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

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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.

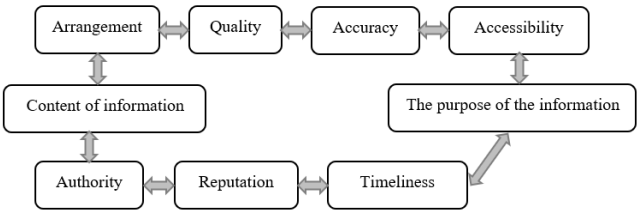

Figure 1. Factors affecting the exchange of information within the reciprocal IS interconnection. (Source: [1], own processing)

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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REFERENCES

[1] Hochmann, J.: Interoperabilita informačných systémov v Slovenskej republike. ITlib Informačné Technológie a Knižnice, 2007.

[2] Interoperability Definition. Techopedia. 2022. Available at: https://www.techopedia.com/definition/631/interoperability.

[3] European Commission. New European Interoperability Framework: Promoting seamless services and data flows for European public administrations. 2017. Luxembourg. ISBN 978-92-79-63756-8.

[4] What is Interoperability? Definition and FAQs. HEAVY.AI. Available at: https://www.heavy.ai/technical-glossary/interoperability.

[5] Interoperability. Identification for Development. Available at: https://id4d.worldbank.org/guide/interoperability.

[6] What is Interoperability? Definition, Benefits, Levels & Standards. RingCentral UK Blog. Available at: https://www.ringcentral.co.uk/gb/en/blog/definitions/interoperability/#Benefits_of_interoperability.

[7] European Parliament and Council of the European Union. 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). Official Journal of the European Union, 32002L0021, p. 349–366.

[8] European Commission. European Interoperability Framework - Implementation Strategy. 2017. COM (2017) 134 final, p. 1-9.

[9] European Commission. European Interoperability Framework - Implementation Strategy: Interoperability Action Plan. 2017. COM (2017) 134 final, p. 1-4.

[10] European Commission. European Interoperability Framework - Implementation Strategy. 2017. COM (2017) 134 final, p. 1-42.

[11] What the Cyber and Information Security Policy for II. and III. ISVS category and how to develop it. Cyber and Information Security Management Department. Slovakia. with. 1-37.

[12] 594/2006 Coll. - Regulation of the Government of the Slovak Republic on technical requirements for interoperability of the trans-European high-speed rail system. SLOV-LEX.

[13] 61/2022 Coll. Government Regulation laying down details on the interoperability of car radios and terminal equipment intended for the reception of digital television signals.

[14] New EDPB statements on border opening and interoperability of COVID-19 applications. Office for Personal Data Protection of the Slovak Republic. Available at: https://dataprotection.gov.sk/uoou/sk/content/nove-vyhlasenia-edpb-k-otvoreniu-hranic-interoperabilite-aplikacii-na-boj-s-ochorenim-covid.

[15] Adebesin, F., Foster, R., Kotzé, P., Van Greunen, D.: A Review of Interoperability Standards in E-health and Imperatives for their Adoption in Africa. South African Computer Journal, South African Institute of Computer Scientists and Information Technologists. 2013. 50, p. 55–72.

[16] Interoperability Requirements. TOGAF® 9.1> Part III: ADM Guidelines & Techniques> Defining and Specifying Interoperability. 2011. Available at: https://pubs.opengroup.org/architecture/togaf91-doc/arch/chap29.html.

[17] Ford, T.C., Colombi, J.M., Graham, S.R., Jacques, D.R.: A Survey on Interoperability Measurement. Twelfth International Command and Control Research and Technology Symposium (12th ICCRTS), 2007. p. 28.

[18] Madlenakova, L., Madlenak, R., Drozdziel, P., & Kurtev, I. (2015). Layers and processes in the model of technological postal system. Transport and telecommunication, 16 (4), 353.

[19] Jabin, J., Dimyadi, J., Amor, R.: Systematic literature review on interoperability measurement models. 2019.

[20] Da Silva Serapião Leal, G., Guédria, W., Panetto, H.: Interoperability assessment: A systematic literature review. Computers in Industry, 2019. 106, p. 111–32.

[21] Andrejčíková, N.: Interoperability and integration of IS in the academic environment. 2008. p. 1-24.

[22] EHR Systems: Definiton, pros and cons of electronic health records. 2020. Available at: https://nix-united.com/blog/electronic-health-records-safety-quality-and-integrations/.