Reaching Sustainable Development Goals Through Tax Reductions and Incentives within a Trustworthy Decentralized Autonomous Organization

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***Abstract*—Fulfilling the Sustainable Development Goals (SDGs) relies on the proper implementation of various governmental policies, among which are also financial and taxation policies. The current public administration in Slovenia is based on a fully digitalized data management process. Our goal is to achieve new data integrity methods based on state-of-the-art technologies of the ONTOCHAIN software ecosystem. ONTOCHAIN includes technologies to achieve decentralised knowledge graphs, smart oracles, smart contracts, and tokenomics principles that rely on high integrity and trustworthiness. Consequently, we study the possibility to realize flexible incentives and taxation policies that contribute to the seamless achievement of SDGs.**

***Index Terms*—blockchain, smart contract, semantic technologies, public administration**

I. Introduction

The Sustainable Development Goals (SDGs) that were published in 2015 as part of the United Nations 2030 Agenda, are a blueprint towards equity and sustainable development [1]. The seventeen identified goals in this agenda can be addressed with various policies and strategies. For instance, different tax policies (e.g. tax reductions and exemptions) can influence the achievement of the SDGs [2]. Although tax incentives are accepted for a variety of reasons (e.g. increase economic growth), there is still a lack of research done to investigate the link between tax policies and SDGs. Nevertheless, none of the research currently addresses the digitization of the process of measuring the effects and applicability of tax policy on the achievement of SDGs.

In the present work, we investigate the possibility of seamless realization of the SDGs through the administration of specific taxation policies based on data of great integrity and trustworthiness.

Today, we live in an era of ubiquitous digitalization. The world is becoming dependent on novel digital and computer technologies. To enhance productivity and efficiency, there is an increasing global trend to bring digitalization into every domain of our lives, such as construction, education, healthcare, manufacturing, public administration and etc. Hence, a lot of data is produced that can be used in the course of the administration of taxation policies.

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Digitalization can be defined as the process of integration of digital technologies into everyday life, which aims at providing access to integrated networks with large quantities of data with potential benefit for the society and the environment [3]. In other words, this process is converting physically collected information and data (e.g. written documents, sensor data, audio, and video recordings) into computer-readable formats, with the goal to transition our existing traditional societies into smart integrated environments.

Research and innovation in the field of data technologies, especially in the field of data integrity and trustworthiness, and the necessary technologies to achieve this, such as blockchain-based decentralized knowledge bases (based on graph technologies), in recent years, have addressed the possibilities of their use for tax administration, but not for use in a way that digitizes processes for SDG analyses [4], [5]. Existing research does not consider the possibility to introduce new incentives to achieve SDGs. However, by considering both possibilities of digitalization of tax processing, they could be directed in two layers (digitization and incentives). This is also the basic starting point of the research, which addresses the use of advanced technologies to combine data from public databases and registers, with the aim of simplifying the processing of tax matters and analyzing existing data aggregated into a set of selected indicators to measure the impact on achieving SDGs. The further development of existing advanced technologies in public administration (i.e. tax administration) is thus related to a number of challenges that the current development does not address together and at the same time, e.g. trust, data interoperability, multi-stage verification, decision automatization, decision traceability and transparency, the possibility of forgetting, incentives and similar.

To act in accordance with policies and related legal frameworks, SDG-oriented policies (e.g. tax incentives for green investments) trigger activities carried out by various stakeholders, such as companies, institutions, and residents. Policy data is recorded in different databases managed by different stakeholders, which are often not integrated with each other. Hence, it is difficult to control the implementation of SDG-oriented policies. Although the data (i.e. policies) is usually digitized, it is at the same time scattered and unconnected. By implementing novel technologies, such as decentralized

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knowledge graphs and distributed ledger technologies, to integrate the public databases, comprehensive analyzes could be performed in one place, in real time, in a trustworthy way, and they could be presented to relevant stakeholders with properly established business intelligence indicators. In such a manner, policymakers would be able to adjust policies and identify and implement new incentives. Thus, the whole circle will be closed. It is crucial that the data is reliable, verifiable, secure, accessible in real-time, available only to authenticated stakeholders, whose access can be controlled by the data owner, and the data collection itself is automated as much as possible (pre-determined rules and conditions of coverage, sharing and use).

The remaining of the paper is structured as follows. Section II delivers information about current trends in semantic technologies and blockchain, and their potential to archive data with high integrity and trustworthiness within the public sector. Section III describes our vision and the proposed solution and its synergy with the ONTOCHAIN ecosystem [6]. Section IV discusses the testing results and concludes the paper.

II. Background

The mission of the Next Generation Internet initiative, which motivates and dictates digitalization by re-imagining and re-engineering the Internet, is to enable human potential, mobility, and creativity at the largest possible scale while addressing topics like transparency, trustworthiness, and data interoperability. Essentially, digitalizing the tax administration, integrating the public administration, and enabling the further development of tools for measuring the effects of tax policy on selected SDGs, requires diligent implementation of semantic technologies (e.g. ontologies, linked data, knowledge graphs) and distributed ledger technologies (i.e. blockchain). Hence, with the rapid growth and adoption of these technologies, there is a potential to reach new levels of decentralization and data interoperability in the public sector. Semantic Web refers to the World Wide Web Consortium's (W3C) vision of a Web of linked data, thus allowing it to consistently and coherently organize and link data over the web. It is envisioned to enable individuals to establish Web-based data repositories, develop vocabularies, and design data-handling rules. This technology allows its users to create vocabularies, data stores, and write rules for handling data and formally describe entities within a selected knowledge domain by using different data formats (e.g. RDF/XML, Turtle, N-Triplets), query languages (e.g. SPARQL), ontologies and notations (e.g. RDF Schema, OWL). In recent years, Semantic Web technology has been widely implemented in the public administration of different countries [7]. For instance, the US allowed public access to datasets that were created by the federal governments [8]. Also, the UK government departments made their datasets freely available in RDF/XML format [9]. Following these trends in public administration, the applicability of the Semantic Web can be extended to establish data connections (i.e. link data) from various public sector institutions into a single global data space, which will help implement various tax policies and achieve the targeted SDGs. Moreover, new data sources will be discovered at runtime, thus providing a more complete output when new data sources appear.

With the emergence of these novel technologies, we now have the potential to reach a new level of decentralization, but also of cooperation between various cyber-physical systems based on the Semantic Web principles. Blockchain technologies with their main properties of decentralization, traceability, and transparency fit perfectly this agenda and may contribute to achieving trusted operations of such smart applications and systems. This technology can provide solutions to a variety of problems, such as monetization, anonymity, agreement programs, transparency, traceability, and more. In our work, we will focus on smart contracts that have the most potential for successful integration for the purposes of the proposed research project. In 2015, Vitalik et al. [10] presented the concept of smart contracts, which are executable programs that cannot be changed and keep permanent traces of their implementation, whilst it is necessary to pay for their implementation and use. The payment for a transaction is usually very low, but given the huge number of transactions, it is not negligible. Due to these features, smart contracts can be seen as general (notarial) contracts with some restrictions, which are at the same time functional enough to cover several different use cases, such as to record and enforce a service level agreement, in banking and insurance. Blockchain technology and smart contracts are encapsulated in their ecosystem, hence they can only receive data within the network. For many applications, this can be too restrictive, leading to the introduction of a technology called oracles, which can securely receive data from the outside world, pass it on to smart contracts, and thus change the state of the blockchain. In principle, oracles can be seen as services that allow smart contracts to communicate with off-chain data in a secure and trustworthy manner [11]. In this paper, we describe our vision to shape a multi-layer and decentralized framework, to enable the implementation of a number of different next-generation real-world solutions (e.g. semantic technologies, smart contracts, oracles and etc) to deliver a trustworthy framework for the digitalization of tax administration and facilitate the interoperability between a plethora of datasets that will also contribute towards improved monitoring of the SDG achievement.

III. Framework for digitalization of the tax administration

Decentralized knowledge graph technologies, as novel semantic technology, can contribute to the integration of data from public and private sector databases and very well-defined computer transactions in the field of public administration and policy implementation. At the same time, using advanced standards such as smart contract standards (e.g. ERC-20, ERC-1155, ERC-721), and decentralized identity (DID) mechanisms, we can achieve different degrees of variability, fungibility, and credibility of data. More specifically, smart contracts could be useful in implementing various regulations and promoting sustainable tax regulation practices, e.g., to pro-

vide incentives to eligible taxpayers in achieving sustainability goals; or simply checking that a specific taxation condition is met, which is transferred to another database to determine the achievement of the set SDGs. Smart contracts could include all elements of ordinary legal transactions, which means the number of parties appearing in the contract, the subject of each contract, the time validity, the conditions for acquiring rights or incentives, the consequences of not respecting the elements of contracts, the possibility of involving a larger number of entities in decision-making and similar. Solutions designed with the help of these technologies could significantly complement and improve the usability of public databases with a trusted system that allows entities transparency and traceability of transactions, and smooth integration of trusted data. The system could also support the capture of public value (duties) or incentive system (facilitation) and enable the development of analytical tools.

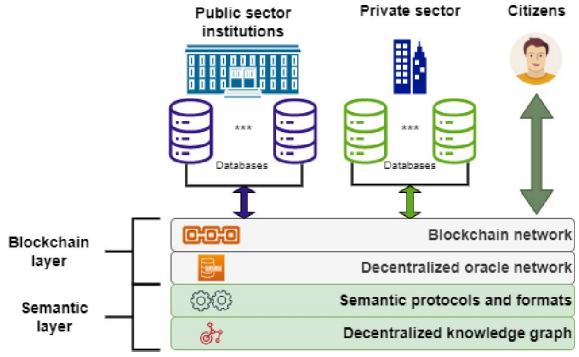

Fig. 1. Digital transformation of tax administration

Our hypothesis is that with the new decentralized graph (database) of knowledge and by developing a set of smart contracts we shall be able to build integration and incentives layers that can be used for the planning of tax policies, particularly in the domain of SDG. Thus, we will achieve: (i) integration of trusted data from public databases, (ii) new and more efficient ways of interacting (exchange of information, incentives, and facilities) between citizens, the private sector, and the state), (iii) automation in the development of smart contracts, (iv) SDG knowledge of tax policy built into smart contracts, (v) new business models for incentives and facilitation, for the effective achievement of SDG through the use of crypto-tokens.

In this way, it is possible to achieve sustainability goals and also greater efficiency in the implementation of various public policy measures. To test our hypothesis, we set ourselves the following main scientific research goals.

The proposed solution is illustrated in Figure 1. The framework is composed of three layers: the application layer, the blockchain layer, and the semantic layer. The application layer is composed of services that allow different user groups to interact with the framework. Namely, users such as public institutions, private sector companies, and residents (citizens) would be allowed to interact with the semantic layer in a safe, transparent, and traceable manner. This will allow the user groups to link their data to a common knowledge base in the semantic layer. The Blockchain layer is composed of an immutable blockchain ledger that records all interactions between the users and the framework. In addition, this layer consists of a set of smart contracts and oracles. They allow secure, transparent, and traceable interaction with the datasets in the semantic layer. The Semantic layer is composed of semantic protocols and formats that define the interaction of the other layers with the linked data in the decentralized knowledge graph.

A. *Smart contracts for public administration*

Smart contracts and decentralized oracles are the core components that guarantee a high level of security in the framework. By using smart contracts and oracles, it is in this case that a voluntary exchange of information between taxpayers and the tax administration could be achieved. For instance, smart contracts would be used to identify users (e.g. blockchain-based self-sovereign identities), manage access to data, compensate users for personal sharing data, and much more. Including all these possibilities, a new concept of digitalization of tax administration will be developed, which will enable the further development of tools for direct integration of measuring the effects of tax policy on selected SDGs. None of the research currently available addresses the digitization of tax policy coherence and measuring its effects on achieving SDG. The framework is thus a novelty in monitoring the achievement of the SDG and thus an innovation in this field, which can be used as a conceptual plan in all environments. As already mentioned in the starting points, the importance of tax policy for achieving the SDG is already emphasized by the United Nations in presenting the SDG. The connection between fiscal tax policy and the achievement of the SDG is addressed in virtually all major forums related to the achievement of the SDGs (International Monetary Fund, OECD, Political Forum for Sustainable Development, etc.). By implementing the envisioned framework, we will go beyond the previous findings (e.g. progressive taxation and poverty reduction; measuring the impact of green investment on greenhouse gas reduction, renewable energy use; the impact of innovation growth, etc.) and upgrade them by digitizing the complete process.

B. *Synergy with the ONTOCHAIN ecosystem*

ONTOCHAIN [6] as a Next Generation Internet program project is a semantically-enriched blockchain software ecosystem that is funded by the European Union's Horizon 2020 Research and Innovation Programme. It allows the development of trustworthy and decentralized applications that can empower users by guaranteeing both their privacy and high quality of service and ultimately support pluralism and democracy. To fulfill the envisioned functionalities, ONTOCHAIN follows a multi-layer approach as depicted in Figure 2, where each layer is built upon the functionalities offered by the lower layers. The decentralized ledger technologies layer allows

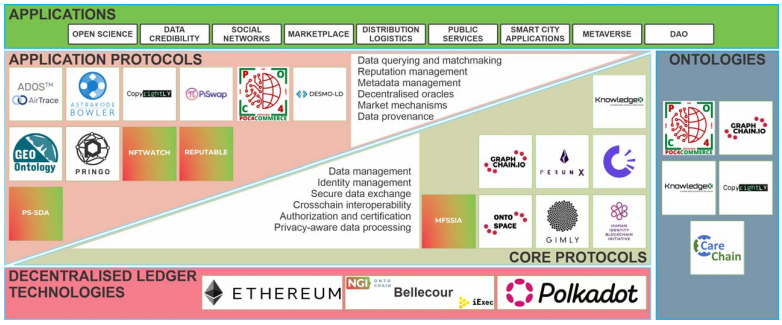

Fig. 2. High-level architecture of the ONTOCHAIN ecosystem

seamless access and use of different blockchain networks, such as Ethereum, Polkadot, and Bellecour. The ontologies layer delivers a set of ontologies that can be used within the ecosystem. The interoperability layer, composed of application and core protocols, is the backbone for interconnecting the other layers and delivers essential services such as decentralised storage, identity management, data management, and data certification.

Given the fact that ONTOCHAIN is composed of various protocols and networks that complement the proposed framework's architecture, the framework for the digitalization of tax administration can be completely integrated within the ONTOCHAIN platform. Namely, its Semantic layer can exploit the ONTOCHAIN ontologies, as well its Decentralised Knowledge Graph (DKG). Moreover, the framework's Blockchain layer can be based on some of the well-defined ONTOCHAIN decentralised ledger networks that are optimized to run fast and cheap transactions; and exploit the smart contracts and oracles for identity management, data management, and cross-chain interoperability.

IV. Discussion and Conclusion

This paper proposed a novel design of a framework to digitalize the tax administration that incorporates semantic technologies (i.e. decentralized knowledge graph) and blockchain technologies (i.e. smart contracts and decentralized oracles) that will allow integration of datasets, link data, and incentivize involved stakeholders.

To analyze the usability and applicability of the proposed framework, its prototype has been developed by exploiting the ONTOCHAIN platform and its ecosystem. On average the smart contracts that were deployed on the ONTOCHAIN blockchain network fulfilled the functions (e.g. identifying stakeholders, linking data and etc.) in less than 2 seconds, whilst keeping the expenses negligible due to the nature of the network. Moreover, the DKG graph database was able to sustain at least 50000 read/write requests per hour. Nevertheless, the proposed framework is still a preliminary design that can be further improved and more thoroughly evaluated. For instance, its main functionalities can be even more improved by further optimizing its smart contracts allowing it to sustain large amounts of transactions, whilst maintaining low costs and high transaction speed. Finally, a further effort has to be spent on refining the ontologies layer, which can lead to a universal standard for governmental ontologies and data formats.

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