The Digitalisation of a National Metrology System

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ABSTRACT

Purpose: This paper deals with the method of digitalisation of the authorisation process for verification of legally controlled measuring instruments, which is under the responsibility of the Slovak Office for Standards, Metrology and Testing, presents the legislative definition of the process and a description of the individual authorisation threads. Furthermore, the work deals with the method of process digitalisation, which can be applied analogously to other processes within the office.

Methodology/Approach: We have analysed the law on metrology and identified 26 processes suitable for digitalisation. These processes were analysed in more detail by flowcharts and process maps.

Findings: We have found that the most complex process in the national metrology system is the authorisation process, and therefore, we concluded that it will be the most appropriate process for the scope of digitalisation.

Research Limitation/implication: Our research is limited by the currently valid legal metrology regulations in the Slovak Republic.

Originality/Value of paper: Creating a universal methodology to define a strategy and implementing the digitalisation of the selected industry in specific national facts. The article can serve as a detailed and qualified background in the processes of specific implementation of national metrology system digital services in Slovakia.

Category: Conceptual paper

Keywords: digitalisation in metrology; national metrology system; legal metrology; law on metrology

1 INTRODUCTION

1.1 The importance of digitalisation in the context of the national economy of the Slovak Republic

The advent of digital technologies has accelerated dramatically in recent years. The company's transition to a new level of industry, referred to as Industry 4.0, represents a fundamental change with a global impact comparable to the discovery of electricity at the beginning of the 20th century.

In 2017, McKinsey conducted an analysis of the digital transformation of CEE countries (The Rise of Digital Challengers, 2017). According to this analysis, in 2016, the digital economy in Slovakia reached EUR 4.8 billion, which represents 5.9% of GDP. The analysis further states that through digital transformation, the share of the digital economy in Slovakia in 2025 could increase up to EUR 20.9 billion, which would represent 16.9% of Slovak GDP.

In order to define policy and specific priorities in the context of digitisation of the national economy and society, the Government of the Slovak Republic approved in 2019 the framework and supra-departmental document *Strategy for the Digital Transformation of Slovakia until 2030*. The vision of the strategy is mainly to improve the quality of state services for citizens and entrepreneurs, through which the state should reduce administrative obstacles in the provision of state services to citizens and entrepreneurs through digitalisation. Digital technologies must, therefore, be developed to improve the quality of life and optimise their contribution to the social, environmental and economic growth of the country (Digital Transformation Strategy of Slovakia 2030, 2019).

1.2 Metrology in Slovakia and the world

An important area of the national economy of the Slovak Republic is undoubtedly the area of making technical products available on the market and ensuring quality infrastructure tools. The main elements of the quality infrastructure in each country are standardisation, metrology, conformity assessment and accreditation. The central authority for these areas in Slovakia is the Slovak Office of Standards, Metrology and Testing (hereinafter referred to as the "Office" or "UNMS SR").

One of the main pillars of quality infrastructure tools is the field of metrology. It is divided into three main categories:

- scientific metrology - deals mainly with the implementation and storage of standards and the transfer of values of units of measurement to lower-order standards and gauges,
- industrial metrology - ensures the use of appropriate measuring instruments, measurement methods and traceability at the level of industrial enterprises, services and other interested organisations,

- legal metrology - deals with measurements from the point of view of trade protection, consumer, environment, health and other areas of public interest (Palenčár et al., 2001).

The Office deals mainly with the area of legal metrology, which is divided into harmonised and non-harmonised areas in the European area. The harmonised area consists of legislation that the Member States of the European Union (EU) must transpose into their legal order and is therefore legally binding in all EU Member States. Other areas of legal metrology are regulated by EU Member States by their own legislation, a non-harmonised area (European Commission, 2023). The non-harmonised area of legal metrology is enshrined in Slovakia by Act No. 157/2018 Coll. on Metrology and on Amendments to Certain Acts, as amended (hereinafter referred to as the "Metrology Act").

The Metrology Act is a regulation that determines the legal framework in the field of metrology. As a rule, it is aimed at legal entities and imposes various obligations on them when measuring and using measuring instruments. In practice, this means that if a legal entity uses a measuring instrument for one of the purposes laid down by the Metrology Act, it should use the so-called legally controlled measuring instrument, for which the Office lays down technical and metrological requirements. In order to ensure compliance with these requirements, legally controlled instruments shall be subject regularly to mandatory metrological checks. Therefore, the Office established the institute of the so-called registered person and authorised person. Registered persons are legal entities or natural persons – entrepreneurs to whom the Office grants the authority to install and repair legally controlled measuring instruments, subject to compliance with certain requirements of the Metrology Act. Authorised persons are legal entities that also, subject to compliance with certain requirements of the Act on Metrology, carry out official measurement or metrological control - verification of legally controlled measuring instruments.

In addition to the Office, entities involved in metrological activities in Slovakia are mainly public authorities and entities determined by the Metrology Act or may be established on its basis. These include the Slovak Metrology Inspectorate (hereinafter referred to as "SMI"), which is the state administration body for the field of metrological supervision, and the Slovak Institute of Metrology (hereinafter referred to as "SMU"), which provides activities mainly related to scientific metrology. It also includes authorised persons carrying out verification of legally controlled measuring instruments or official measurements and registered persons repairing and/or fitting designated instruments, or registered persons packing or importing marked prepackages. Each of these entities belongs to the national metrological system of the Slovak Republic (hereinafter referred to as "NMS") and is governed by the requirements arising from the Metrology Act.

A national metrology system is best understood as comprising the organisations (public and private) together with the policies, relevant legal and regulatory framework, and practices needed to support and enhance the metrology activities

undertaken within a country or economy (National Metrology Systems Developing the institutional and legislative framework, 2021).

1.3 Digitalisation and National Metrology System of the Slovak Republic

The current digital era has not yet dealt with paper documents and manual transcription of data in the field of legal metrology. Legal metrology processes where this is possible and efficient clearly need to be digitalised. The aim of this paper is to indicate the way of digitisation of the national metrology system of the Slovak Republic by analysing the selected area. The selected area or group of processes is the authorisation of entrepreneurs for verification of designated measuring instruments or performance of official measurements.

2 MAPPING SYSTEM PROCESSES

Let us repeat that the actors of the NMS are the UNMS SR, SMU, SMI, authorised persons and registered persons. Thus, we will deal with the processes of NMS actors. When designing the digitalisation of NMS, we identified 26 processes from individual actors, which include the main activities of the NMS (see Table 1). Authorisation and registration processes are listed separately in the table. The identified processes result from the Metrology Act, i.e. they are activities carried out by individual NMS actors, as they are required to do so by law.

Table 1 – Numbers of identified processes

Process area	**Number of identified processes**
UNMS SR	**13**
Of which: Authorisation processes	*5*
Registration processes	*4*
Other	*4*
Slovak Institute of Metrology	**12**
Slovak Metrology Inspectorate	**1**
Together	**26**

For each NMS actor, we have prepared a list of processes that govern, and for each process, the process input and output have been identified, the paragraph of the Metrology Act from which the activity follows and has been assigned a designation, which is necessary when depicting processes using flow charts according to ISO standard (ISO 5807, 1985). As an example of a more detailed identification of processes, we present the processes within the competence of the Office, which are listed in Table 2.

Table 2 – Identified processes within the competence of the Office

Marking of process	Name of process	Subject of Metrology Act	Input	Output
H3.1	Granting of authorisation	§ 31 – § 35	Application to authorisation to perform OM/VF	Decision on authorisation; Decision to stop the administrative proceedings
H3.2	Change in authorisation	§ 36	Application to change in authorisation	Decision on change in authorisation; Decision to stop the administrative proceedings
H3.3	Prolong of authorisation	§ 37	Application to prolong of authorisation	Decision on prolonging authorisation; Decision to suspension of administrative proceedings
H3.4	Suspension on authorisation	§ 38	The situation according to will occur § 38	Decision on suspension of authorisation
H3.5	Cancel of authorisation	§ 39	The situation, according to § 39, will occur	Decision on cancellation of authorisation
H3.6	Granting of registration	§ 42 –§ 46	Application to registration	Decision on granting registration; Decision to suspension of administrative proceedings
H3.7	Change in registration	§ 47	Application to change in registration	Decision on change in registration
H3.8	Suspension of registration	§ 48	The situation, according to § 48, will occur	Decision on suspension of registration
H3.9	Cancel of registration	§ 49	The situation, according to § 49, will occur	Decision on cancellation of registration
H3.10	Declaration, Change and Cancellation of National Standard	§ 9	Proposal by SMU	Decision on Declaration, Change or Cancellation of National Standard
H3.11	Temporary use other than legally measuring units	§ 15	Application to approval of use other than legally measuring units	Decision on approval/disapproval to use other than legally measuring units
H3.12	Exception to approval usage of mandatory calibrated measuring instrument	§ 17	Application to the approval of use other than the legally controlled measuring instrument	Decision on approval/disapproval to use other than legally controlled measuring instrument
H3.13	Exception to perform verification of legally controlled measuring instrument	§ 25	Approval to perform verification	Decision on approval/disapproval to perform verification based on measurements performed by an accredited laboratory

We further analysed each of these processes and used a flow chart and process map. We illustrated each of the processes using a flowchart, and then we illustrated all processes on a process map indicating mutual process inputs and outputs. We called this process map the main process map. As for the way of digitalisation of individual processes, the intention was to create schemes of individual identified processes for digitalisation purposes. The following framework headings had to be addressed when digitalising each process:

- identification and objective of the process;
- the activity carried out in the process;
- actors in the process;
- process inputs and outputs;
- control authorities' access to the process and its output;
- the technical solution of digitalisation.

3 RESULTS

Based on the main process map of the NMS and the representation of identified processes using flowcharts, we came to the conclusion that the most complex is the set of processes related to authorisation, so we will use it as an example process of digitisation.

The area of authorisation covers five processes:

- granting of an authorisation,
- change in authorisation,
- renewal of an authorisation,
- suspension of authorisation,
- cancellation of authorisation.

The issue of authorisation in the field of metrology is regulated by Sections 31 to 41 of the Metrology Act. The individual requirements of the authorisation processes are further elaborated in the methodological instruction of the UNMS SR No. 52: 2019 (MP 52: 2019, 2019).

As part of the authorisation, we have identified the documentary documents used, which we can divide into the following groups:

- application
- administrative procedure documents,
- records of controls within the authorisation processes,
- documents issued by SMI

- documents demonstrating compliance with authorisation requirements,
- documents issued by an authorised person.

These data units constitute the documents listed in Table 3. It lists all 50 paper documents used in the authorisation processes.

Table 3 – Paper documents used in the authorisation process

Applications
Application to authorisation to perform the verification of legally controlled measuring Instruments
Application to authorisation to carry out official measurements
Application to prolong of authorisation
Application to change in authorisation - § 36 par. 1
Application to change in authorisation - § 41 par. 1
Application to suspension of authorisation
Application to cancel of authorisation
Documents proving compliance with authorisation requirements
Incorporation list
Property list/lease contract
List on ownership/lease of technical equipment
Insurance contract
List of employees
Declaration of integrity
Documented system of work (Handbook of quality)
Certificate of Accreditation (optional)
Calibration certificates of measuring standards
Work manuals for performing control of measuring instruments
Documents of administrative proceedings
Decision on authorisation to carry out the verification of legally controlled measuring instruments
Decision on authorisation to carry out official measurements
Decision on prolonging authorisation
Decision on change in authorisation
Decision on suspension of authorisation
Decision on cancel of authorisation suspension
Decision on cancellation of authorisation
Letter of Head of Metrology Department – approval/disapproval changes in authorisation
Notification of initiation of administrative proceedings in the matter of authorisation
Notification of initiation of administrative proceedings in the matter of authorisation and a call for the elimination of deficiencies
Decision to suspension of administrative proceedings
Records from inspections within authorisation processes
Credential to check compliance with authorisation requirements
Report on the result of the inspection for the application for authorisation
Record of the result of the inspection for the request for authorisation
Protocol on the result of the inspection for the request for authorisation
Record of the review of the removal of formal deficiencies in the application for authorisation
Report on the result of the inspection for the application for prolonged of authorisation
Record of the result of the inspection for the request for prolonged of authorisation
Protocol on the result of the inspection for the request for prolonged of authorisation
Record of the review of the removal of formal deficiencies in the application for prolonged of authorisation
Report on the result of the inspection for the application for change in authorisation
Record of the result of the inspection for the request for change in authorisation
Protocol on the result of the inspection for the request for change in authorisation
Report on the result of the inspection for the application for change in authorisation

Table 3 – continuation

Report on the result of the inspection for the cancellation of authorisation suspension
Record of the result of the inspection for the cancellation of authorisation suspension
Protocol on the result of the inspection for the cancellation of authorisation
Report on the result of the inspection for the application for cancel of authorisation suspension
Documents of SMI
Schedule of metrological supervision of authorised bodies
Protocol on the result of metrological supervision
Documents issued by authorised body
Verification certificate of the legally controlled measuring instrument
Rejection letter

Those documents should be subject to digitalisation, which means that all data added to or retrieved from external databases should be recorded in such a way that a specific document in the required digital format can later be generated from them. We therefore proposed to create a database of authorised persons (DB_AO), the inputs and outputs of which are shown in Figure 1. We have designed this database to store all information currently stored mainly in paper form. When designing the database, we dealt with:

- what information it will contain,
- inputs,
- outputs,
- users and their permissions,
- document formats.

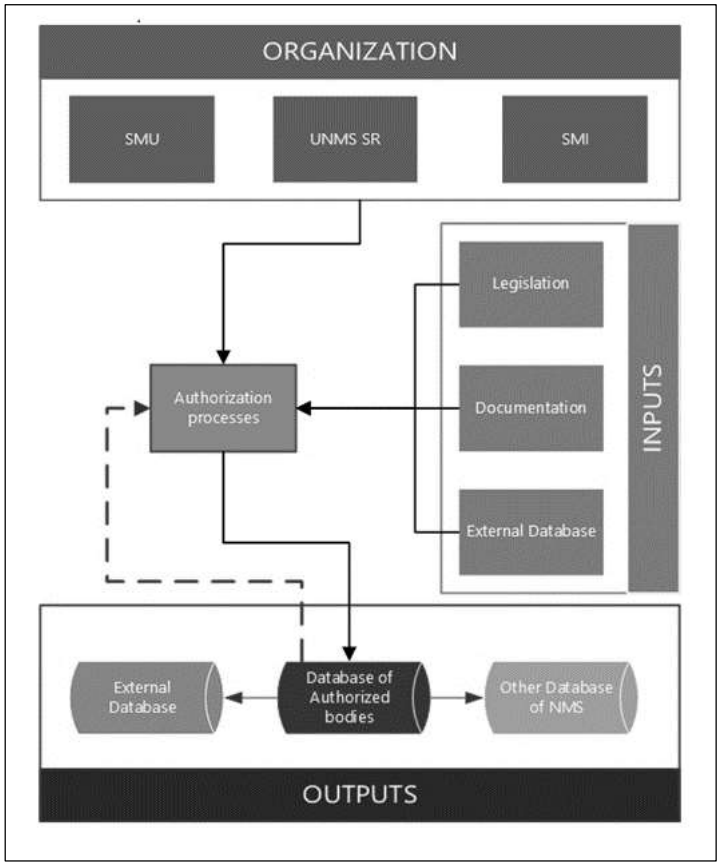

Figure 1 – Inputs and outputs of authorisation processes

At the same time, we also designed the basic structure of the database of authorised persons (see Figure 2). The structure reflects the basic division between authorised persons to carry out verification of legally controlled measuring instruments and authorised persons to perform official measurements. The lower level is then a specific authorised person, denoted as "xy" to represent a larger number. The sub-level of each authorised person are datasets:

- basic data,
- competence in metrology,
- administrative procedures, and
- metrological supervision.

Each of the enumerated datasets for a specific authorised person can contain either data in the form of text, date, number, a specific document e.g. (.pdf) or additional subsets that contain data in that form.

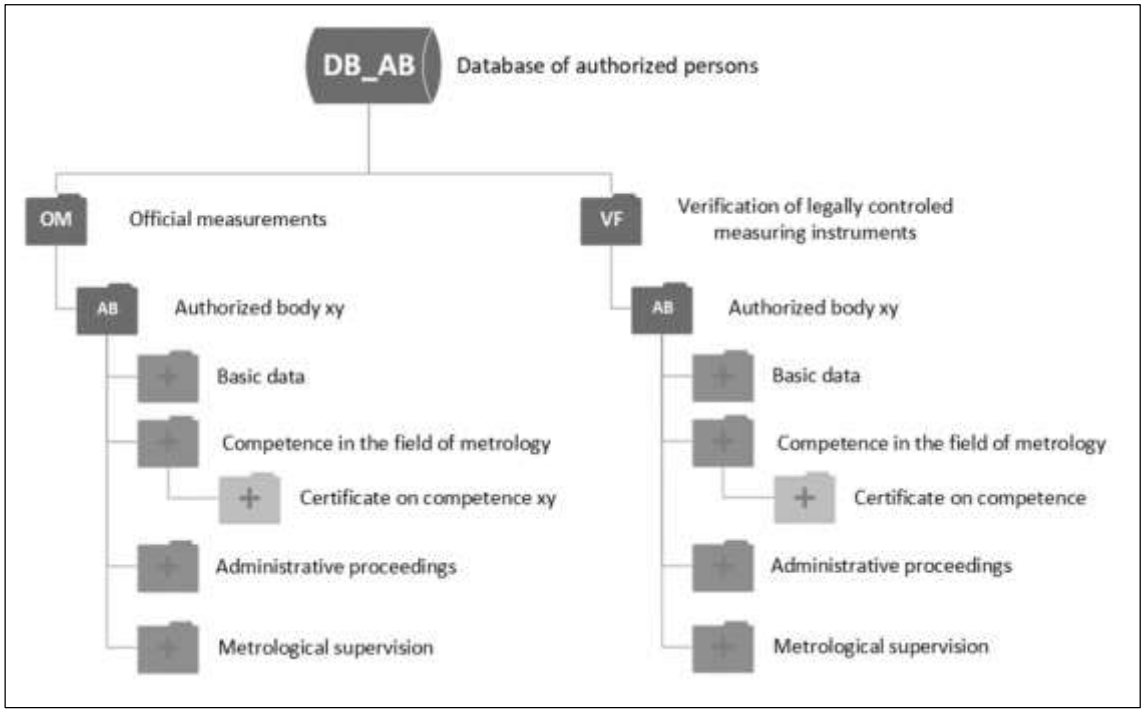

Figure 2 – Design of the hierarchy of the database of authorised persons

The basic data section should contain the data necessary for the identification of the authorised person, in particular the identification number of the organisation (the so-called IČO), which will be the key identification data in the database, the name of the company, contact details, etc. The data contained in the Metrology Competence Data Set will store the data provided on the Certificate of Competence in Metrology. The set of administrative procedures will contain chronologically, by date, subsets, each of which will represent a single process (authorisation, change in authorisation, suspension, revocation) that can be repeated until the organisation identification number changes. In the last set of metrological supervision, the data from the metrological supervision protocol will be stored with an authorised person.

In order to ensure that only those who need the data for their activities can access specific data, the database takes into account the NMS actor accessing the stored data. We therefore designed a competency matrix that specifies for each piece of data its data format, data type and how the data is accessed (see Table 4). The letter **E** indicates that the subject can edit (insert/change) the data in question. When editing data, it is recorded who edited it and when. The letter D indicates that the data in question can only be displayed to the subject and cannot be changed by the subject. Finally, the letters *ND* indicates that such an indication will not be displayed to the subject at all.

Table 4 – Part of the competence matrix of the database of authorised persons

Data			Competence					
Description of Data	**Data format**	**Data type**	**ÚNMS SR**	**SMÚ**	**SMI**	**Other government subject (SR)**	**EU Institution**	**Public**
Administrative proceedings – granting of authorisation								
Decision on authorisation	**PDF**	N/A	**E**	D	D	D	D	D
Number of decision	Number	CHAR	**E**	D	D	D	D	D
Date of issue of the decision	Date	DATE	**E**	D	D	D	D	D
Date of approval of the decision	Date	DATE	**E**	*ND*	D	D	D	*ND*
The decision was sent on the date	Date	DATE	**E**	*ND*	D	*ND*	*ND*	*ND*
Application letter	**PDF**	N/A	**E**	*ND*	D	*ND*	*ND*	*ND*
Date of application	Date	DATE	**E**	D	D	*ND*	*ND*	*ND*
Number of application	Number	CHAR	**E**	*ND*	D	*ND*	*ND*	*ND*

The data is stored in the database:

a) automatically, via web forms,
b) automatically by accessing other authorities' databases,
c) manually by the database administrator (UNMS SR).

File formats suitable means of ensuring digitalisation are .CSV or .JSON, because the use of freely available formats will allow the database to be applied to existing systems within NMS. These file formats store information as plain text in the UNICODE character set with UTF-8 encoding.

Due to the fact that the database of authorised persons contains a lot of data, the use of cryptographic protection methods is necessary in its creation. There is legal regulation in this area in Slovakia, namely Act no. 272/2016 Coll. on trust services, as amended, and Act no. 69/2018 Coll. on cybersecurity and on amendments to certain acts, which determine the framework of cryptographic protection of the database of authorised persons.

4 CONCLUSION

The complexity of the issue of NMS digitalisation requires a well-thought-out system view in solving it. This is reflected in a detailed and thorough analysis of individual processes. This paper elaborates in more detail on the analysis of processes in the field of authorisation under the Metrology Act. The authorisation process represents one of the most complex processes within NMS and appropriately demonstrates the chosen methodology of gradual digitisation of NMS.

The key activity for the design of digitalisation of the authorisation process group according to the Metrology Act was the processing of flow charts and the analysis of the requirements of the Metrology Act and the relevant methodological procedure. These define the sequence of steps within individual processes and determine the ranges of inputs and outputs of information. Data on the inputs and outputs of authorisation processes have been further disaggregated into structured, logical units, which represent the basic blocks of the database of authorised persons.

When designing the database, the simultaneous use of paper documents was considered during the transitional period. The advantage is that the proposed solutions will allow to gradually replace paper documents with data in the database and allow relevant data to be made available to all NMS actors. This will significantly facilitate and streamline the performance of metrological supervision and the performance of controls by other public administration control bodies.

The aim of further professional activities in the field of NMS digitisation will be a deeper elaboration of the structure of the database of authorised persons and similar detailed elaboration of the structures of other databases.

The digital transformation of the national metrology system is clearly expected to deliver:

- reducing the Office's costs in providing services;
- effective electronic communication with public administration, which will save time and money for entrepreneurs;
- greater efficiency of the metrological supervision body;
- new possibilities for statistical use and data processing;
- ensuring the free movement of data between NMS actors;
- compatibility with digitalised solutions at European level;
- efficient and transparent archiving of related data.

If the national metrology system wants to fully benefit from the digital transformation and the opportunities it brings, the time to implement it is now. Responsible and ambitious implementation of digitalisation will transform NMS into a modern system with efficient public administration and with citizens, entrepreneurs, and other public authorities able to use the potential of digitalisation. The implementation of the proposed solutions can thus realistically rank the NMS of the Slovak Republic among the successful areas of digital transformation and make it a system worth following.

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REFERENCES

Digital transformation strategy of Slovakia 2030 (2019) Available at: https://mirri.gov.sk/sekcie/informatizacia/digitalna-transformacia/strategia-digitalnej-transformacie-slovenska-2030 (Accessed: 27. September 2023).

European Commission (2023) *Measuring instruments* Available at: https://single-market-economy.ec.europa.eu/single-market/goods/building-blocks/legal-metrology/measuring-instruments_en (Accessed: 27. September 2023).

ISO 5807: 1985. Information processing. Documentation symbols and conventions for data program and system flowcharts, program network charts and system resources charts.

Law on Metrology (2018) *Act No 157/2018 Coll. on metrology and amending certain laws as amended*. Available at: https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2018/157/20230401 (Accessed: 1. October 2023).

Methodological guideline (2019) Methodological guideline for authorisation to perform verification of legally controlled measuring instruments and official measurements. Available at: https://www.normoff.gov.sk/stranka/15/autorizacia/ (Accessed: 24. August 2023).

National Metrology Systems Developing the institutional and legislative framework (2021). Available at: https://www.bipm.org/documents/20126/42177518/National-Metrology-Systems.pdf/3f13d88c-aef6-9c50-62dc-39fa6f48f6e9 (Accessed: 10. September 2023).

Palenčár, R., Kureková, E., Vdoleček, F. and Halaj, M. (2001) Measurement control system. ISBN 80-968449-7-0.

The Rise of Digital Challengers - Perspective on Slovakia (2017) *How digitisation can become the next growth engine for Central and Eastern Europe*. Available at: http://digitalchallengers.mckinsey.com/files/McKinsey%20CEE%20reportThe%20Rise%20of%20Digital%20Challengers.pdf (Accessed: 23. August 2023).

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Conceptualisation, M.S.; Methodology, M.S. and M.H.; Formal analysis, M.S.; Investigation, M.S.; Resources, M.S.; Original draft preparation, M.S.; Review and editing, M.H.; Visualization, M.S.; Supervision, M.H.; Project administration, M.S.; Funding acquisition, M.H.

CONFLICTS OF INTEREST

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