Supporting the Implementation of the SDGs Through a Blockchain-Based Platform: The Case of Italy

Parisa Sabbagh, Orlando Troisi, Anna Visvizi, Antonino Galati, and Hossein Hosseinalibeiki

Abstract One of the very successful collective efforts aimed at improving the lives of billions of people are the Sustainable Development Goals (SDGs), and their predecessors, i.e., the Millenium Development Goals (MDGs). The assessment of the implementation of the SDGs in Italy in 2019 demonstrates that, overall, Italian cities have achieved 53% of the targets. Nevertheless, a performance output gap exists between Italy's North and South. Considering the—proven by research and practice—value of blockchain, the objective of this paper is to explore how blockchain may improve the implementation of the SDGs in Italy. To this end, a qualitative analysis supported by systematic literature review and thematic analysis have been adopted. Against this backdrop, a comprehensive and structured model outlining the key imperatives (governance, sustainability, and data sciences) pertaining to the SDGs has been built to offer a meta-framework for the performance output analysis. This model, integrating blockchain Ethereum, and Inter Planetary File System (IPFS), offers insights on the scope and scale of the SDGs implementation by local and regional stakeholders. In this way, it may serve as a tool for policymakers, at the regional and national levels, to support strategy and decision-making process geared toward the implementation of the SDGs in Italy.

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A. Visvizi et al. (eds.), *Research and Innovation Forum 2023*, Springer Proceedings in Complexity, https://doi.org/10.1007/978-3-031-44721-1_39

Keywords SDGs · Blockchain · Ethereum · Model · Platform · Italy

1 Introduction

The 2030 United Nations Agenda for Sustainable Development was adopted by the UN in September 2015. The agenda lays out seventeen Sustainable Development Goals (SDGs) the implementation of which is thought to further prosperity, wellbeing and peace across the globe. Meanwhile, the UN has highlighted the critical role of ICT in delivering integrated, creative, and cross-sectoral sustainable development outcomes [1, 2]. Blockchain seems to be a feasible accelerator for reaching global sustainable development goals [3]. In the academic sector, and under the auspices of the UN, novel stakeholder alliances and organizations with a particular emphasis on blockchain technologies are forming [4, 5]. In the same context, the European Union (EU) supports initiatives aimed at harnessing the value of information and communication technology (ICT) to attain the SDGs-related national and EU-level targets. Along these lines, in Italy, a three-year plan for ICT in Public Administration emphasized the adoption of emerging technologies, such as blockchain at the national level [6]. Still, concerning delays and a lack of a clear implementation strategy of the 2030 Sustainable Development Agenda in Italy [7] are reported. For instance, the SDGs city score from SDSN Italia shows that, on average, Italian cities have achieved 53% of the international targets for the SDGs, and even the best performers have not reached the 8% threshold [7].

In an attempt to measure the progress in SDGs implementation in Italy, the Italian Cities Sustainable Development Goals (SDGs) Composite Index was [8]. Research employing this index confirms the existence of the North–South divide in Italy. It also reveals a major diversification of performance output at the municipalities level [8]. Given that the use of the transformational power of blockchain technology to achieve the SDGs looks promising, which has been recognized by the Italian government the objective of this paper is to propose a model blockchain-based platform designed to support all stakeholders in sharing, comparing, benchmarking and employing information about SDGs-related actions and attainments across Italy. Integrating blockchain Ethereum and Inter Planetary File System (IPFS). this model platform is thought to have the capacity to support local and national stakeholders in the process of facilitating the SDGs implementation. The following research questions guide the discussion in this paper: RQ1. How can blockchain contribute to the improved implementation of the SDGs, considering existing discussions in data science, sustainability science, and governance science? The remainder of the paper is structured as follows. In Sect. 2, the key concepts defining the context of the discussion in this paper are outlined. In Sect. 3, the research methodology, involving a systematic literature review and thematic analysis, is elaborated. In Sect. 4, the theoretical model which results from the integration of the systematic literature review results and thematic analysis. to implement the SDGs is introduced. In what follows, the blockchain-based platform to implement the SDGs is discussed. In the concluding section, the

theoretical and practical implications of this research, but also its limitations ways of advancing it are discussed.

2 The Main Concepts of the Study

The SDGs represent a major multilateral effort to shift the stakeholders' attention toward more sustainable and resilient pathways to growth and development [9]. The 17 SDGs address the economic, social, and environmental pillars of development, with the goal of achieving a sustainable future by 2030 that balances equal prosperity within global boundaries (Fig. 1).

In 2019, Kostoska and Kocarev proposed a unique ICT framework for addressing the complexity of the implementation of the (SDGs). Their suggested framework consists of three main module including data module, sustainability module, and governance module (Fig. 2).

The data module combines data from a variety of sources, processes it, and transforms it into intelligible data and knowledge. The sustainability module implements SDGs at the city level, guaranteeing those are prioritized in accordance with local communities' values and requirements, and gives an integrated approach to modeling social-ecological systems. The sustainability module indeed seeks to map SDGs at the local level, promote stakeholder inclusion, give priority ranking of SDGs, implement SDGs at the local level, and exchange and manage knowledge. The governance

Fig.1 UN graphical illustration of the 17 SDGs (2015). *Source* https://www.un.org/sustainabledevelopment/

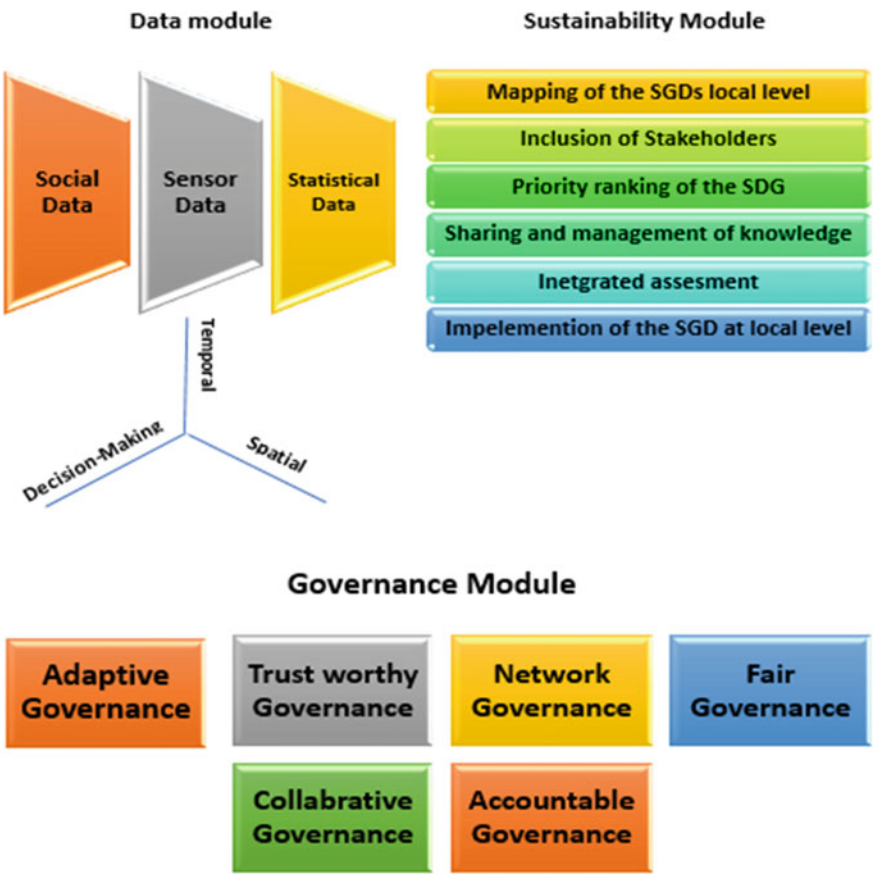

Fig. 2 The ICT framework for the 2030 agenda authors, based on Kostoska and Kocarev [1]

module allows for successful public engagement in SDG governance by putting governance theories into practice. Kostoska and Kocarev [1], believe that to apply this platform in practice, the three modules should be linked together to ensure that SDGs are addressed holistically. Digitalization, allows the growth of innovation through the positive impact of data-driven management strategies [10]. With this regard, innovative blockchain projects could help deliver socially and environmentally beneficial outcomes by challenging existing business models and providing new opportunities [3, 11]. The ways to use the blockchain are developing. For instance, consensus mechanism based on blockchain to collective decision-making among stakeholders [12].

In addition, one of the most application of blockchain is smart contract that can automatically carry out the contract's terms [12–14]. A novel practical solution based on smart contracts to enhance the overall standard of living for all individuals, namely the "rWallet," proposed by Visvizi et al. [15] with the aim of obtaining

international legal protection for refugee status. Ethereum as a second-generation blockchain allows for the building of decentralized applications (Dapps) [16], and can be used to execute smart contracts [17].

3 Materials and Methods

This section describes the research method and materials. In the present study, in order to data collection and data analysis we adopt the systematic literature review [18], and thematic analysis [19] methods.

3.1 Systematic Literature Review

The statistical population of this research in the stage of systematic literature review, includes studies from 2015 to 2020 in the field of blockchain and its applications.

Based on the systematic literature review protocol [18], which includes; initial search, studies to determine the scope of research, search for articles, article selection, reference articles backtracking, content analysis of articles, and reporting the data analysis, we conducted this section with including the following keywords in reputable scientific databases: blockchain, use case, application, benefit, opportunities, solution, sustainable development, Innovation, and SDG. The results of this section are reflected in Fig. 3 and with more details in the appendixes section that we identified the blockchain use cases that look promising for supporting the implementation of three main modules (Data, Governance, and Sustainability) by textual content analysis method and relying on the researcher's knowledge. Finally, we extracted the proposed framework of blockchain use cases for supporting the implementation of the three main modules in Fig. 4.

3.2 Thematic Analysis Method

In this research, we applied the Braun and Clarke [19] method for thematic analysis. The statistical community for the thematic analysis method consists of the experts and university professors who have a history of study or implementation in the field of understanding blockchain theories and models and their applications, especially in the field of sustainability. Attempts have been made to select an equal number of experts for interviews from both the academic and executive groups. The characteristics of these experts are listed in Table 1. We studied in-depth the text of the data extracted through the semi-structured interviews and then created the initial codes. In the next step, based on the basic themes identified in the previous stages we drew the Thematic Network. Table 2. As a result, 117 basic themes, 5 organizer themes,

Fig. 3 Steps for selecting articles (researcher)

and 1 key theme were extracted. More details on the research data related to this section are provided in the appendix section.

4 The Theoretical Model to Support the Implementation of the SDGs

In this section, we present a theoretical model which emerges from the integration of the systematic literature review and thematic analysis results to support the implementation of the SDGs. The model includes respectively five, seven, and ten blockchain use cases to support the implementation of the data module, governance module, and sustainability module. In addition, 15 features of blockchain, and 18 strategies for development of a practical platform to support the implementation of the SDGs proposed by experts (Fig. 5).

5 Research Findings and Discussion

In this section, we will illustrate the main results, which emerge from the integration of the research findings of the two phases of the research method including SLR and thematic analysis, and we discuss them. From our study, three main findings emerged as follows: Data module with five blockchain-based dimensions, governance module with seven blockchain-based dimensions, and finally, sustainability module with ten blockchain-based dimensions. In fact, in this section, we discuss how each of the identified blockchain use cases can contribute to the improved implementation of

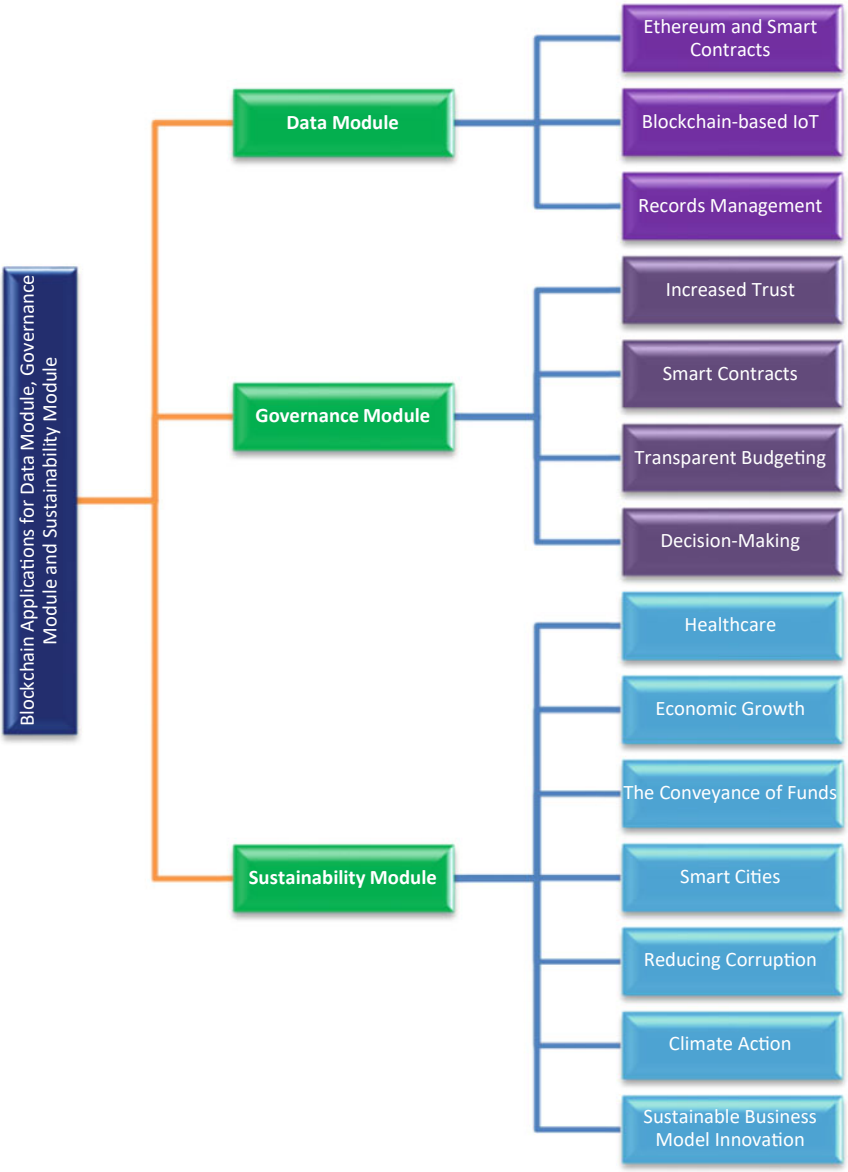

Fig. 4 Framework of blockchain applications in three modules of data, governance, and sustainability based on the results of a systematic literature review (researcher)

Table 1 Profile of the experts interviewed

Code	Age	Education	Position	Font size and style
P1	46	Ph.D	Member of the advisory board of the blockchain in the ministry of economic development of Italy and Assistant Professor	Information engineering
P2	27	Ph.D	Marie Curie is Researcher in Aalborg Business school	Electrical engineering
P3	41	Ph.D	Postdoc	Machine learning
P4	45	Post Doc	Head of Department	Politics, economics, computer
P5	30	Ph.D	Researcher	IoT and technology convergence, digital, twin
P6	40	Ph.D	Assistant Professor	Information systems
P7	32	Ph.D	Researcher	Blockchain technology in the field of security and privacy
P8	28	Ph.D	Researcher	Big data management

Table 2 Types of themes and their number in this research

Theme type	Number
Basic them	117
Organizer theme	5
1. Basic features of blockchain technology	1
2. Data module	1
3. Governance module	1
4. Sustainability module	1
5. Strategies for the development of blockchain technology	1
Global theme	1
Development, and application of blockchain in sustainable development goals	1

the three main modules we proposed for our platform to support the implementation of SDGs.

Our findings on the blockchain use cases that can support the implementation of the data module indicate that blockchain could five main contributions including; providing security for secure data sharing across multiple domains, reducing and eliminating the possibility of hacking registered information, Ethereum, smart contracts, (IPFS), and blockchain-based IoT for improved records management and data flow.

As mentioned by Hu et al. [16] blockchain boosts knowledge-sharing transparency and security, and can be utilized for data integrity and providing suitable security architecture [20]. A combination of Ethereum and IPFS can broaden the range of

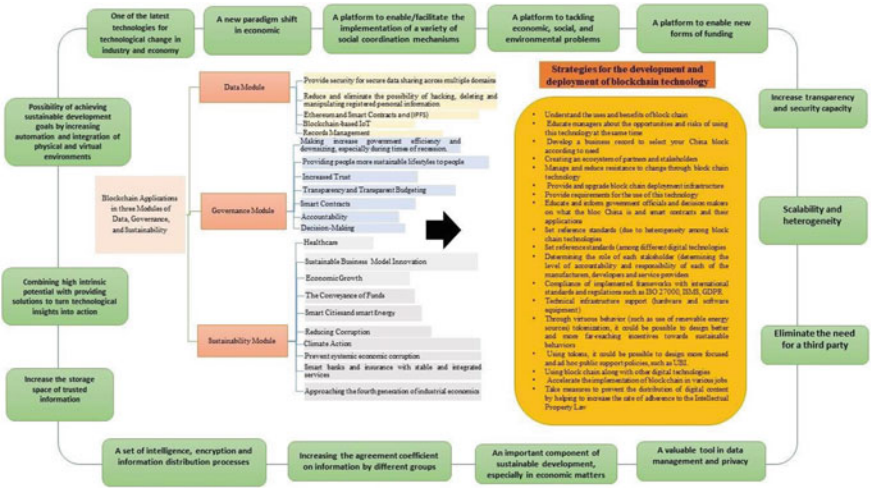

Fig. 5 The integrated network resulting from the thematic analysis and systematic review of the blockchain potential for implementing 2030 (researcher)

statistical data [21]. The IoT and wireless networks also allow us to communicate among the components of a microgrid [22] in our proposed platform.

Our research findings on the blockchain use cases that contribute to support the implementation of the governance module, highlight that blockchain in seven-way could be effective including; Increasing government efficiency and downsizing, providing more sustainable lifestyles to people, increasing trust, transparent budgeting, smart contracts, accountability, and decision-making.

Alexopoulos and colleagues [23] believe that Blockchain improves government operations by speeding up necessary subprocesses. In this regard, smart contracts also make interagency procedures more effective [24]. In the meantime, some authors stated that blockchain could be used to help people break free from poverty and improve their economic engagement, through microfinance and greater financial inclusion [3, 25], as well as to improve welfare for citizens [26]. In addition, blockchain provides openness and trust in the government process [27]. Considering the fact that government agencies in countries with high levels of corruption have difficulty complying with the law, hence, blockchain could provide a solution to such issues [28]. Finally, smart contracts can be used to automate a variety of functions, as well as to improve workflows and decision processes [29], especially for expanding involvement in existing democratic procedures [30].

Finally, the key findings emerge on the blockchain use cases that could contribute to improve the implementation of the sustainability module in ten ways including; Improved healthcare, sustainable business model innovation, economic growth, conveyance of funds, smart cities, reducing corruption, climate action, preventing systemic economic corruption, smart banks and insurance with sustainable and

integrated services, and finally, approaching the fourth generation of industrial economics.

In the context of healthcare, blockchain can be applied to increase the security of data [31], and to better deliver medical services by keeping patient health information accessible in a low-cost way [32]. Tiscini and colleagues [33] indicated that blockchain could be a source of sustainable business model (SBM) innovation in the Agri-Food sector. In line with this, the research findings of Galati and colleagues [34] in a case study in Deliveroo Italy, demonstrated that digitalization as a sustainable strategy contributes to the sustainability challenges of the Agri-Food sector. Narayan and Tidström [35] believe that blockchain supports innovation in the circular business models. In the context of economic growth also, Palacio [36] stated that blockchain allows for encouraging fair economic growth by impacting income inequality. In the conveyance of funds, all transfers of monies in the organizations could be tracked by blockchain. Also, the government can benefit from smart contracts to automate the confirmation of eligibility and the distribution of social welfare funds. In the context of smart cities, blockchain are regarded as crucial contributors to the advancement of inclusive urbanization and resilience, which aligns with Goal 11 of the SDGs [9]. Blockchain is able to reduce corruption, for instance, land ownership cannot be altered [37]. Managing the low-carbon transition [38], managing sustainable fisheries [39], and water management [40] by blockchain and (IoT) improve the climate action. In addition, blockchain may prohibit government authorities from misusing their powers [41]. Moreover, the Ethereum network looks promising to free users from third-party such as banks [17]. The insurance firm can also apply blockchain to gain insight into any events that occur on the road [42]. and finally, digital transformation can be used to affect value co-creation including resource integration [43]. And finally, blockchain has the potential to industrial transformation, and change the horizontal integration or close connection of companies in a value chain [44].

6 The Proposed Platform to Implement the SDGs

Our proposed platform to implement the SDGs consist of three main module including data, sustainability, and governance. We offer blockchain Ethereum, and (IPFS) in order to create connection among three modules to boots implementation of the SDGs. Since the hash is added to the Ethereum blockchain at the time of upload to the IPFS network, the signed document is timestamped in a tamper-proof way [45]. Therefore, the proposed integration of Ethereum and IPFS on the platform allows us to timestamp any data we want, no matter how big the size was. In this way, the participation of the key stakeholder group in local development [46] could be facilitated. Moreover, the key features of blockchain such as consensus mechanism and smart contracts allows the stakeholder to collective decision-making [47] and prioritize the ranking of SDGs at the local level. Therefore, the proposed platform as an innovative infrastructure brings together the different groups of local citizens along with the government authority in order to implementation of the SDGs (Fig. 6).

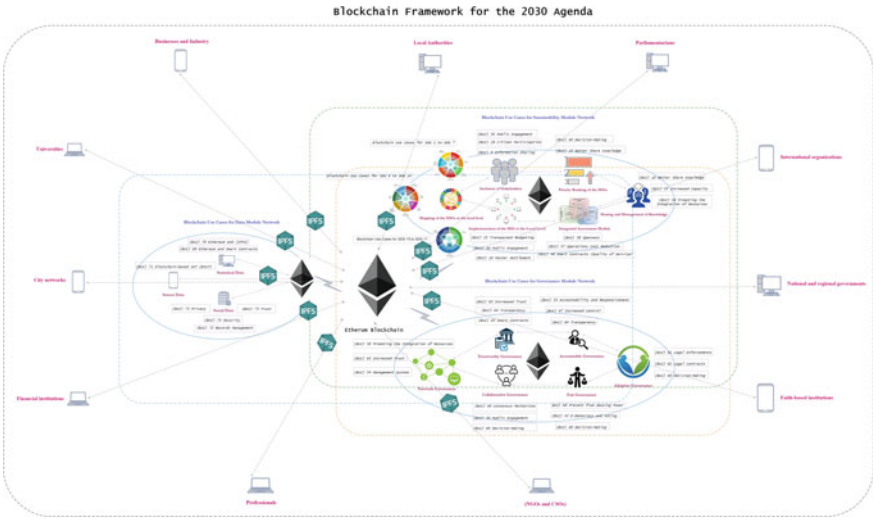

Fig. 6 The proposed platform to improve implementation of the SDGs

7 Conclusion

This study proposes a new paradigm for supporting the implementation of the SDGs by integrating Ethereum and IPFS technology. By leveraging Ethereum smart contracts and creating a decentralized application (DAPP) on the Ethereum blockchain ledger, our platform offers a promising solution. In this way, ongoing network improvements will enable the development of a long-lasting and scalable protocol for global use in the future. Overall, the research findings and our proposed platform, demonstrate the emergence of innovation in smart service systems and how actor relationships through technology-enabled interactions can give birth to novel processes, strategies, and value [48] to implement the SDGs.

Three theoretical and practical contributions are made in the present study. First, we indicate how blockchain as emerging technology allows of innovation in the digital age. Second, by proposing a blockchain-based platform to support the implementation of the SDGs we enhance the existing body of knowledge in the fields of blockchain and sustainable development goals. Third, governors and official authorities in Italy who are devoted to pursuing sustainable urban development could use the findings of the thesis to help implement the SDGs at the regional level and minimize territorial inequalities in the country.

8 Limitations and Future Research

As for limitations, since the present study was conducted during the Coronavirus Pandemic period, there were limitations to get access and conduct more interviews with the experts, however, conducting an interview with a member of the Blockchain Advisory Board of the Ministry of Economic Development of Italy, can be considered in evaluating the extent to which results from the interviews conducted might generalize. For future studies, we suggest conducting more interviews to build a stronger evidence base. Also, our proposed platform could be developed for a proof of concept (POC) process by the municipalities to implement SDGs. Moreover, the proposed platform could be developed by offering tokenization as an innovative way to attract more involvement of the main stakeholders to participate for implementation of the SDGs.

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