Fiscalization Instruments and Concepts for Digital Economy Enhancement

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***Abstract*— This article explores modern fiscal instruments and their use as an integrated framework in the digital economy focused on efficiency and interoperability improvement. An overview of modern research in the field of the fiscalization process is presented. The types of fiscal instruments are analysed. A new concept of the single fiscal framework is proposed and described. As a result of the study, the main recommendations for fiscalization process efficiency growth are offered and introduced.**

Keywords—fiscalization, fiscal device, digital economy, smart city

I. INTRODUCTION

Management of the modern government requires instruments for generating value by stimulating efficient production of goods and services. According to Organization for Economic Cooperation and Development (OECD) formulation taxes are "compulsory, unrequited payments to the general government sector" [1], therefore have a direct impact on the process of producing goods and services. Most countries have fiscal rules that require all business transactions to be reported to the authorities for managing and avoiding the risks of tax evasion. This process is called the fiscalization process and is the main focus of this research.

In 2015 the European Parliament and the Council of European Union (EU) introduced a general procedure for the provision of information in the field of technical regulation and rules on Information Society services (codification) as a basis for recommendations for fiscal regulation, stimulating the integrity and accessibility of the business environment. Therefore, countries themselves adopted EU recommendations and introduced their own fiscal laws [2]. A lack of technical and intellectual resources, a diversity of operating environment, difference in the availability of public and private services, e-government instruments and their security aspects [3] in the introduced fiscal laws have lead to a need for conceptual and technological changes.

Recently, there have been various studies on several fiscalization issues. In 2015 Peter Casey and Patricio Castro studied taxpayer compliance and administrative efficiency. The authors observed fiscalization as a self-contained process with controls deployed by government agencies and created a study to examine the effects of such a strategy for fiscal devices such as electronic cash register (ECR), electronic fiscal device (EFD), electronic fiscal printer (EFP) etc., [4]. Fiscalization as a self-sustainable process represents a strategy based on the individual technical regulations of each country. As a consequence, the impact and risk management must be measured to obtain an accurate fiscal tool. However, the studies do not take into account the effectiveness and risks of the employed technologies. There are no arguments in favour of selecting particular hardware instruments. As well as, the issues of interaction between countries are not considered properly. On the other hand, the authors proposed the idea that the efficiency of the fiscalization process can be improved by placing fiscal devices in an automation system, where information collection is automated. Additional efficiency can be achieved while observing fiscalization as a "*part comprehensive compliance improvement process"* [4]. The authors also indicated that new digital security skills would be required to cover the fiscalization process in the near future.

Another type of research about improved fiscal devices was made by Milan Prokin and Dragana Prokin and published in 2016 in two articles [5], [6]. The first research contains information about the specific implementation of the fiscalization process, that is - fiscal devices upgraded with communication modules collecting fiscal data and sending it to authorities. The authors compare improved fiscal devices with the transaction (journal) memory on the motherboard and improved fiscal devices on additional circuit boards, analysing the security and costs of both devices in an aspect of immunity to both sales suppression and tax zappers [5]. In the second research same devices are compared with the improved fiscal device, which communication module contains additional services, like fiscal software for authentication and key exchange, control software server with Point of Sales (POS) communication module, web interfaces for integrity tracking and tracing of sales for specific product groups [6]. Research is done for fiscal devices of the Republic of Serbia and not discusses other fiscalization solutions of other EU countries.

Later, in 2018, Milan Prokin, Dragana Prokin, Alexander Neshkovich, and Natasha Neshkovich conducted an additional study of the cybersecurity of improved fiscal devices with and without General Packet Radio Service (GPRS) terminals [7]. The authors gave an insight into the security of cyberattacks, which are performed to steal personal data. According to the authors of the study, misuse of Internet of Things (IoT) and the mobile network communication protocols can cause malicious information to be sent, causing problems for service providers [8]. The authors briefly described methods for manipulating data and proposed to protect the data itself using an information-oriented approach.

In turn, the current study considers fiscalization as a complex process with a unified approach to EU member states, which requires an appropriate level of technology and governance. A new strategy of fiscalization as an integrated process of the digital economy is proposed.

This paper is organized as follows: in the second section hardware and software instruments for fiscalization are described and an example of a modern approach for fiscalization instruments used in Germany is given; in the

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third section the way how fiscalization instruments can be integrated into a digital infrastructure is introduced and an example of the ecosystem of a smart city is proposed. And last, but not least section presents conclusions and developed recommendations.

II. FISCALIZATION INSTRUMENTS

There are three well-known approaches for fiscalization: hardware-based, software-based and both, hardware and software-based. Flowchart, shown in Fig. 1, represents fiscalization instruments and different levels of their implementation. Hardware fiscalization instruments perform transaction reporting, fiscal receipt printing, processing of corresponding data, their storage functions, while software instruments – validation of fiscal operation, a signature of fiscal data, data storage and archiving functions.

As shown in Fig. 1. fiscalization process first of all, depends on application type. The potential applications could be petrol stations, ECR, POS, self-service kiosks, parking automates. For each application type, the hardware or software instruments can be used. Commonly used hardware instruments are fiscal memory (FM) or fiscal printer with integrated FM.

FM contains non-volatile memory for storing fiscal operations and Global System for Mobile Communication (GSM) or GPRS modem for fiscal transaction reporting to authorities.

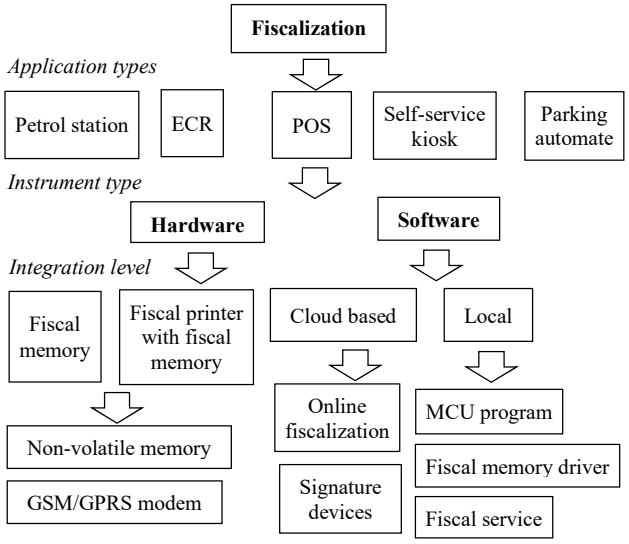

Fig. 1. Fiscalization instruments overview [4].

ECR – electronic cash register, POS – point-of-sales, GSM/GPRS modem - Global System for Mobile Communication/General Packet Radio Service modem, MCU programm – microcontroller program

Popular software instruments are cloud-based or locally installed software. Cloud-based software is used for online fiscalisation with signature devices and locally installed software within FM with microcontroller (MCU) program or Windows-based FM drivers and fiscal services.

A. Hardware instruments

Hardware-based fiscalization means the use of FM in which corresponding data is stored. In turn, FM is installed in a printer (fiscal printer) or in the form of a fiscal memory card with non-volatile memory, usually using the Recommended Standard 232 (RS232) or Universal Serial Bus (USB) connection type. All POS transactions are registered in the fiscal memory at the time moment when the receipt is printed. The first country which introduces fiscal devices was Italy in 1983 [4]. Since that time, hardware instruments for fiscalization have been adopted in most countries (Greece, Albania, Bulgaria, Bosnia and Herzegovina, Hungary, Montenegro, Poland, Romania, Slovak Republic, and Serbia, etc.) [4].

B. Software instruments

The software-based fiscalization process is more liberal as it enables a solution implemented using both on-premises and cloud architectures, providing a secure application programming interface (API) or data transaction, online dashboards for management, and automated instruments for authorities to perform control. Today, three scenarios of software fiscalization are widely used [4]:

1. Data on transactions with a digital signature are transmitted via communication protocols to the fiscal authority in real-time (Poland, Czech Republic, Croatia, Slovenia, and Slovakia);
2. Each transaction is stored locally in a fiscal journal, additionally generating a transaction data file in a special format (CSV, XML and JSON) (Latvia, Lithuania, and Albania);
3. Cloud-based fiscal software with cryptographic algorithms used for verification, digital signature, and storage of transactions for control purposes (Germany, Austria).

Software fiscalization solutions should be certified, so these costs are usually covered by enterprises [4].

C. Hardware and software instruments

The modern approach to the fiscalization process includes both software and hardware instruments. Taxable item transaction data is first generated by the software and verified by hardware security modules (HSM) devices - crypto servers [4]. Transaction data is stored locally or in the cloud and then reported to authorities, providing additional access to confirmed transactions and security procedures to control data integrity.

An example of hardware and software fiscalization solution could be found in Germany, where the Federal Ministry of Finance (BMF – Das Bundesministerium für Finanzen) introduced a new fiscal regulation called KassenSichV in 2017 [9]. In addition, Federal Office for Information Security (BSI - Bundesamt für Sicherheit in der Informationstechnik) has published technical standards for the new fiscal regulation [10]:

1. General Technical regulation: Technical Safety device for electronic recording systems (TR-03153).
2. Common Criteria Protection Profile for VPN Concentrator TI (BSI-CC-PP-0060), Cryptographic Service Provider (BSI-CC-PP-0104-2019), Secure Module Application (SMA) standard (BSI-CC-PP-0105-V2-2020).
3. Standards for cryptographic service providers: Cryptographic Mechanisms (TR-02102), Secure Certification Authorities (TR-03145-1), Elliptic Curve Cryptography (BSI TR-03111), Crypto Requirements (TR-03116).

4. Technical Guide for application programming interface (API) Secure Element (BSI TR-03151).

Published technical regulations are based on open standards for secure communication and software architecture, backed up with code examples and workload tests. Thus creating a need for fiscal service providers to certify their solutions with BMF and providing a fiscal management interface and integration API for POS software vendors.

Between 2017 and 2021, more than 50 fiscal service providers have certified their solutions. This became possible when Oracle Corporation - Secure Communications Alliance (SCA), BSI and others developed additional security profiles under the rules that accelerated the process of fiscal regulation adoption [10]. The flowchart shown in Fig. 2, is an example of the implementation of cloud fiscalization in Germany for Fiskaly Cloud Technical Security Solution (Cloud-TSS), presenting main components and data exchange between POS and Cloud-TSS [11].

The central components of Fiskaly Cloud-TSS are: Security Module, Software Development Kit (SDK), and Technical Security Solution environment (TSS environment).

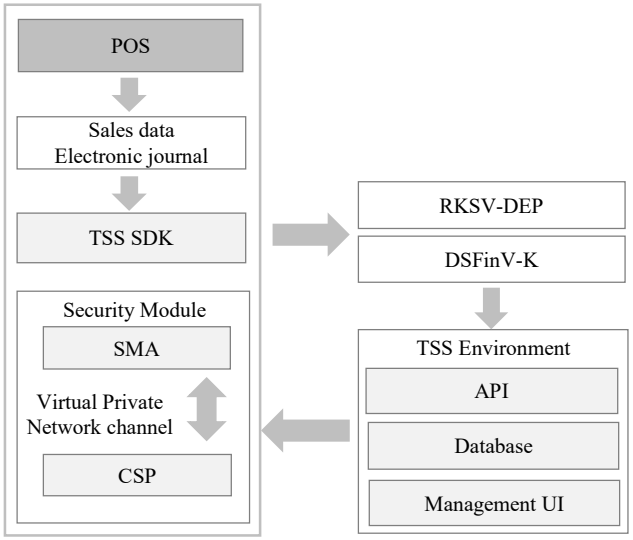

Fig. 2. Fiskaly Cloud Technical Security Solution according to Germany fiscal regulation KassenSichV [10].

POS – point-of-sales, TSS SDK – technical security solution software development kit, SMA – simplified memory-bounded algorithm, CSP – crypto service provider, RKSV-DEP – cash register security regulation data acquisition log, DSFinV-K – the digital interface of the cash management for financial systems, TSS Environment – technical security solution environment, API – application programming interface, Management UI – user management interface

Technical Security Solution software development kit (TSS-SDK) is implemented as part of a secure module application (SMA) in the POS operating system and is used to connect to the TSS environment via an API. The security module is responsible for verifying the transaction data and signing the receipt using the appropriate cryptographic key obtained from the cryptographic service provider (CSP) for every transaction made at the POS.

The flowchart work process starts with the installation of TSS SDK and software plugin on POS. Software plugin is created as a Windows service and is integrated using TSS SDK with TSS Environment via API. In user management interface (Management UI) each organisation generates TSS data for the cash register of the cash system: public keys, TSS ID, and other parameters, necessary to perform exchange between POS and TSS. Generated data is inserted into the configuration file of the software plugin. The exchange process is performed when the TSS device is being set to active in Management UI and the exchange process starts. Every receipt that is created on POS is validated and signed by TSS and its component CSP, creating sale data that is sent to cloud storage of TSS. Exchange of processed data is performed using virtual private network (VPN) for API requests and stored according to SMA structure. Data integrity of stored data in a cloud is achieved in two ways: POS software plugin generates clear data file in JSON format that is stored directly on POS and can be downloaded directly from POS system; additionally, every transaction that is performed during the accounting period (end of the accounting period is Z report, that is printed at the end of transaction day) is stored in an electronic journal using the digital interface of the cash management for financial systems (DSFinV-K) format and sent to TSS Environment. Electronic journal format consists of all operations created in accounting day and TSS generated data for every sale transaction.

The exchange process begins when transaction data (sales data and electronic journal) is generated in the POS software. Transaction data in appropriate cash register security regulation data acquisition log (RKSV-DEP) formats and DSFinVK are sent to the Fiskaly Cloud API and stored in a database, providing access for the collected data to an authorized person through the Management UI. The Management UI is also used to create TSS Client profile, generate TSS IDs for POS, activate TSS, view audit logs, and communicate with authorities (external systems). This implementation allows POS providers to handle fiscalization for a binding transaction by managing, processing and storing the required data in a certified fiscal cloud.

It is obvious that software instruments have advantages over hardware ones, as the software provides additional security, scalability, and interoperability by introducing integration standards and communication protocols. Despite all the mentioned advantages, in most EU countries software instruments are implemented as additional tools increasing the cost and time of implementation. The current study proposes and introduces an approach designed to improve the efficiency of fiscalization. To obtain it fiscalization instruments are combined and integrated into a single digital infrastructure improving interoperability, data transparency, and fiscal compliance.

III. SINGLE FISCALIZATION FRAMEWORK CONCEPT

The actual status of the fiscalization strategy in European countries is stand-alone implementation, not signed with digital infrastructure. Fiscal instruments need to be constantly updated, resulting in ineffective business costs and reduced tax compliance.

However, efficiency can be significantly increased by integrating fiscalization instruments into digital infrastructure, enhanced by technologies like the IoT and blockchain. There are some examples of such integration:

1. Exchange of fiscal data using a single digital infrastructure for the public and private sectors.

2. Fiscal data management framework integrated with smart city and private sector services.
3. A data-driven Smart Service layer for the digital economy used for predictive analysis, real-time monitoring, and fraud prevention systems.

Recent researches [12], [13] on a smart city and smart services have introduced ideas explaining how fiscalization might evolve.

In 2018, Adnane Founoun and Aawatif Hayar, in their study [12] evaluating the concept of a smart city through local regulation, proposed the idea of introducing smart city rules for smart economy. This type of regulation has the potential to transform the process of fiscalization from stand-alone to integrated service for a smart economy. These conceptual changes are taken into account developing the concept of a single fiscal infrastructure.

Gonzalo R. Ceballos, Victor M. Larios from the Smart Cities Innovation Center, in their research [13], offered a model for promoting civilian government in a smart city. The process of fiscalization in a smart city, according to the authors' point of view can be driven by market participants. The change of the strategy of the fiscalization process could contribute to sustainable development, while fiscalization would become an integral part of the services provided in a smart city.

A. Single digital infrastructure

In the current study, the examined transformation of the fiscalization process from stand-alone to integrated service has provided opportunity to propose a vision of the Single Fiscal Infrastructure (SFF) concept as a progressive approach to future fiscalization. Along with research, a good example of a unified digital infrastructure can be found in Estonia, where the X-road ecosystem was implemented as a blockchain-based data exchange layer for communication between organizations and countries [14]. The main idea of X-road is to employ blockchain-generated data over X-road secure network for the public and private sectors. The integration of fiscal standards and the expansion of the fiscal data exchange protocol would create a unified fiscalization infrastructure that solves the problems described in current research. Eventually, this would mean:

- Automatic fiscalization of data exchanged by all participants in the infrastructure.
- Avoiding local-only regulations for the fiscalization process, minimizing costs.
- Creation of transparent, simple management of data processed by the network

B. Single fiscalization framework for smart city services

The unified fiscalization infrastructure also fits perfectly into smart city services and is based on the strategy of the European Union's single digital market, where infrastructures of local e-government are combined into one information flow. This would lead to the efficient use of smart city services, for example, measured and registered data such as Global Positioning System (GPS) coordinates of moving vehicle could be used for logistic issues, traffic regulation, public transport's workload, delivery services management etc. Similarly, employment of real-time collected data from sensors of smart city infrastructure [15] including intelligent transport systems [16], enhancement of data transfer protocol with the appropriate fiscal data, collected data comparison with business financial data submitted to authorities should enable complete real-time analysis. Processing of measured data with employed fiscal protocol and reported financial data to the authorities would provide an opportunity for the functionality of real-time analytics.

The current study offers several recommendations to the authorities of the EU countries, public organizations, and individuals with a keen interest in the fiscalization process, to create the prerequisites for such infrastructure implementation:

- Creation of a Knowledge and Research Center on the field of Information Technology security for the processing of fiscal data in the infrastructure of Smart Cities.
- Creation of Public Associations on fiscalization and the digital economy, bringing together experts and stakeholders for proposed infrastructure research and development.
- Promotion of public initiatives such as seminars on fiscal infrastructure and digital economy integration, existing technology adoption at the national level, research on the impact of technology implementation on domestic markets, etc.
- Arrangement of academic courses on fiscalization process and instruments transformation with practice options in the public sector in the field of certification of fiscalization solutions, management, and governance.

These prerequisites could create a competitive advantage and raise the level of experts in academia and industry, which, according to this and previous researches, is urgently needed.

Based on the premises, we assume that:

1. The most advanced fiscalization instruments as a stand-alone solution are implemented in Germany under the KassenSichV regulations - general standards for the exchange, protection, and storage of data.
2. Fiscalization can be integrated in digital infrastructure to provide sustainability and transparency.
3. The integrated fiscalization process should be self-driven, which means that the exchange, processing, maintenance, and control of data is carried out by digital infrastructure.
4. There is a need for a new kind of regulation for a smart economy and the use of fiscal tools in digital infrastructure.

IV. CONCLUSION

In this research the fiscalization process as an integrated process into digital infrastructure has been examined. The previous studies on fiscalization are limited to detailed overviews of the impact on the market of the precise implementation of fiscal policies such as fiscal devices (hardware), cloud fiscalization (software), assuming commonly used strategy for fiscalization as a stand-alone process. Considering fiscalization instruments, which are

consistent with modern and safe fiscalization, was identified the need to improve efficiency by introducing a completely new approach to fiscalization - a unified fiscal infrastructure.

Implementation of fiscalization process as a part of smart city services for the digital economy could increase transparency, minimize costs of implementation, and create a basis for sustainable development. In addition, the Estonian technology called X-road is observed as a good example of a data exchange layer, which in the future may become the leading technology for smart city and e-government services. Recommendations on the prerequisites for the implementation of a unified fiscalization infrastructure in the EU countries have been offered.

As offered key assumptions of research should be implemented or modelled in a real environment, then the next steps of research to examine the concept of a unified fiscalization infrastructure implemented in the smart city data management framework and using blockchain with smart contracts as an exchange layer for processing, storing and controlling fiscal data.

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