

## ***The Role of Blockchain Technology in Supporting Local Participatory Decision-making: Participatory budgeting as a model***

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### ***Abstract:***

Nowadays, engaging citizens in local decision-making is crucial, particularly as nations aim to enhance participatory democracy in every aspect. To improve this involvement, decision-makers are progressively concentrating on utilizing the technological advancements that are presently accessible .

This application goes beyond simple electronic engagement in local participatory decision-making; it has transformed to include new technologies like blockchain in the participatory process. Thus, our objective is to emphasize this matter by creating a conceptual framework and analyzing its groundbreaking implementations, especially in the area of participatory budgeting in Korea and Russia.

**Keywords:** democracy, e-participation, blockchain, budget, decision-making ...

### **المخلص**

أضحى إشراك المواطن اليوم في عملية صنع القرار المحلي اليوم أمرا لا بد منه سيما في ظل حرص الدول على تكريس مسألة الديمقراطية التشاركية بمختلف صورها، وفي سبيل ذلك يحرص صناع القرار اليوم على جعل هذه المشاركة أكثر فعالية عبر الاستفادة المثلى من مخرجات التطور التكنولوجي الذي نشهد أوجه اليوم. والواقع أن هذه الاستفادة لم تعد قاصرة على فكرة المشاركة الإلكترونية في صنع القرار التشاركي المحلي؛ بل بلغ الأمر مداه ليصل لمسألة إقحام التقنيات الناشئة على غرار البلوك شين في صنع القرار التشاركي، الأمر الذي جعلنا نسلط الضوء على هذه المسألة عبر وضع مقارنة مفاهيمية لها، ومن ثم رصد تطبيقاتها الرائدة تحديدا في مجال الموازنة التشاركية وهذا على مستوى كل من كوريا وروسيا.

**الكلمات المفتاحية:** الديمقراطية، المشاركة الرقمية، البلوك شين، الموازنة.

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## **I. Introduction:**

The involvement of citizens in public decision-making has emerged as a crucial subject in the realm of open government. Advances in digital technology have empowered citizens to seek a new kind of relationship with public administration, one that is based on enhanced transparency and more inclusive systems through the creation of e-platforms that facilitate a more interactive and engaging form of participation (Beatrice et al., 2023, p.1).

Community involvement in local decision-making demonstrates nations' dedication to building the pillars of participatory democracy and improving governance systems. To accomplish this, nations consistently strive to adopt optimal practices for achieving this objective by formulating activation strategies and expanding the extent of community involvement, as well as the domains in which this engagement takes place .

There is no doubt that government responses to the outcomes of digital transformation can significantly contribute to realizing these demands. This is being pursued through what is known as electronic local participation or electronic participatory democracy, which involves enhancing the role of e-governance in this process.

The significant interest in this technology stems from its fundamental characteristics, which are primarily based on transparency, decentralization, security, and trust. These advantages are essential for the public sector, particularly in the realm of participatory local governance .

Consequently, governments are currently working to implement this technology in various aspects of participatory democracy, with participatory budgeting being one of the most important and prominent. This raises the following problematic :

***How effective is blockchain technology in establishing participatory democracy ?***

The objective of this study is to explore a conceptual approach that connects participatory democracy with blockchain technology from a theoretical perspective, while also examining its popular applications in practical scenarios .

To achieve this, we have decided to employ a descriptive approach combined with analytical tools, structured around two main themes:

**Section 1:** Blockchain and Digital Participation: a conceptual approach

**Section 2:** Blockchain-Based Participatory Budgeting: pioneering experiences

### **1. Blockchain and Digital Participation: a conceptual approach**

The blockchain technology is one of the most prominent emerging technologies that has brought about a qualitative shift in governance practices. It is now widely used to support the concepts of smart government, particularly in countries that have officially adopted it, either as a reliable means of proof or as an effective mechanism for digital authentication. This technology is characterized by its ability to ensure transparency, security, and the immutability of data, making it a conducive environment for enhancing trust in government digital operations.

In light of the rapid shift towards digitization, the importance of linking blockchain with digital participation has emerged, as the latter is considered one of the most significant aspects of electronic democracy, enabling citizens to actively engage in public decision-making through technological means. From this perspective, the study first requires a conceptual foundation for both "blockchain" and "digital participation," in preparation for understanding the nature of the integrative relationship that can exist between technology and democratic practice in the digital space, which we will illustrate in the following sections:

Blockchain technology is being used in many nations to establish e-participation frameworks for citizens in public policy. This promotes transparency, inclusivity, and collaboration in government, while also enhancing citizen engagement and marginalized group inclusion. However, current methods' narrow focus makes e-participation ineffective (Shaikh et al., 2023, p.1).

### 1.1 The concept of blockchain

The official inception of blockchain technology dates back to October 31<sup>st</sup>, 2008, when an anonymous author or group of authors, known by the pseudonym Satoshi Nakamoto, published a paper titled "Bitcoin: A Peer-to-Peer Electronic Cash System."

In this 2008 publication, Nakamoto suggested an innovative e-payment system that relies on a peer-to-peer network for the public recording of transaction history..., positioning it as a solution to the financial crisis of that time, with its initial application limited to the financial sector as a first phase (Merrell, 2022, p.10).

Later on, the next-generation blockchain developer, Vitalik Buterin, made significant advancements to his initial concept by designing Ethereum, which enabled the support of smart contracts (Saikal et al., 2022, p.1).

This technology has now evolved into a third phase, allowing for the creation of a global decentralized computing platform that extends beyond the payment system originally envisioned by Satoshi .

It now encompasses a wide range of applications, including decentralized financial models such as insurance and escrow accounts, as well as non-financial applications like supply chain management, digital identities, voting, and decentralized governance..(Merrel, op.cit., p.86).

#### 1.1.1 Explanation of the technical and functional blockchain

There are various definitions of blockchain technology, one of which describes it as a "distributed database of records or a public ledger for transactions or digital events that have been executed and shared among the participating parties. Each transaction in the public ledger is verified by the consensus of the majority of participants in the system, and once the information is recorded, it cannot be erased."

Some also view blockchain as a "decentralized and distributed database that continuously maintains a growing list of records, referred to as blocks, with each block containing a timestamp and a link to the previous block. Depending on the design and purpose of the blockchain, it is inherently resistant to data modification (Haithem, 2021, p.14).

It is defined by one aspect as a "distributed ledger technology that consists of a series of "blocks" linked in an encrypted manner, which contain aggregated transactions; and generally, all data is published for all participants in the network" (Haithem, Ibid., p.15).

In general, blockchain, also known as a chain of blocks, can be defined as "a decentralized database composed of a series of interconnected, sequenced, and encrypted blocks that contain data and information which are difficult to breach or alter, and are exchanged more quickly, easily, and at a lower cost by network members without intermediaries" (Yasser, 2018, p.2)

#### 1.1.2 Blockchain components

The blockchain technology derives its name "chain of blocks" from its operational system. Transactions recorded on this network are grouped into blocks, each of which accommodates a specific number of transactions. These blocks are interconnected through a digital signature that ensures the transaction is recorded with a timestamp of its actual completion, maintaining its integrity. Any attempt to modify, withdraw, or add to the record will invalidate the encryption fingerprint of the entire chain.

The blockchain typically includes information systems that enable it to perform functions such as sending and receiving data, storage, and automating agreements. These systems include the Hash system, peer-to-peer networking, and asymmetric encryption keys. Consequently, the blockchain is composed of four main elements, which are (Aya, 2022, p.256).

**The block:** It is the building unit of the chain and consists of a collection of operations or tasks that are intended to be performed or executed within the chain, such as

transferring funds or registering properties. A new block is then created and linked to it to prevent fraudulent transactions within the block, which would render it invalid.

The information: is the sub-process that occurs within a single block, which represents a collection along with other data and commands within the same block.

**The hash:** is a distinctive element of the blockchain, also referred to as a digital signature. It is a code generated by an algorithm within the blockchain program, serving to differentiate one chain from another

The hash connects the blocks within the chain, with each block linked to its preceding and succeeding hashes. This creates a unidirectional flow from the original block to the subsequent ones. It is important to note that the hash prevents any modifications to the blocks that have already been create

**Timestamp:** This refers to the timing at which the operation or block was recorded within the chain (Aya, Ibid., p.257).

### **1.1.3 The blockchain: from a digital currency to a decentralized system**

The development of blockchain technology began with digital currencies, as it formed the foundational infrastructure for the world's first crypto currency, Bitcoin. This led to widespread popularity in the financial sector due to its ability to secure transactions and ensure transparency without the need for a central intermediary. This early success prompted many researchers and developers to delve deeper into the characteristics of this emerging technology, opening the door to exploring its potential applications beyond crypto currencies.

A significant leap occurred with the emergence of Ethereum, which is considered the second generation of blockchain due to the new capabilities it introduced, particularly the support for smart contracts—digital programs that automatically execute the terms of agreements between parties without direct human intervention.

This functionality garnered considerable interest from researchers, especially in the field of private law, due to the new legal and regulatory challenges it presents. By the end of 2017, the world began to witness a growing interest in the potential applications of blockchain in the public sector, which was seen as the birth of the third generation of this technology, shifting the focus from crypto currencies and smart contracts to more diverse and comprehensive uses in various fields.

#### **1.1.3.1 The roots of blockchain**

The origins of blockchain trace back to the emergence of the "Bitcoin" currency on October 31, 2008, when a programmer using the pseudonym "Satoshi Nakamoto" sent a research paper via email to a group of cryptography experts. This paper presented a comprehensive technical vision for overcoming the "double-spend problem," which is one of the fundamental obstacles in the digital financial system, by utilizing advanced cryptographic protocols developed in the context of the global financial crisis at that time(Nadhir, 2020, p.100).

The paper introduced the concept of "digital currency" for the first time, which can be traded with low fees and without relying on trusted intermediaries(Jalakas, 2018, p.16).

The evolution of blockchain has gone through three main stages, which we will briefly outline below, as they represent pivotal turning points in the expansion of this technology and the diversity of its applications:

#### **a- Blockchain Phase (1.0): (Crypto currency as a Starting Point)**

The first phase of blockchain development started with a complete focus on its application in the realm of crypto currencies. This phase officially began on January 3<sup>rd</sup>, 2009, when the pseudonymous programmer "Satoshi Nakamoto" mined the first block of the blockchain, known as the "Genesis Block."

This phase recorded the first actual transaction using Bitcoin, where Nakamoto sent 10 units of the currency to American programmer "Hal Finney" on January 12<sup>th</sup>,

2009, marking the first documented exchange of Bitcoin in history. Over time, this currency began to be traded more widely online and gained acceptance for payment and transaction settlement, contributing to its increasing popularity and a significant rise in its market value(Haithem, op.cit., p.5).

#### **b- Blockchain Phase (2.0): Expanding Horizons to Smart Contracts and Decentralized Applications**

The second phase has witnessed an unprecedented qualitative evolution in blockchain technology, moving beyond the exclusive use of cryptocurrencies. Researchers have begun to recognize the immense technical possibilities that the blockchain network offers, not only concerning financial trading but also as a reliable and secure platform for conducting digital transactions and storing data in a decentralized manner. The primary advantage of this phase is that the network's database has become a Distributed Ledger, allowing all members to interact directly without the need for an intermediary(Haithem, op.cit., p.6).

One of the key contributors during this phase was the Russian-Canadian programmer Vitalik Buterin, who proposed the creation of a new platform based on blockchain technology in late 2013, which was later named Ethereum. This project was funded through a crowd funding campaign in mid-2014, before its official launch on July 30<sup>th</sup>, 2015.

Ethereum is an open-source platform that allows for the creation and operation of decentralized applications known as Smart Contracts, where parties establish the terms of the contract in the form of code that is automatically executed on the Ethereum network, without the need for intervention from any third party or central authority. This network uses a crypto currency known as Ether (ETH), but unlike Bitcoin, Ethereum is not just a currency; it is a comprehensive development platform through which a wide variety of applications can be programmed and operated (Haithem, Ibid., p.6).

#### **c- Phase (Blockchain 3.0): Towards Comprehensive Digital Transformation**

The third phase of blockchain evolution started at the end of 2017 and the beginning of 2018, during which applications expanded to encompass areas beyond just the economy and finance, reaching the public sector and various aspects of social life.

Governments and public institutions began to adopt this technology in vital fields such as healthcare, education, digital identity management, and administrative services, aiming to achieve a comprehensive digital transformation that enhances efficiency, promotes transparency, and reduces reliance on traditional bureaucracy. This phase represents the broadest horizon for blockchain applications, as it is employed as a strategic tool to support sustainable development efforts.

##### **1.1.4 Principles of Blockchain**

To effectively carry out various tasks and services based on blockchain technology, the latter relies on three fundamental principles that form the core pillars of its operation across all versions, whether in the initial phase related to digital currencies or in subsequent applications. These principles are: the decentralized ledger, the distributed database, and the mining mechanism.

###### **1.1.4.1 The decentralized ledger**

known as blockchain technology, serves as a non-centralized record for transactions, indicating the absence of a central authority that monopolizes data storage or management. Instead of relying on a central server, copies of the ledger are distributed among all participants in the network.

The network operates based on the principle of collective agreement (Haithem, Ibid., p.20) among these members, eliminating the need for a higher supervisory entity. Furthermore, blockchain utilizes the peer-to-peer (P2P) communication feature, which allows participants to conduct transactions or exchange data directly and securely,

without the involvement of intermediaries. This enhances the transparency of operations, accelerates their completion, and reduces associated costs.

#### **1.1.4.2 The Distributed Database**

The Distributed Database feature is based on the previous principle, as the decentralization of blockchain is achieved by distributing data among all participants. Each member of the network maintains an identical copy of the ledger, ensuring transparency and making it difficult to manipulate the content.

Any change in the chain is recorded instantly and simultaneously by all members, achieving a high level of security and reliability. The blockchain is characterized as a Chronological Ledger, where each Block contains an unchangeable Timestamp, enhancing the credibility of transactions and preventing fraud through the advanced encryption techniques employed in the system. (Iheb, 2018, p.3).

### **1.2 Blockchain-based E-participation**

Before delving into the activation of blockchain technology in the digital participation process, it is essential to first clarify the concept of digital participation and its implications. This understanding will allow us to subsequently grasp the outcomes of linking the two terms.

#### **1.2.1 Evolution of e-participation features**

The United Nations has affirmed that participation is a key dimension of governance and an essential pillar of sustainable development. It has also defined electronic participation as "the process of engaging citizens through information and communication technology in policy-making, decision-making, service design, and delivery to make it participatory, inclusive, and accessible" (UN, 2020, p.127).

The conventional framework for e-participation is recognized as part of the digital governance paradigm, wherein relevant civic engagement initiatives are generally launched, advanced, and advertised via established e-government platforms .

The public sector is responsible for the upkeep and administration of these electronic participation systems, employing centralized databases, communication networks under public oversight, and centralized licensing processes through digital signatures provided by the government itself (Kassen, 2021, p.101).

The electronic participation in this manner is considered a form of public service that is received in a more advanced and transparent way. It is intended to enable civil communities to submit requests to government entities through these centralized e-platforms.

However, decisions are traditionally made exclusively within public institutions, without any external involvement, except for occasional engagement with non-governmental stakeholders and powerful lobbying groups.

In the context of implementing blockchain technology, independent peer-to-peer platforms can offer a more dynamic and competitive means to further enhance the concept of electronic participation. This creates an independent space for civic engagement in a networked manner, rather than merely serving as a source of digital services. The political decision-making process becomes increasingly significant, particularly if it is achieved within the framework of a public institution's black box mechanism (Kassen, op.cit).

#### **1.2.2 Advantages of blockchain-based e-participation**

The digitally enhanced democracy benefits from distributed ledger technologies to strengthen governance values such as transparency, trust, and independence .

In particular, blockchain serves as an enabling technology for participatory digital democracy, introducing new governance mechanisms by facilitating permanent data storage and reliable accounting, for instance..

This technology also enables the execution of smart contracts, which in turn allows for the identification of various interaction patterns within the community. This

facilitates increased political participation, resource sharing, or even the establishment of responsible and sustainable behavior, ultimately contributing to the global goal of e-participatory democracy (Dirk et al., 2023, p.6).

Beyond that, blockchain technology is ideally suited for establishing trust among unknown parties and can serve as a significant support or even an alternative to governments that lack confidence in their institutions. This is due to its well-known advantages such as stability, immutability, consensus mechanisms, encryption, rewards, and peer-to-peer systems that foster an ideal democratic community, allowing everyone to contribute equally to the participatory process.

Even malicious actors will undoubtedly be compelled to act in the best interest of the entire network, thereby establishing trust without the need for a third-party institution .

In fact, this proposition is particularly appealing to countries where trust in government bodies is low, which means that blockchain technology can assist in creating and enhancing this trust through the use of smart contracts and non-financial applications to improve community performance (Saikal et al., op.cit., p.3).

What sets blockchain apart is that the blocks, which hold and store transactions, are recorded by a network of millions of connected computers on the internet. These are automatically updated through a mathematical algorithm and encrypted codes that are difficult to breach or alter in any way due to their connection to the previous block.

Participants in the network interact with one another through encrypted identities, meaning they remain anonymous to each other during transactions. Each transaction and its associated value are visible to anyone with access to the system, and every user in the chain has a unique alphanumeric address consisting of 30 characters or more, which they define, allowing users the option to either remain anonymous or provide proof of their identity to others (Aya, op.cit., p.255).

## **2. Blockchain-Based Participatory Budgeting: pioneering experiences**

In recent years, the increasing use of technologies and digital platforms at the local level has enabled more citizens to engage directly in the participatory budgeting process, making decision-making in this area more effective, a process described as "Digital Participatory Budgeting".

The latter not only signifies empowering local citizens to engage in the budgeting process, but it also encompasses the concept of building a global network of digitally-enabled "Urban Diplomacy" characterized by open communication and collaborative learning. This aims to empower the democracy of urban communities, enhance transparency, and promote participatory budgeting initiatives worldwide.

### **2.1 The meaning of blockchain-based participatory budgeting**

The participatory budget has become a form of citizen engagement in urban planning processes, reflecting the interaction between authority structures and citizens, facilitated by rapid development tools for electronic participation .

The online voting process in participatory budgeting is characterized by transparency and reliability, thanks to the advantages of blockchain technology, which addresses the primary issue of low voter verification reliability by identifying voters through their accounts in a unified identification and authentication system.

#### **2.1.1 The development of the idea of participatory digital budgeting**

In an effort to directly involve citizens in the political decision-making process, the concept of participatory budgeting has emerged. This concept describes the process by which citizens engage in the allocation of public revenues and oversee public spending (Yves et al., 2008, pp.164-178). Today, this process is classified as one of the most significant operations in participatory urban planning.

The participatory budget emerged in Brazil at the end of the 1980s, during a transitional period from dictatorship to democracy. This era saw a public discussion

emerge regarding new constitutional forms of civic participation in administrative decision-making, which needed to become one of its features .

In 2006, the Brazilian city of Belo Horizonte introduced the first opportunity for electronic voting on projects funded by budgetary resources, significantly raising public awareness of this issue. The initiative proved to be so successful that it became an annual practice (Valentina & Natalia, 2021, p.7).

In parallel with the expansion of blockchain technology in the public sector, attention has been directed towards various aspects of urban development. Some researchers have begun to explore the use of this new technology and its integration into participatory urban planning processes.

The participatory budget is currently classified among the five categories of use cases where blockchain technology can enhance and promote urban public participation. These categories include: document and record management, social network governance, surveys and voting, crowd funding, and finally, participatory budgeting .

The fundamental role of blockchain technology in this process lies in its function as a decentralized and shared database, which facilitates increased openness, transparency, and accountability while providing a secure and fraud-free computing environment during public participation (Farnaghi & Mansourian, f2020).

### **2.1.2 Advantages of Blockchain-Based Voting in Participatory Budgeting**

Blockchain technology enhances the traditional voting system. To this end, specialists in the field have proposed several blockchain-based electronic voting systems, such as the Blockchain-Enabled Voting (BEV) and the Auditable Ballot Voting System (ABVS). These systems can be effectively implemented whenever the blockchain supports smart contracts.

In fact, these systems significantly contribute to addressing the shortcomings of traditional voting systems, such as the lack of transparency and accessibility for voters. Electronic voting based on blockchain ensures security, fairness, and user privacy, while also expanding the voter base and reducing the costs of elections, which is one of the major challenges faced by countries around the world, especially in developing nations (Saikal et al., op.cit., p.3).

## **2.2 Popular Blockchain-Based Participatory Budgeting Applications**

First, it is important to reiterate that the implementation of blockchain technology in the public sector is still a relatively new and limited experience worldwide, particularly concerning the issue of participation in drafting and voting on participatory budgets. Among the pioneering experiences in this field are those of South Korea and Russia.

Incorporating blockchain technology within the public sector enhances transparency, accountability, and encourages citizen engagement in e-government services (Ibrahimi et al., 2025).

### **2.2.1 In South Korea**

This is the actual experience of voting on the participatory budget based on blockchain technology. South Korea is renowned for its global leadership in technological innovation .

In March 2017, a blockchain platform developed by the Korean startup Block for financial technology was utilized in local elections to prioritize community projects in Gyeonggi-do Province. Over 9,000 votes were cast by residents of the area to select 527 local projects. This process was completed in support of representative democracy and was simultaneously regarded as the first initiative of its kind in electronic voting using blockchain technology (Menassel & Chaouch, 2022, p.1262).

### **2.2.2 In Russia**

In Russia, blockchain platforms have been used as a space for selecting local development projects, an initiative launched in 2019 in the Nizhegorodskaya and Volgogradskaya regions. In the Volgogradskaya region, the number of electronic voters reached 82,500, while in Nizhegorodskaya, it was 161,000. Voting took place at designated sites where citizen verification relied on personal phone numbers and a one-time password. Through these platforms, voters were granted access to a list of proposed participatory budget projects in their area and the right to vote on any of them.

To facilitate easy and quick access to the voting process, versions have been prepared to adapt to mobile devices, which were used by 80% of the total respondents. Once the winning projects that received the majority of votes were announced, the corresponding regional and local budgets were allocated and implemented in practice (Valentina & Natalia, *op.cit.*, p.2).

### **Conclusion:**

The blockchain technology has become one of the most significant emerging technologies, witnessing its initial applications in the public sector across countries that adopt this technology. It has effectively contributed to enhancing transparency in the sector, particularly concerning digital participation. Since the implementation of this technology in this specific sector is still in its early stages, it is important to note that the findings related to this research paper will also be preliminary until there is further expansion and in-depth application of this technology.

Incorporating blockchain technology within the public sector enhances transparency, accountability, and encourages citizen engagement in e-Government services. The fundamental characteristics of blockchain, such as decentralization, immutability, traceability, and disintermediation, address issues related to insufficient public discourse, poor tracking of public budget funds, minimal citizen involvement, and transparency.

Participatory budgeting has emerged as an influential mechanism for involving citizens in the decision-making processes and guaranteeing that public funds are distributed in a manner that corresponds with the community's needs and priorities.

The prospects for participatory budgeting in the future are highly encouraging, as it has the potential to empower citizens and revolutionize public expenditure. By enhancing digital platforms, incorporating data and analytics, fostering collaboration between governments and communities, and promoting scaling and institutionalization, participatory budgeting can emerge as a fundamental element of democratic decision-making.

By seizing these opportunities and tackling the challenges that lie ahead, we can create a pathway towards a more inclusive and accountable method of public spending, which will ultimately result in stronger and more resilient communities.

### **Findings:**

- ✓ The digital age has enabled the emergence of collaborative digital platforms that can significantly enhance the active participation of civil society in local participatory decision-making processes .
- ✓ Blockchain technology is one of the most compelling emerging technologies for decision-makers, as it serves as a decentralized, encrypted database that promotes openness, transparency, and accountability while providing a secure and fraud-free environment for public participation .
- ✓ The blockchain-based participatory budgeting experience is one of the most widely implemented practices in participatory urban planning, gaining popularity in several countries, including South Korea and Russia .

## **Recommendations:**

- ✓ Based on the advantages gained from implementing blockchain technology in community participation for local decision-making, we propose initiating pilot projects in specific municipalities. This is particularly relevant as blockchain technology is beginning to be applied in Algeria through the efforts of researcher Mohamed Lotfi Mekhnache.
- ✓ It is important to note that since blockchain technology eliminates the need for a third-party intermediary, this could potentially lead to the long-term dissolution of the state's physical structures. This situation necessitates caution regarding the expansion of this technology's application, emphasizing its restriction to very specific areas such as participatory local budgeting.
- ✓ Therefore, while the benefits of blockchain are promising, careful consideration and limited application in targeted fields are essential to ensure a balanced approach to its integration in local governance.

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