejustice.gov.sk, finančná správa, www.eznamka.sk, www.portal.minv.sk, e-sluzby.zilina.sk, Národný portál zdravia (www.npz.sk) and others.
IOMO – integrated citizen service point
Other access points: single point of contact (physical or electronic), call center, client center and others

Source: [4,6,7,8], [online]. [cit. 2022-4-07]. Available on the Internet: < combination of several source>, Own processing.

Access points are slovensko.sk, national health portal and so forth. For signing up to the access points is necessary to have eID with electronic reader because it is the only way to log in. It implies that, Slovakia only has one method of signing up into Central Government Portal. However, other European countries often use so-called mobile-ID in order to make available to modern services of a state for all citizens and all age categories. [9] E-Government services has in current state of some barriers. The Slovak citizen has access to electronic services under certain conditions. That conditions are essential to be used e-Government services. [10] Unless these conditions are met, they made barriers in the use of eGovernment services. (see table 3).

Central government portal. In order for a citizen to be able to use the electronic services of the Industrial Property Office, it is necessary to have an eID with an active BOK, digital skills, computer or laptop, network, card reader for eID and software designated by the state for the transformation of data from an electronic form into a PDF.

Table 3. Terms of use for eGovernment service

Conditions for using e-Government services	**Types of electronic services that can be used for the conditions**
Own an electronic ID card with (BOK)	Central Government Portal, Specialized portals
Digital skills	
Device - computer or laptop	
Network	
Card reader for eID	
Software	Central Government Portal

If a citizen wants to use all these services, it is necessary to satisfy all these conditions. Use of electronic services of specialized portals. Services can be divided into two categories, which are services without the use of eID and readers, for instance eznamka.sk, katasterportal.sk and so on. Consequently, it is necessary to use eID with a reader for the service for instance CGP, e-sluzby.žilina.sk etc. The level of digital skills of a citizen determines what services they are able to use. The IOMO service can be used without the mentioned conditions (see Table 3). [1,2,6]

The Government of the Slovak Republic has approved a new type of identity card, which will contain biometric data. The biometric date will be fingerprints and a facial image, which will be in the form of encrypted biometric data. Subsequently, all this data will be deleted from the public administration server and biometric data will be available only in the identity card. Another innovation of the eID will include NFC "near field communication" chip. the new eID holder will be able to retrieve information contactlessly. Loading the ID card by shifting should be maintained. [11,12]

Moreover, citizens will also able to use eID as access point to health data in electronic form and it from first January 2022. Patients have to verified with the new eID. This verification will be the only way how to access to health information about oneself. Furthermore, the eID will be used to select drugs from the pharmacy, in this case citizens will not be able to use the health insurance identifier. [13] This project was made for the field of e-health. Young citizens under up to 15 years will use eID without faceless, which will only be used for the eHealth project. This eID will be valid until the age of 15, respectively until the issue of a standard identity card. [11,12]

2. Goal and methodology

The aim of the questionnaire was to identify the advantages and disadvantages that are perceived by the citizens of the Slovak Republic and also which portal is the most using out of access points. The questionnaire was created in February 2020 and conducted a survey of 296 respondents age from 19 to 70. The results of the primary survey were interpreted graphically and in writing and the values are given in percentages. Data collection for primary research was in the time interval from 10.02.2020 to 28.02.2020. Questions were answered by 201 women and 95 men by 95 percent.

The questionnaire consists of three areas: [14]

- Determining the advantages that respondents perceive when using e-Government services,
- Determining the disadvantages that respondents perceive when using e-Government services,
- What e-Government access point is most used.

The subject of the primary survey was the citizens of the Slovak Republic. There are much more 500 000 in the Slovakia, therefore for calculation was used this equation. See (2) [15] The variability of the base file "p" is 0,5. The confidence interval is 95% and the maximum permissible error range "Δ" is 5.7%.

$$\sigma = \sqrt{p * (1-p)} = \sqrt{0{,}5 * (1-0{,}5)} = 0{,}5 \qquad (1)$$

$$n \geq t^2_{1-\frac{\alpha}{2}} * \frac{\sigma^2}{\Delta^2} = 1{,}96^2 * \frac{0{,}5^2}{0{,}057^2} = 296 \text{ respondetov} \qquad (2)$$

Table 4. Identification table of respondents

Which age category do you belong to?	Number of respondents	Total in (number) and (%)
to 19	19	296 100 %
to 20 to 29	79	
to 30 to 39	75	
to 40 to 49	54	
to 50 to 59	43	
to 60 and more	26	
What is your economic position?	**Number of respondents**	**Total in (number) and (%)**
Employed	147	296 100 %
Businessman	73	
Student	61	
Maternity leave	7	
Retiree	6	
Unemployed	2	

Source: own processing

The largest group consists almost mainly of citizens in aged category from 20 to 39. Besides, the largest group consist entirely of the employee. The total number of responses to the questionnaire was 296.

3. Results

All paragraphs must be indented. All paragraphs must be justified alignment. With justified alignment, both sides of the paragraph are straight. Respondents had a choice of several access points and had to mark which access points they used. The graph implies that Slovensko.sk is the most used accessible place for e-Government services. Subsequently, the second accessible place is the financial administration, eznamky.sk, justice gov, etc. (See Figure 1).

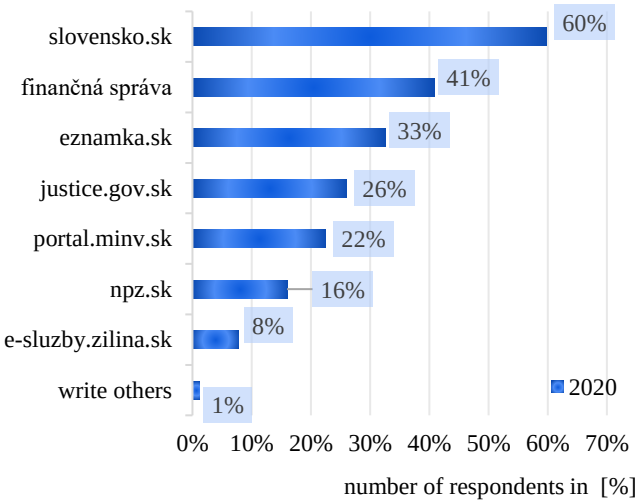

Figure 1. Place of use of e-Government services (Source: Author, Own processing)

IOMO services were used by 81 respondents out of a total of 296 respondents. In relative numbers, this represents 23% of respondents. It follows that 78% of respondents did not use this service. This means that citizens prefer and are focused on online electronic state services. Another area was which service is used the most from CGP and specialized portals.

Table 5. Used e-Government services

Used e-Government services Total number of responses: 595	Absolute frequency of response	Relative response rate	Relative number of respondents
Electronic vignettes for motorways	98	16%	58%
Filing tax returns	77	13%	46%
Finance (slovensko.sk)	65	11%	38%
E-prescription	63	11%	37%
Housing (slovensko.sk)	59	10%	35%

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Transport (slovensko.sk)	47	8%	28%
Citizen and state (slovensko.sk)	43	7%	25%

Source: Author.

Table 6. Continuation of Table 5

Used e-Government services Total number of responses: 595	Absolute frequency of response	Relative response rate	Relative number of respondents
Registration of motor vehicles	34	6%	20%
Processing of personal documents	31	5%	18%
Processing of electronic accounting documents	19	3%	11%
Electronic medical book	17	3%	10%
Notification of change of residence, address	17	3%	10%
Travel (slovensko.sk)	14	2%	8%
Payment of fines, interest and penalty interest	8	1%	5%
Others	3	1%	2%
Together	595	100%	-

Source: Author.

The results from Tables 5 lead to the conclusion that the most used service is the Electronic vignettes for motorways. In addition, tax filing and financial administration services are the second most commonly used services. If we count services such as finance, housing, transport, citizen and state, etc. The largest number of services is used by means of CGP.

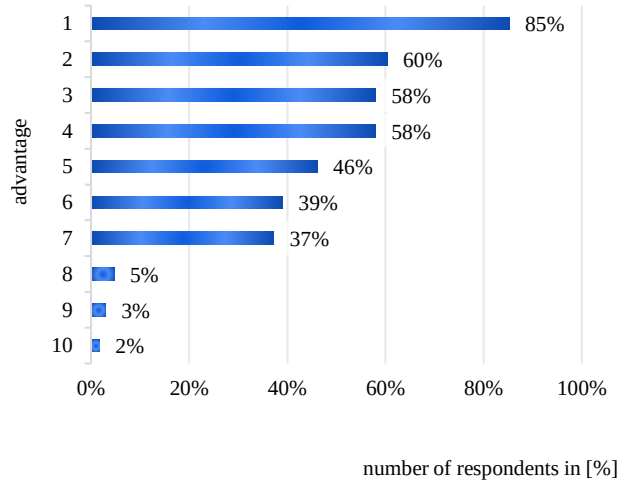

Figure 2. Advantages of e-Government for respondents

The authors identified advantages and disadvantages. Each number represents an advantage that the respondents marked. 10 (Other than listed benefits), 9 (ease of use), 8 (quality services), 7 (environmental protection), 6 (reduction of administrative burden), 5 (saving of financial resources), 4 (speed), 3 (availability 24 / 7), 2 (minimum physical attendance of the office), 1 (time saving).

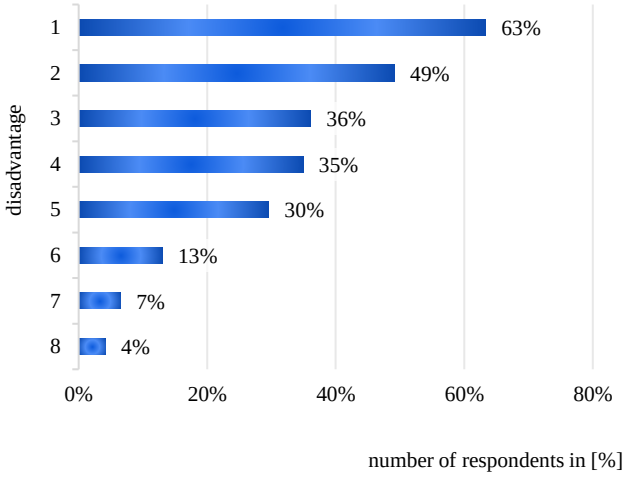

Figure 2. Disadvantages of e-Government for respondents

Each number represents a disadvantage which the respondents marked. The least marked answer was number 8 (do not see any disadvantage), 7 (do not list), 6 (absence of personal contact), 5 (possible risk of personal data), 4 (necessity of personal visit to the office (retrofitting), 3 (User complexity), 2 (Low digital literacy of citizens), 1 (Low level of information of services, etc.)

The results of the survey show that the negatives experience with the services had 6% of respondents only. There are some reasons, why respondent did not use e-Government services. Negative factors can cause for instance: system outages, service implementation, forgetting login data, complicated way of logging in to these services and the like.

The results of the survey imply, that time savings, minimal physical office visits and the availability of e-Government services 24/7 are key aspects, why respondents use these services. Time is an important aspect of official buildings because there are big lines in this time which are on certain days and hours for up to several hours or the customer does not equip the service, which leads to frustration and a negative image on public administration. However, these shortcomings could be eliminated with e-Government services.

Outcomes

To summarize, the first part of the article identified the access points of e-Government in Slovakia and the main accessories for using. There is a trade-off between using specialized access point and Central Government Portal. Besides, this paper also identified physic access point which is IOMO and so on. Furthermore, the article explains that citizens must have digital skill in order to use some e-Government services such as from CGP, National Health Portal. Hence, the login to CGP plays an important in using e-Government services in order to improve the number of the users. The previous fact affects what age categories and how often make use of the modern e-Government services. The article has shown that the eID and the reader for eID are necessary so that the citizen can use the services through slovensko.sk. Slovakia has no other means of login. Other data were drawn on primary research. The outcomes show, that slovensko.sk is the most used portal and access point of all. In addition, the most used service is electronic stamp and financial management services. However, the most used services were from the portal Slovensko.sk. Framework of primary research exposed the advantages and disadvantages of e-Government services in Slovakia. The main advantages of e-Government services are time saving, availability 24/7, financial savings and so forth. Moreover, the main disadvantages of e-Government services are low level of information of e-services or low digital literacy of citizens and so on.

4. Conclusions

In the end, the work was divided into main 2 parts. In short, at the first part of the work was identified e-Government access points in Slovakia. Furthermore, conditions for making use of e-Government services and innovation in the field of eID. On the other hand, to establish which access point is the most using we had to the do primary survey. Therefore, the second part of the article evaluates the primary survey which identification of the most used public administration portal.

Although this article focuses on e-Government access points, the article describes eID innovations. The State will upgrade the eID and based on that may change the way to login which will be user friendly. Slovakia have to come with up a new way to login for instance Mobile ID. [16]. Especially, much progress has been made in recent years, mainly by reason of the impact of digitalization and new ICT. Unlike other counties, Slovakia must innovate this area and be more transparency. In last years, use of ICT increases and changes in this area affect behavior of people and the way they work and communicate, yet the Slovakia should utilize new technologies [15-17]. Slovakia should concentrate on the creation of Mobil-ID, which could lead to an increase of the use of services through Slovenska.sk. To solve this problem, state have to invest to new modern technology at once. Interestingly, in many countries, AI strategies are beginning to be used and implemented in public administration to increase the efficiency of processes and eliminate, for example, duplication of contributions, etc. A great deal of countries with a high level of e-Government digital index have more options to log in to the state portal or almost most services digitized. For instance, Estonia has modernized the state portal and created a so-called life events that facilitate exploitation [15,16]. To some extent, data decentralization is common in many countries. The good examples are countries as Estonia and Denmark in order to protect user data and eliminated cyber-attacks.

The digital content of the portal consists of information and electronic services themselves. The goal of the CGP is similar to other countries. However, the method of login or access to services is different. [16,17] The main purpose of the portal is to guide users to particular public e-service along with the use of relevant information resources and simplify communication with the state for all citizens, which is not possible at present. This is due to the fact that the state does not use state-of-the-art. The use of the CGP is essential for saving resources as well as for increasing state trust.

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Localization of Transport and Logistics Units through IoT Technologies

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Abstract The paper deals with the application of IoT (Internet of Things) technologies for localization or other monitoring functions for logistic units using the IoT element. At the beginning of the paper, we analysed currently the most used technologies for localization and monitoring of logistic units. Then, we described the basic requirements for LPWA (Low-Power Wide-Area) technologies, including the information they can collect and provide. The main part of the paper is devoted to the design and testing of IoT solutions based on one of the LPWAN (Low-Power Wide-Area Network) technologies for a real logistics company. The conclusion of the paper is dedicated to testing the evaluation and prognosis of further use of LPWAN technologies.

Keywords IoT, LPWAN, Logistics, Logistics unit, systems

JEL L90, L96, L99, L86

1. Introduction

The current trend of most companies is to increase the efficiency of their processes. It is no different for logistics companies or companies that use logistics within their business processes. The main reasons for carrying out these activities and measures can be different. In general, these reasons are linked to dynamic economic changes as well as increasing supply chain pressure. The above-mentioned changes are mainly related to an acceleration of production cycles of products while maintaining and increasing the high quality of processes (service products). The process of eliminating bottlenecks in the transport process and the related increase in competitiveness and more is also important. That is a set of processes that enable the logistics unit to be transported at the right time to the right place and in the required quality, all while maintaining optimal costs. Although the logistics discipline addresses the above parameters, it has not always been possible to effectively control them throughout the entire transport process. The reason for this is simple. In general, there was no way to efficiently collect data within these processes in real-time.

As it has been mentioned for effective management of these processes, a considerable amount of high-quality input data is required. That is such input data that could be collected and evaluated in real time to identify their point of origin. It is very difficult to imagine a similar concept that would automatically and effectively collect these input data 10 years ago. However, information technologies have matured to the point where we look at the whole issue from a different perspective. It is not only about new technologies, but also about new approaches, ideas, creativity, and a way of thinking that lead to problem-solving. All these developments have led to the possibility of attaching specialized small electronic devices of varying functionality to logistics units. Overall, this concept has evolved into an area known as the Internet of Things.

The main goal of the research was to verify the possibilities of using LPWAN technology for the localization of vehicles and logistics units. The actual verification of the created solution was subsequently verified at a selected logistics company. The research itself was carried out not only to verify the test equipment but also to map the signal coverage of the Sigfox network.

2. Internet of things

Although the name "Internet of Things" does not accurately reflect its true depth, its definition is quite the opposite. Several definitions generally describe the meaning

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and content of the Internet of Things concept. It is equally important to emphasize that the definitions may evolve, themselves. We can simply explain this concept in one simple definition. The Internet of Things is a network of physical objects, especially day-to-day needs that are legible, recognizable, addressable through information capture technologies and accessible over the Internet, regardless of the type of Internet communication protocol. The subject of this paper is selected technologies for localization and transmission of telemetric data in the area of logistics and that is why only mentioned technologies are mentioned here. [1]

LPWAN is a low-power, low-power broadband network. These are wireless technologies that allow you to connect low-voltage and low-bandwidth devices at low intervals. Even though LPWAN technology has existed for some time now, its implementation is largely intended for the Internet of Things. LPWAN has higher energy efficiency and lower costs than standard mobile networks. They can also support multiple connected devices per node. The size of messages transferred subsequently can range from 10 bytes to 200 kilobytes. The communication distance of the type of technology used is up to 40 km. Most LPWAN networks have a star topology where the endpoint is connected to the access points (node gates). In view of the possibility of using LPWAN networks in logistics, we selected three networks that pose the greatest potential for the monitoring of logistics processes. [2,3]

Within LPWAN, several technological solutions differentiate their character. The differences may be apparent at the following points:

- use licensed, unlicensed bands,
- use of closed or open Standards,
- limitations on the number or size of messages,
- possibilities and distance of message sending,
- the capabilities of creating your local networks, etc [2,3]

Sigfox is a global operator with the same network name based in France. A specific feature of this network is that all the data from all sensors are sent and stored in the cloud on servers in France. Then, the data is distributed from the servers to the parent company's user systems. The key element and the very character of LPWAN technology is the quality of Sigfox transmission and low power consumption. The transmission is not synchronized between the device and the network. The device sends a message at a random frequency and then sends two identical messages at different frequencies. The principle of cooperative reception is that, unlike the cellular protocol, the object is not connected to a specific base station. The broadcast message is received by all base stations nearby. [3,4,5]

In general, Sigfox technology has a rich base of technology partners developing simple or combined communication modules. Thus, such combined modules contain the most common types of sensors. This is because Sigfox tries to get into the position of a global service provider for the Internet of Things. However, each technology has its weaknesses. The maximum message size that can be sent has a size of 12 bytes. Similarly, the maximum number of messages sent per day is only 144. It is based on one message sent every 10 minutes. [3,4,5]

In the field of logistics, these are primarily Sigfox modules that allow localization of logistics objects through GPS coordinates. A huge range of connectable sensors also allows you to increase the value added when monitoring logistics units. They can be sensors: temperature and humidity, opening sensor, sunshine sensor, vibrations, and shocks ad.

Sigfox in its basic form enables geolocation. The geolocation is realized based on the radio signal of the sent message. The key is the RSSI value of the sent message captured by several stations. These values are then compared to one another. Depending on the location of the base stations, it is possible to analyse the location of the message with accuracy from a few meters up to several kilometres. [2]

LoRaWAN is another low-power wireless network protocol designed for the Internet of Things. Communication between end objects and gates is spread over different frequency bands and transmission rates. Choosing the data transfer rate is a compromise between the communication range and the length of the message. Individual communication streams with different baud rates do not interfere with each other, but they create a set of "virtual" channels to increase gateway capacity. The LoRaWAN network server manages the baud rate and RF for each end device individually through ADR (Adaptive Data Rates). All of this leads to maximizing battery life and efficient network capacity utilization. The LoRa system is based on spread spectrum modulation. LoRaWAN defines the communication protocol and network architecture of the system, while the LoRa physical layer allows long-distance communication. [6,7,8]

Like the Sigfox technology, Lorawan has endpoints, access gates, and a network server. Communication is similar, again asynchronous. The sent message is received by all gateways in the vicinity and sent to the network server. Unlike other solutions, the entire access network and its components belong to the customer. The entire communication and data flow is managed by end users. This gives users a great deal of flexibility to customize the network settings. [6,7,8]

Similarly, both Sigfox and LoraWan have the means to geolocation their transmitting devices. For the success of geolocation, it is necessary to receive at least three base stations. The principle consists in naming the transmitted message with a time stamp and comparing this value with a time stamp by receiving messages within the abovementioned base stations. [1,6]

NB-IoT (NarrowBand IoT) is a standard-based LPWA technology designed to connect a wide range of new devices and services. Significantly it improves user equipment power consumption, system capacity, and spectrum efficiency, especially with inflated overlays. Battery life is over 10 years

for a wide range of applications. It is designed to meet the demanding requirements of extended coverage, remote or deep in the interior, and very low complexity of the equipment. [8,9]

NB-IoT works in compatibility with LTE (Long Term Evolution) mobile networks, utilizing all the security and privacy features of mobile networks. One of the main advantages of this new standard is its compatibility with traditional cellular networks. Data transmission is limited to 250 kbps for transmitting and 20 kbps for receiving signals. [8,9]

3. Materials and Methods

Design and testing of IoT equipment were realized for an unnamed manufacturing company which is engaged in the production of parts for the automotive industry. Its integral part is also the implementation of logistics operations. This company manufactures and supplies its parts for different landscapes in Europe. These are mainly Germany, Poland, the Czech Republic, Hungary, and others. That is why this company needs to have enough information about its logistics units. One of the shortcomings that this company feels is due to the lack of real-time information on the current location of its means of transport. If these data were available, it would be easier for the company to eliminate bottlenecks in the transport process. It would also improve interoperability between the company and the buyers of their goods. [10]

Main requirements for location devices:

- they can be connected not only with the means of transport itself but also with the trailer itself or with a specific logistics unit (container and pallet),
- a long battery life,
- use of localization and also sending of information from the countries of the customer (coverage of the technology network),
- easy scalability (option to add additional sensors). [10]

Nowadays, many states, not only in the European Union but in other parts of the world, report that their state has already implemented one or another technology. However, the truth is a little more complicated and is primarily related to the coverage of a network. Just as mobile operators try to cover the largest part of their territory with the signal, these LPWAN operators have the same task. If we mention Lorawan technology, there is no ambition to become a global operator. Therefore, it will always be a technology that can only help in the territory where the technology is applied, for instance in the area of large cities or industrial zones. Other mentioned technologies NB-IoT has already had ambitions to become a global operator, but the speed of their implementation at present in the territory of the Slovak Republic and other EU countries is not enough. The last mentioned Sigfox technology has a relatively large coverage of the territory of Slovakia and the states to or through which it carries out transport activities. Information on the level of Sigfox network coverage can be found on the Sigfox website. For this reason, Sigfox technology has been chosen for this design and testing.

The design of this device was conceived in such a form to allow the additional connection of other peripherals. The basic part of the whole design was the Arduino nano integrated circuit which was modified to reduce overall consumption. The GPS module GPS6MV2 with the appropriate receiving antenna was chosen for localization. The Sigfox WiSOL SFM10R1 communication module including the antenna and a test license valid for one year was chosen for communication. There are several Sigfox modules on the market that allow communication in various ways. The main advantage of the above-mentioned module is the relatively low price and the possibility of simple communication via AT commands. Atmel Studio and Arduino IDE were used for the programming of integrated circuits. The first assembled model is shown in Figure 1 and the improved version of this model is presented in Figure 2.

Figure 1. Model sample no. 1 [10]

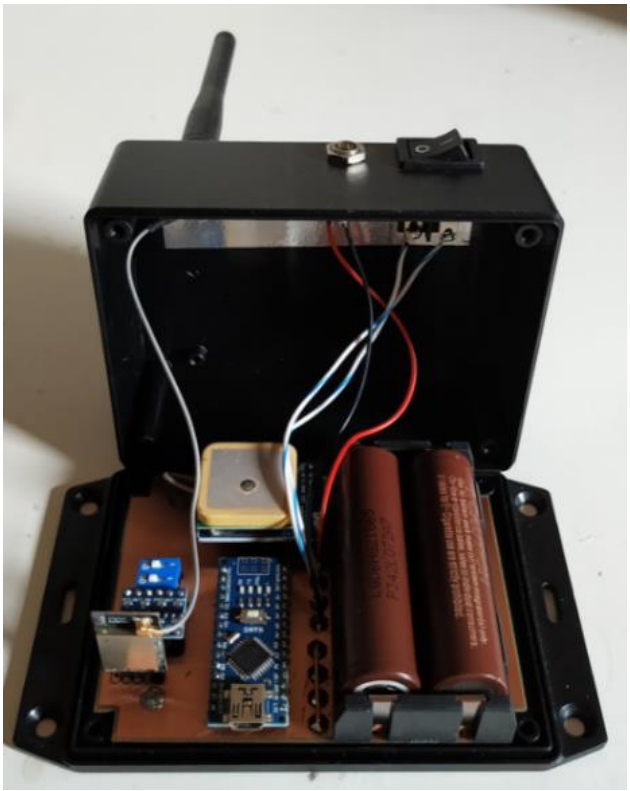

Figure 2. Improved model sample no. 2 [10]

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The main information that is sent by the device is the GPS coordinates. The maximum message size is 12 bytes. Most of the capacity can be used for more accurate GPS coordinates or in varying proportions of less accurate coordinates in combination with other outputs of potentially connected sensors. The messages are always sent to the Sigfox cloud. They can be routed from the cloud to superior systems by various methods. You can also connect to so-called emulated networks. One of the devices that emulate the Sigfox network is the SDR dongle. This device was used in laboratory tests. Within the backend of the Sigfox cloud, you can view the messages of connected devices, set methods, routing and types of output data read by individual modules. An example of the display of individual messages sent by a specific module is shown in figure 3. The software to the SDR Dongle hardware emulator has a very similar functionality and visual appearance.

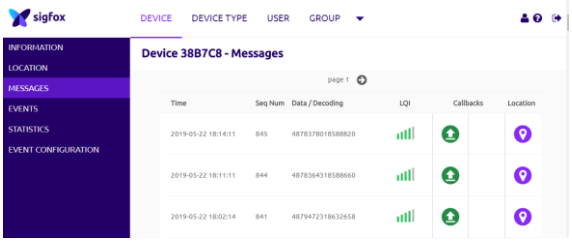

Figure 3. Example of graphical interface sifox backend [10]

There are several options for routing data. These are mainly the services of IoT platforms. Of course, you can connect to your own servers. This can be used, for example, by using known HTTP methods such as "GET", "POST" or "PUT". This research used the GET method on the one hand and a PHP server with a script on the other hand. All incoming messages from the Sigfox cloud are processed and stored in the MariaDB web database server. The Apache server also runs on the same server. The stored data can then be visualized via web applications or other services on the Internet. Within the created application, it is also possible to export the selected data to an XML file in GPX format (GPS Exchange format). The exported file can be used again for visualization within the Internet services or through desktop applications. The whole process is better seen in the following figure.

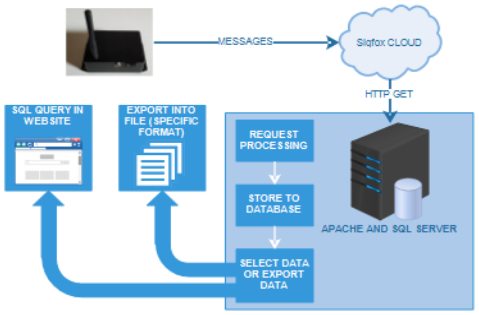

Figure 4. The principle of storing and retrieving data in the created solution

Within the web application, it is possible to monitor a means of transport, a semi-trailer or a logistics unit located within a means of transport in real time, including their location. The output of web applications can be seen in Figure 5.

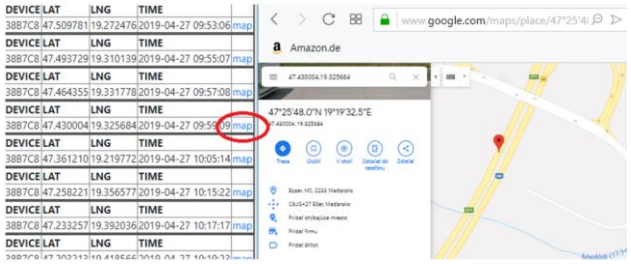

Figure 5. Example of output data in the presentation module of the created solution [10]

4. Results

Testing of the created solution took place in a laboratory and real environment in the company producing components for the automotive industry. Laboratory testing consisted of finding errors and optimizing the equipment for the real environment. The SDR dongle emulator was used in laboratory tests.

The first real testing took place between two branches of the company, one of them was located abroad. The test subject was a vehicle carrying parts. The location device was attached to the front instrument panel. The starting point of the journey was a place near the town of Prievidza and the destination point was a place near the Hungarian town of Kecskemet. The standard route is 322 km long and the time needed to implement this trip was set at 4 hours and 45 minutes. As was mentioned the maximum number of messages set for one day is a maximum of 144 messages (1 message every 10 minutes). Because the trip was planned for a shorter period, the recording time was set at 1 message for 2 minutes. The expected number of messages was about143 pieces per journey. The tested vehicle set off from the starting point at 06:43 and arrived at the destination at 020: 53. The total travel time was shorter by 35 minutes, ie the travel time was 4:10 minutes. The expected number of messages was adjusted to 125 in time, only 47 messages were recorded. The shortest difference between adjacent scanned points was in the value 00:02:05, ie the corresponding setting. The largest difference between adjacent scan points was 00:16:06 which was significantly more than the scanned value. The device was set to send the message only if it read the GPS coordinates and was also close to the Sigfox base station. From this, it can be concluded that the vehicle was not always in an ideal environment, which would allow it to read the coordinates and send a message at the same time. In the end, the average retrieval time of one message corresponded to the time value 00:05:29. The output of this testing can be seen on the used geolocation application programming interfaces in Figure 6. At present, the countries of Europe are

constantly expanding to cover and improve the optimal operation of the Sigfox network. The use of other components could also significantly increase the ability to obtain GPS coordinates. However, this is the subject of further research. It can be assumed that the gradual expansion of networks, but alternative solutions for remote messaging will allow a more massive deployment of these technologies. [10]

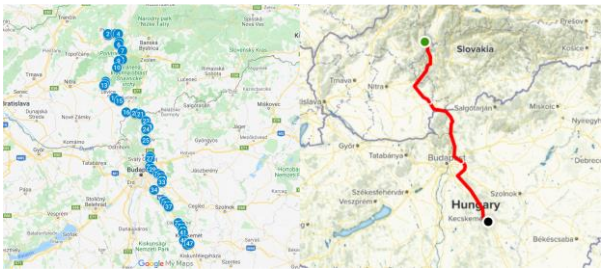

Figure 6. Rendering coordinates into google maps using the created application (on the left) and Rendering coordinates into the Alltrails app (on the right) [10]

5. Discussion

The main goal of the research was to verify the possibilities of using selected LPWA technology for the location of vehicles and logistics units. Although the results of the research did not reveal such great ambitions, they can be considered successful. Thus, it is possible to identify at least every quarter hour where a particular vehicle is located. It is also possible to identify the average time shift between the recorded points.

Based on the results of testing in a real environment and their subsequent analysis, provides us with additional facts. Then, these facts will be used for further research in this area. This research will consist of the use of alternative hardware modules (ie GPS, Sigfox module as well as different antennas for these modules) and the different ways of placing the device in a vehicle. After changes and new measurements, the analysis of individual experiments will be performed again to maximize the obtained data. Given the current logistics requirements, it can be assumed that LPWA technology will be essential for real-time data acquisition in the future.

The research was carried out on the territory of two states that have Sigfox technology widely spread on their territory. Unfortunately, the situation in other countries, where the production company carries out its logistics, is currently under construction. For this reason, the research could not be applied to other places. However, this will change in the future and testing on other routes is planned. For the same reason, the manufacturing company does not currently plan to implement this technology in its processes. It can be logically concluded that the future rate of use of this technology in international logistics is determined primarily by the existence and degree of coverage within the territory.

6. Conclusion

Based on the facts found above and the results of research and testing, it can be concluded that the use of Sigfox technology is highly applicable to the field of logistics. Location localization can be assisted with the help of these devices via RSSI or time stamp or via a connected GPS module. By using the individual options, it is possible to obtain the location of logistics units from the orientation position very accurate. From the point of view of existing similarly furnished based on classic GMS communications, there is no revolution at first glance. When looking at the whole issue deeper, just the price and high consumption of classic GMS modules, was the main reason for the bad use of such devices in logistics. The main positive aspects of LPWAN technology are not only low consumption with a battery life of 15 years but also a lower purchase price compared to GMS technology. Of course, the semi-object is one piece of information, but additional information can be sent via additional modules. Additional information such as transported subjects may include information about the environment in which the transported subjects are and how it affects them. All this information is the source of decision-making or the basis for the possible elimination of bottlenecks in the transport process. These old-new technologies make it possible for logistics to be upgraded to a remarkable level. Because they can track real-time logistics subjects, whether in a shipping process or a warehouse. In the end, an important aspect is whether the information so accumulated will be correctly interpreted.

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