# AUTOMATED DECISION FLOW FOR MOBILE TELEPHONY SERVICES BASED ON BLOCKCHAIN AND ARTIFICIAL INTELLIGENCE

**Mihai ANDRONICEANU**
Ministry of Transport and Infrastructure, Romanian Railway Authority, Bucharest, Romania
androniceanu.mihai@afer.ro

**Abstract**
The paper presents the development and validation of an integrated digital ecosystem, built on blockchain technology and artificial intelligence, designed to optimize the acquisition, monitoring and management processes of mobile telephony services in public institutions. The research starts from the creation of a logical scheme for the acquisition of telephony services, which is subsequently transposed into a smart contract capable of automating the assignment, execution and verification of contractual obligations. In the field of telecommunications, smart contracts allow the coding and automatic execution of SLA clauses (Service Level Agreement that establishes the minimum quality level), facilitating performance monitoring and conditional payment. Their integration with external monitoring systems ensures the automatic feeding of smart contracts with real-time operational data, supporting the rapid detection of quality deviations and the triggering of corrective actions. A central element of the research is the connection of the smart contract to an artificial intelligence module, which takes the data recorded on-chain and processes it for predictive analysis, anomaly detection and the generation of operational recommendations. The results are taken and presented in an interactive dashboard that includes: histogram for national data traffic, scatter plot for comparison of national vs. SEE consumption, bar chart for extra-SEE international minutes, cost-consumption analysis and a K-Means clustering model for user segmentation. The resulting digital ecosystem demonstrates the feasibility of a fully autonomous, transparent and efficient mechanism, capable of reducing costs, eliminating human errors and improving the decision-making process through real-time monitoring and analysis.
**Keywords:** Blockchain, Smart contract, SLA, Artificial intelligence, Dashboard, K-Means clustering.
**DOI:** https://doi.org/10.24818/beman/2026.S.I.6-13

**Article history:** Received: 10 May 2026, Revised: 31 August 2026, Accepted: 09 September 2026, Published online: 11 September 2026

**How to cite this article:** Androniceanu, M. (2026). Automated decision flow for mobile telephony services based on blockchain and artificial intelligence. *Business Excellence and Management*, *16*(S.I.6), 248–270. https://doi.org/10.24818/beman/2026.S.I.6-13

## 1. INTRODUCTION

The digital transformation of public administration has profoundly changed the way institutions manage operational processes and the relationship with service providers. Androniceanu and Štreimikiene (2025)

Business Excellence and Management
Volume 16 Special Issue 6 / 2026

emphasize that the modern public manager needs to develop advanced digital skills and adopt innovative governance models to leverage emerging technologies. The increase in the volume of data, the complexity of public contracts and the pressure for efficiency have determined the adoption of technologies capable of providing transparency, automation and control. In this context, blockchain and artificial intelligence are emerging as complementary solutions, with the potential to modernize the monitoring, acquisition and management processes of mobile telephony services (De Filippi & Wright, 2018). The vulnerabilities of traditional systems – lack of data traceability, difficulty in objective verification of SLAs, fragmentation of information flows and slow reaction in critical situations – highlight the need for automated and secure mechanisms. In parallel, the high costs of telecom services and the complexity of subscription portfolios in public institutions require solutions that allow for optimization and predictability. Specialized literature confirms that blockchain, through immutability and verifiability, provides a robust framework for managing operational data and automating contractual rules. Smart contracts can automatically execute SLA clauses, reduce errors and increase compliance, and AI allows advanced data analysis, anomaly detection and consumption optimization (Veith et al., 2024). Thus, the topic of the paper is placed at the intersection of distributed ledger technologies, intelligent data analysis and administrative processes in the public sector.

### 1.1 Relevance of the topic

The digitalization of public administration has entered a stage in which the requirements of transparency, automation and auditability are no longer optional, but mandatory. In this context, blockchain technology is emerging as an essential tool for modernizing administrative processes, due to its fundamental properties: immutability, traceability and verifiability (Albshaier, 2024). Sghaier et al. (2024) emphasize that blockchain offers “immutability and complete traceability of events”, features that allow public institutions to manage sensitive data without the risk of their alteration or loss. In the field of public procurement, the relevance is even more evident. Hunhevicz & Hall (2020) show that the use of blockchain can “increase trust in the process of awarding and executing public contracts”, reducing the risk of favouritism and strengthening the integrity of administrative processes. Kshetri (2018) confirms this perspective, stating that the transparency of blockchain contributes to reducing “corruption and favouritism”, two major vulnerabilities of traditional systems. Smart contracts extend these benefits through their ability to formalize and automate contractual rules. Hamdi et al. (2022) show that they can “encode and automatically execute SLA clauses”, eliminating subjective interpretations and delays in performance verification. Casino et al. (2019) complete the picture, demonstrating that smart contracts can “automate the verification of contract conditions and the execution of payments”, reducing administrative costs and the risk of human error. In telecommunications, the relevance is particularly strong. They highlight that blockchain is suitable for “back-office processes such as billing, settlement and SLA management", areas where data accuracy and objective verification are critical. Monitoring systems such as SLAMer (Schweizer, 2019) demonstrate that performance metrics can be mapped directly to on-chain functions, allowing for automated assessment of SLA compliance. Integration with AI amplifies the relevance of the topic. Andoni et al. (2019) show that advanced analytics and artificial intelligence can transform raw data into "operational recommendations", and Gai et al. (2018) confirm that AI can optimize telecom service management processes. Thus, the topic of the paper positions itself at the centre of an emerging field, where the convergence of blockchain, AI, and automated monitoring is redefining the way public institutions manage essential services.

### 1.2 Necessity of reporting to the context

The accelerated digital transformation puts pressure on public institutions to modernize their operational processes, reduce costs and improve service quality. In this context, traditional methods of monitoring mobile telephony services are outdated: they are slow, fragmented and vulnerable to errors. Nguyen (2016) shows that blockchain can support "faster and better-founded decision-making processes in the public sector", thanks to access to immutable and verifiable data. In telecom service procurement, the need is amplified by the complexity of SLAs, high roaming costs, and strict contractual obligations. The lack of an automated mechanism to verify SLA compliance leads to situations where institutions cannot objectively demonstrate contract non-compliance. Hamdi et al. (2022) emphasize that oracles and APIs are essential for "automatic detection of SLA violations and triggering corrective actions", providing a continuous and verifiable data stream. Hybrid architectures – off-chain monitoring and on-chain anchoring – are considered the optimal solution for scalability and sustainable costs. Sghaier et al. (2024) and Li et al. (2020) show that this model allows institutions to simultaneously benefit from the performance of traditional systems and the transparency of blockchain. In this context, the paper responds to a real need: the modernization of public processes through secure, transparent, and automated technologies, which can support rapid and substantiated decisions.

### 1.3 Problems that the research helps to solve

The research addresses a set of structural problems that public institutions face in managing mobile telephony services:

- Lack of transparency and traceability of data on consumption, incidents and compliance with contractual obligations. Traditional processes are based on manual reports, vulnerable to errors and interpretations.



Business Excellence and Management
Volume 16 Special Issue 6 / 2026

- Inefficient monitoring of SLAs, which prevents objective demonstration of non-compliance with contracts.
- Absence of an automatic mechanism to detect consumption overruns, especially in international roaming, where costs can increase rapidly.
- Difficulty in optimizing the subscription portfolio, as manual analysis is time-consuming and rarely accurate.
- Fragmentation of the data flow, which hinders rapid reaction and informed decisions.

The integration of blockchain, smart contracts, oracles/APIs, AI and a unified dashboard provides a coherent infrastructure that automates verifications, detects deviations, optimizes costs and ensures full auditability.

### 1.4 Research questions

The paper investigates how the processes of purchasing and managing mobile telephony services in public institutions can be modernized and automated by using blockchain and artificial intelligence. In particular, it analyses:

- Whether a smart contract can ensure transparency, automatic consumption control and objective verification of SLAs.
- How AI can optimize the subscription portfolio and reduce costs.
- How a complete flow can be built – from data collection to automated decision generation – to support the efficient management of public resources.

Relevant references from the literature that emphasize and apply the research topic are presented below by components, as follows in the field:

a) Blockchain and smart contracts in public administration

Battista et al. (2026) – Blockchain and smart contracts for public administration. The authors demonstrate the practical application of smart contracts in public infrastructures, showing how operational data can automatically trigger contractual actions and how blockchain can automate technical checks, payments and performance monitoring.

b) Legal and operational analysis of smart procurement

Alotaibi (2026) – Blockchain technology and automated project governance. The paper looks at how blockchain can support public project governance through automated verification, audit, and compliance mechanisms. The author points out that procurement processes can be integrated into a blockchain-based 'project governance' framework, where contractual rules, eligibility criteria, and supplier obligations are monitored automatically. The study highlights the benefits in reducing operational errors, increasing transparency, and strengthening legal accountability, as well as the challenges related to interoperability and institutional adoption.

c) Integration of blockchain and AI in public procurement

Badra et al. (2024) – From traditional SLA management to blockchain-enabled smart contracts: A survey shows that moving from traditional SLAs to blockchain smart contracts allows for immutability, traceability, and full automation of contractual rules, which are essential in public procurement. Smart contracts reduce the risk of fraud by eliminating subjective interpretations, and integrating AI adds predictive analysis, anomaly detection, and automatic alerts for non-compliance. The authors' conclusions are fully in line with international trends, where blockchain and AI are used together for transparency, auditability, and decision support in procurement processes. The selected and presented references cover all essential components of the topic, providing both theoretical support and practical evidence that the solutions proposed in the paper are feasible, relevant and aligned with international trends.

## 2. LITERATURE REVIEW

The international literature analyses in depth the evolution of blockchain technologies, smart contracts and artificial intelligence, highlighting their potential to transform administrative, operational and digital governance processes. These works offer a modern perspective on how distributed ledgers, contractual automation and intelligent analytics can be integrated into end-to-end architectures applicable to public institutions. Almi'ani et al. (2026) highlight the fact that blockchain has become a central tool in the modernization of public services, due to its ability to provide transparency, immutability and complete auditability. The authors show that distributed ledgers significantly reduce operational risks and administrative costs, especially in sensitive processes such as public procurement, digital identity and service management. I believe that this perspective is directly applicable to the field of mobile telephony, where traceability of consumption and incidents is essential. In the area of contract automation, Badra et al. (2024) demonstrate that smart contracts can automatically monitor SLA obligations, generating real-time notifications when contractual parameters are exceeded. Their study confirms that contract automation reduces the reliance on manual verifications and increases the accuracy of supplier performance monitoring. This contribution is highly relevant to my work, as verification of telecom consumption and incidents needs to be a continuous, automated and verifiable process. The integration of blockchain with artificial intelligence is analysed in depth by Touloupou & Kapassa (2026), who show that decentralized AI agents can evaluate operational metrics in real time, detect anomalies and trigger automated actions based on codified rules. The authors classify four modern AI–blockchain architectures,

Business Excellence and Management
Volume 16 Special Issue 6 / 2026

confirming that hybrid models (AI off chain + verification on chain) are the most efficient. In my opinion, this direction is essential for optimizing the telecom subscription portfolio, where AI can identify consumption patterns and generate recommendations. In the area of digital public administration, the combined adoption of AI and blockchain in e-government depends on interoperability, standardization, and integration with existing administrative processes. The authors emphasize that the technology cannot generate impact without alignment with the legal and procedural infrastructure. This conclusion is critical for public procurement of telecom services, where compliance and auditability are mandatory. In the area of supplier performance, Afraz et al (2023) demonstrate that blockchain can significantly improve the monitoring of digital service performance through automated verification and reporting mechanisms. Risk management in public administration is closely linked to the ability of institutions to implement technologies that ensure traceability and control, highlighting the need to adopt robust and verifiable technical solutions. Evaluating the existing contributions, it can be seen that post-2020 literature deals with concepts like blockchain, smart contracts, artificial intelligence, oracles, and APIs in an advanced manner, but most authors analyse them separately, without proposing a fully integrated architecture. My work goes beyond this conceptual fragmentation, proposing an end-to-end model that can be directly applied in public procurement of mobile phone services. The developed architecture demonstrates the practical applicability of emerging technologies in a real, regulated context characterized by strict requirements for auditability, traceability, and operational control.

Recent international literature provides a solid framework for understanding how blockchain, smart contracts and artificial intelligence can transform administrative and operational processes. Studies conducted after 2020 outline a technological landscape in full evolution, in which transparency, automation and intelligent analysis become central elements. In the following, I present the main contributions of foreign authors, together with the critical assessment and how they integrate into the architecture proposed in the paper.

Sghaier et al. (2024) demonstrate that blockchain can ensure complete traceability of SLA metrics, validating the hybrid model of off-chain monitoring and on-chain anchoring. Their results confirm the robustness of a distributed architecture, but the lack of integration with artificial intelligence limits the system's ability to generate predictive analytics. My work extends this direction by adding an AI module that transforms monitored data into operational recommendations.

Hamdi et al. (2022) highlight the potential of smart contracts to automatically encode and execute SLAs, reducing human error and interpretive ambiguities. Their model is robust, but remains isolated from telecom operational ecosystems, as it does not integrate specialized APIs. In my work, this limitation is overcome by connecting the smart contract to real data sources, automatically extracted through APIs.

Schweizer (2019) provides a remarkable technical contribution, demonstrating that performance metrics can be mapped directly to on-chain functions, allowing for the automatic evaluation of SLAs. The approach is elegant and efficient, but predominantly applied in technical domains such as location and mapping. I adapt this principle to the telecom domain, applying it to consumption metrics, incidents, and response times.

Another expert analyses the use of blockchain in telecom back office processes, such as billing, settlement and SLA management. The results confirm the applicability of the technology in the telecom industry, but focus on the commercial environment. My work extends this perspective to the public sector, where auditability and compliance requirements are stricter.

Casino et al. (2019) demonstrate that smart contracts can automate payments and financial flows, reducing administrative costs. Their contribution is valuable, but does not address the integration of AI, which limits the system's ability to predict behaviours or optimize costs. In my work, AI fills this gap, providing a higher level of analysis.

Li et al. (2020) apply clustering techniques on on-chain data, identifying consumption patterns and recurring behaviours. This contribution is highly relevant for optimizing telecom subscriptions, as it allows segmenting users according to real needs. I take this approach and apply it to validated on-chain data, generating recommendations for streamlining the subscription portfolio.

Azzopardi et al. (2018) analyse the role of oracles in connecting external data to the blockchain, highlighting the importance of APIs in modern architectures. Their results are essential for my work, as they confirm the need for an automatic data flow between telecom systems and blockchain. I operationalize this direction by integrating telecom APIs with automation platforms made in Python or Logic Apps.

Tan et al. (2022) tackle a key topic: blockchain governance in the public sector. The authors show that adopting the technology is not just a technical matter, but a deeply administrative one, where governance decisions affect the transparency, accountability, and efficiency of institutions. This perspective is fundamental for my paper, which proposes an integrated technical architecture, but anchored in the compliance requirements of public institutions.

Zhagalov et al. (2026) investigate the use of blockchain in public procurement, showing that the technology can increase transparency, reduce corruption risks, and improve auditability. Their contribution is essential for the legal side of my work, but it doesn't include technical integration. I complement this perspective by adding AI, APIs, and workflow automation.

Afraz et al. (2023) analyse the use of blockchain in telecom, focusing on costs, scalability, and operational requirements. Their study is highly relevant, as it confirms the feasibility of the technology in the telecom field, but it doesn't address AI integration. My work fills this gap by adding an analytical module.

Business Excellence and Management
Volume 16 Special Issue 6 / 2026

The literature review shows that there is a global interest in the use of blockchain in public procurement, for the automation of SLAs and for the integration of AI in administrative processes. However, existing studies treat these elements separately. My work positions itself exactly in the identified gap, proposing a complete, integrated, end-to-end architecture.

## 3. RESEARCH METHODOLOGICAL FRAME AND DISCUSSIONS OF THE RESEARCH RESULTS

### 3.1 The purpose and objectives of the research

The central objective of the research is the design and validation of an integrated digital ecosystem, built on blockchain technology and artificial intelligence, capable of modernizing and streamlining the process of purchasing and managing mobile telephony services in public institutions. The approach aims, in a first stage, to define a unitary purchasing logic and transpose it into a smart contract that automates the assignment, execution and monitoring of contractual obligations. As Liu et al. (2025) show, smart contracts can automatically monitor compliance with clauses and trigger actions without human intervention, thus substantiating the proposed technical architecture. The contract validation in the Remix environment demonstrates the feasibility of a transparent, immutable and verifiable mechanism for managing telecom services. An essential objective is to integrate this contract with an artificial intelligence module, which processes data recorded on the blockchain for predictive analysis, anomaly identification and operational recommendations generation. Recent literature confirms the relevance of this direction: Almi'ani et al. (2026) highlight the role of blockchain in increasing administrative transparency, and Alotaibi (2026) shows that it allows predictive and automated governance, reducing operational risks. In the same sense, Androniceanu (2025) emphasizes that AI offers the administration the ability to anticipate problems and optimize decisions. The research aims to build a complete flow, in which data automatically collected via API are validated on-chain, analysed by AI and presented in an interactive dashboard. Histogram-type visualizations for national data traffic, scatter plot for national–SEE consumption comparison, bar chart for extra-SEE international minutes, and cost–consumption analysis completed by K-Means clustering provide institutions with an advanced decision-making tool. Overall, the objective of the paper is to demonstrate that public institutions can benefit from an automated, transparent and efficient system for the acquisition and management of mobile telephony services, capable of reducing costs, eliminating human errors and improving the decision-making process through real-time analysis.

### 3.2 Stage 1 – Designing the unified logic diagram for smart contract-based telecom procurement

The first stage of the research consists of translating the requirements of the telecommunications services acquisition process into a unitary logic diagram. This stage begins with the complete definition of the technical and functional needs of public institutions, including the types of telecom resources (minutes, SMS, national, EEA and international extra-EEA data traffic), performance indicators (SLA, consumption limits, intervention times, penalties), as well as the structure of the contractual flow from initiation and validation, to consumption, reporting and payment. Based on these requirements, the legal and technical foundation of the process is outlined, which will later be transposed into a smart contract. Identifying the minimum specifications for the services contracted from the telecom operator is an essential step: these include details on the types of subscriptions, traffic volumes, roaming conditions, performance requirements, tariff structure, reporting obligations, data security and incident management. This set of requirements becomes the basis for modelling the smart contract. The realization of the logic diagram transforms these elements into a clear and sequential operational flow: publishing requirements, submitting offers, automatic evaluation, awarding the contract, configuring services, monitoring consumption, managing incidents, invoicing and updating the contract status. The conceptual diagram (Figure 1) provides a structured representation of the entire process and allows the conversion of a traditional procurement mechanism into an automated, transparent and verifiable digital system, ready for subsequent implementation in a smart contract.

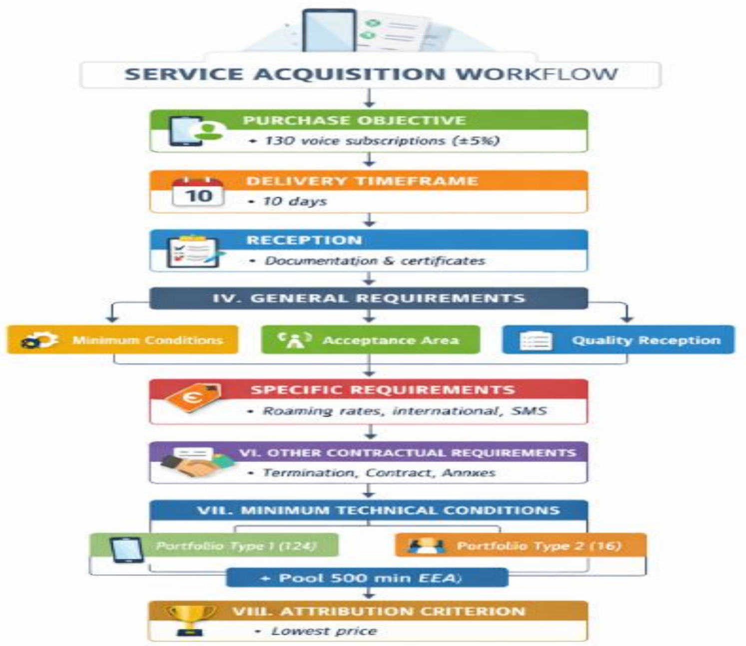


**FIGURE 1. SERVICE ACQUISITION WORKFLOW**
Source: Author



Business Excellence and Management
Volume 16 Special Issue 6 / 2026

### 3.3 Stage 2 – Operational validation of the smart contract in the Remix environment

The second stage of the research consists of testing the smart contract in the Remix environment to validate the technical functionality and logical behaviour defined in the conceptual scheme. The contract, developed in the Solidity language, was imported into the Remix IDE (a platform dedicated to the development and simulation of blockchain applications), where the structures, functions and events necessary to manage the process of acquiring and administering mobile telephony services were defined. Testing begins with the compilation of the code, the first moment in which the syntactic and structural integrity of the contract is verified. Error-free compilation confirms that the internal logic is correctly implemented and ready for execution. Subsequently, the contract is implemented in the JavaScript VM environment by configuring the initial parameters (provider, contract duration, number of subscriptions, international minutes included). The message "Transaction mined and execution succeeded" confirms the activation of the contract and the generation of its own address on the test blockchain. After implementation, subscription plans are configured through the setSubscriptionPlan function, where the types of subscriptions, monthly costs, data traffic and included resources are defined. Next, the setTariffs function sets the operational tariffs, respectively costs for roaming, international calls, SMS and monthly fees so that the contract reflects the economic rules of a telecom provider. The next step consists of adding subscribers through addSubscriber, each phone number being associated with a plan. The contract thus begins to simulate the behaviour of a real operational system, managing users and resources. To verify the quality mechanisms, operational incidents are simulated through openIncident, each incident automatically receiving a unique ID. The respondIncident and resolveIncident functions allow the evaluation of how the contract manages SLA compliance, acting as an impartial arbitrator in the remediation process. Through the reportMonthlyUsage function, the contract receives monthly consumption data (minutes, data traffic, incidents and quality indicators) based on which it automatically calculates the costs of each subscriber. Before payment, the amount due is checked with calculateTotalMonthlyFee, and the transaction is finalized through payMonthlyInvoice, which records the payment in the native ETH unit (wei), simulating an automated accounting system. To cover all contract scenarios, the termination, suspension and reactivation functions (terminateContract, suspendContract, reactivateContract) are tested. The contract responds correctly to state changes, faithfully replicating real processes in the telecom field. Going through these configuration steps, managing subscribers, incidents, SLA, reporting, payments and changes to the contract status confirms the full functionality of the smart contract and is presented in Figure 2. Testing in Remix gradually transformed the code into a coherent operational system, validating the flows defined in the logic diagram and demonstrating that the proposed architecture can be technically implemented in a blockchain environment.

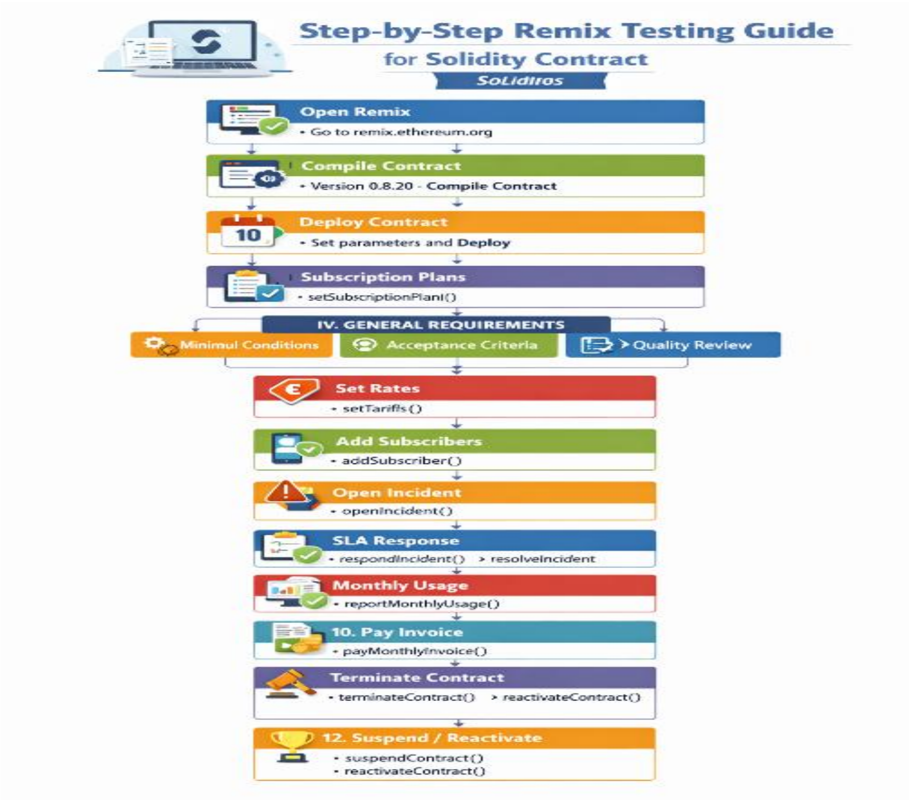


**FIGURE 2. SMART CONTRACT TESTING IN REMIX**
Source: Author

### 3.4 Stage 3 – Implementing and publishing the smart contract on the blockchain

The third stage consists of integrating the smart contract on the blockchain, the moment when the previously developed software logic becomes a transparent, immutable and globally accessible mechanism. Implementation on a public blockchain transforms the contract into a permanent component of the digital infrastructure, which is why the process requires rigorous checks before publication (posting online). After compiling the code and eliminating any errors, the contract is tested on testnet networks, such as Sepolia, which reproduce the behaviour of the Ethereum network without costs and without operational risks. This stage is essential because, once implemented on the blockchain, the contract can no longer be modified, and any vulnerability becomes permanent. To assess the robustness of the code, tools such as Slither, dedicated to the static analysis of Solidity contracts, and OpenZeppelin Defender, oriented towards the operation and security of contracts in production environments, are used. The contract is published through Remix or through automated scripts connected to blockchain nodes provided by services such as Alchemy, which offers scalable access to Ethereum networks through specialized APIs. The implementation transaction is signed with the developer's private key, the execution cost (gas) is paid, and after confirmation on the network, the contract receives a public address. Subsequently, the

Business Excellence and Management
Volume 16 Special Issue 6 / 2026

source code is verified on Etherscan, which ensures transparency, auditability and the possibility of interacting directly with the contract's functions. Integration with external applications is achieved through libraries such as ethers.js or web3.py, which allow reading on-chain data, sending transactions and listening to events generated by the contract (Voshmgir, 2020). The data recorded on the blockchain is then taken over by analytical systems and artificial intelligence modules, either through Python programs or through enterprise platforms such as Azure Machine Learning or Power BI, where they are transformed into analyses, predictions and operational insights. Through this complete flow: implementation, verification, integration and analysis, the smart contract becomes a secure, scalable and intelligent element in a modern digital ecosystem. It automates processes, provides full traceability and feeds advanced analysis models, thus strengthening the ability of public institutions to manage mobile services efficiently and transparently.

### 3.5 Stage 4 – Connecting the smart contract to the artificial intelligence system and intelligent processing of data on chain

The fourth stage aims to integrate the smart contract with an artificial intelligence system, so that the data recorded on chain is transformed into analytical information and automated actions. In this phase, an interconnection module is developed that takes the data generated by the contract (consumption, costs, timestamps, and operational indicators) and transmits it to an AI model for advanced processing. The smart contract continuously provides relevant data: the number of active subscribers, types of subscriptions, consumption of minutes and traffic (national, SEE, roaming), incident response times, number of incidents, monthly costs, and costs per subscriber. This information is accessible on-chain and can be extracted through specialized libraries such as Web3.js or ethers.js, which ensure communication with the blockchain network through a provider such as Alchemy or a proprietary node. The integration with AI is achieved through an off-chain flow: an external application (Node.js or Python) extracts data from the blockchain, and the artificial intelligence model processes it. AI can generate cost predictions, detect anomalies, assess SLAs compliance, and formulate automatic recommendations for optimizing subscriptions and consumption. In this context, the principle formulated by Russell and Norvig becomes essential for the conceptual foundation of the mechanism: 'A system is rational if it does the right thing, given what it knows.' In this way, AI becomes an analytical engine that complements the deterministic logic of the smart contract, transforming raw data into useful insights for management. The AI results are later available for the analysis and visualization stages, but at this stage the focus remains on the technical connection and intelligent processing of data, without yet building the complete analysis flow or dashboard.

### 3.6 Stage 5 – On-chain data processing and building the analytical flow for the intelligent dashboard

The fifth stage develops the complete automated analysis flow, in which the data provided by the smart contract is collected, transformed, and visualized in an intelligent dashboard. This stage does not deal with connecting the AI to the contract (done previously), but with processing the data and generating visual and analytical indicators. The process starts with extracting on-chain data through blockchain APIs, using off-chain scripts (Node.js/ethers.js or Python/web3.py) that listen to contract events (monthly reports, incident opening, payments) and read the information exposed through view functions. The data is saved in a database and organized into tables dedicated to consumption, incidents, costs, subscribers and SLAs. An ETL (Extract–Transform–Load) flow runs periodically to clean, normalize and transform the raw data into relevant indicators: cost per subscriber, cost per GB, average response times, percentage of SLA compliance, identification of abnormal values. This prepared data is then taken over by the AI modules, which apply prediction, anomaly detection, clustering or forecast models to anticipate costs and identify unusual behaviours. The results are integrated into an intelligent dashboard (Power BI or web application), where consumption graphs, cost evolution, incidents, SLA indicators and AI predictions are displayed, along with automatic recommendations (Androniceanu, 2025a; Androniceanu, 2025b). The system can generate notifications regarding traffic exceedance, SLA non-compliance or subscription optimization opportunities. This stage completes the digital ecosystem, transforming the data provided by the smart contract and processed by AI into visual and decision-making tools, ensuring continuous monitoring and rapid reaction.

### 3.7 Stage 6 – Building the analytical dashboard and evaluating the portfolio

The sixth stage completes the digital ecosystem by developing an analytical dashboard that centralizes operational indicators, AI model results, and automatically generated recommendations. The dashboard, developed in Python or Power BI, transforms blockchain-collected data into a clear, easy-to-interpret visual interface, providing public institutions with a modern monitoring and decision-making tool.

**Table 1. Subscription portfolio (NL-unlimited)**

| Characteristic | Type A | Type B | Type C | Type D | Type E |
|---|---|---|---|---|---|
| National minutes/SMS | NL | NL | NL | NL | NL |
| SEE minutes/SMS | NL | NL | NL | NL | NL |
| National data (GB) | NL | 20 | 40 | 80 | NL |
| SEE data (GB) | 10 | 10 | 15 | 20 | 30 |
| International minutes outside SEE | 0 | 0 | 100 min | 200 min | 500 min |
| Cost (EUR) | 8 | 8 | 12 | 18 | 25 |

Source: Author



Business Excellence and Management
Volume 16 Special Issue 6 / 2026

Business Excellence and Management
Volume 16 Special Issue 6 / 2026

To feed the dashboard, a realistic dataset was built, necessary to train the AI models. Five types of subscriptions were defined (Table 1), each with different resources for national traffic, EEA traffic and extra-EEA international minutes. These plans cover a wide spectrum of needs, from low-consumption users to heavy users. Based on these plans, a portfolio of 20 subscribers was generated (Table 2), each with distinct consumption values, incidents, and costs. The dataset is diverse enough to allow the AI models to identify usage patterns and additional cost risks.

**TABLE 2. SUBSCRIPTION PLAN FOR 20 SUBSCRIBERS**

| Subscriber | Current plan type | National data (GB) | SEE data (GB) | International minutes | Incidents | Cost (EUR) |
|---|---|---|---|---|---|---|
| 1 | A | 5 | 9 | 0 | 0 | 8 |
| 2 | B | 10 | 10 | 40 min. | 1 | 8 |
| 3 | B | 2 | 11 | 0 | 0 | 8 |
| 4 | C | 25 | 14 | 120 min. | 2 | 12 |
| 5 | C | 38 | 15 | 95 min. | 0 | 12 |
| 6 | D | 60 | 19 | 180 min. | 1 | 18 |
| 7 | D | 75 | 20 | 210 min. | 3 | 18 |
| 8 | E | 50 | 29 | 480 min. | 0 | 25 |
| 9 | A | 8 | 3 | 0 | 0 | 8 |
| 10 | C | 40 | 16 | 130 min. | 1 | 12 |
| 11 | A | 1 | 0,5 | 0 | 0 | 8 |
| 12 | B | 18 | 9 | 10 min. | 0 | 8 |
| 13 | C | 39 | 14 | 80 min. | 1 | 12 |
| 14 | D | 10 | 2 | 0 | 0 | 18 |
| 15 | E | 150 | 30 | 500 min. | 4 | 25 |
| 16 | B | 4 | 1 | 0 | 0 | 8 |
| 17 | C | 20 | 15 | 110 min. | 2 | 12 |
| 18 | D | 78 | 20 | 190 min. | 1 | 18 |
| 19 | A | 12 | 7 | 0 | 0 | 8 |
| 20 | B | 95 | 25 | 350 min. | 2 | 25 |

Source: Author

To highlight the portfolio structure, the dashboard includes several visualizations:

1. Histogram – national data consumption

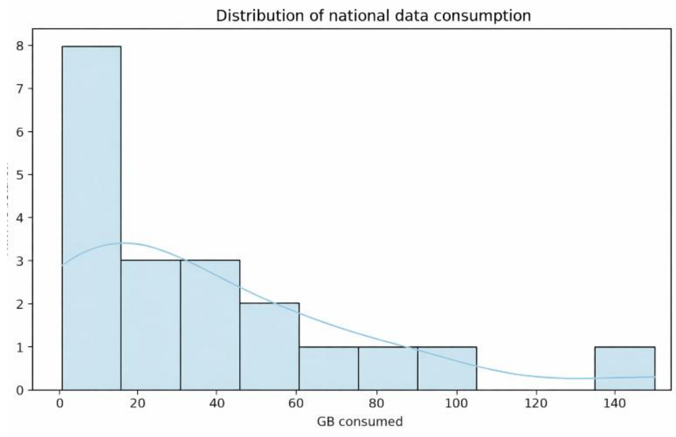


**FIGURE 3. DISTRIBUTION OF NATIONAL DATA CONSUMPTION**
Source: Author

The histogram in Figure 3 highlights the distribution of national data usage by subscribers, allowing for quick identification of areas where subscriptions are oversized or undersized. Most users fall within the 0–20 GB range, indicating a high potential for optimization by downgrading to Type A or Type B plans. This range accounts for about 40% of the portfolio, and the difference between actual usage and the resources included in higher-tier plans generates unnecessary costs for the institution. A second, much smaller group consumes between 50 and 150 GB, justifying Type D or Type E plans. These heavy users are easy to spot visually, and their presence confirms the need to maintain higher-tier plans to avoid traffic overages.

2. Scatter plot – comparison between national and SEE data

The scatter plot in Figure 4 gives a two-dimensional view of consumption behaviour, correlating national traffic with roaming traffic in the EEA. This visualization makes it easy to spot natural clusters of users and assess whether current plans are a good fit. The chart shows a tight cluster of users with high EEA usage, between 14–30 GB, which lines up with C–E type plans. These users tend to travel internationally more, so plans with extra EEA resources make sense. On the other hand, users consuming less than 3 GB in the EEA are at the bottom of the chart and could go for more affordable plans (Type A/B). This group is key for cost optimization since the extra EEA resources in higher-tier plans often go unused. Overall, the scatter plot provides an intuitive visual way to segment users, making it easier to make quick decisions about adjusting plans based on actual usage.

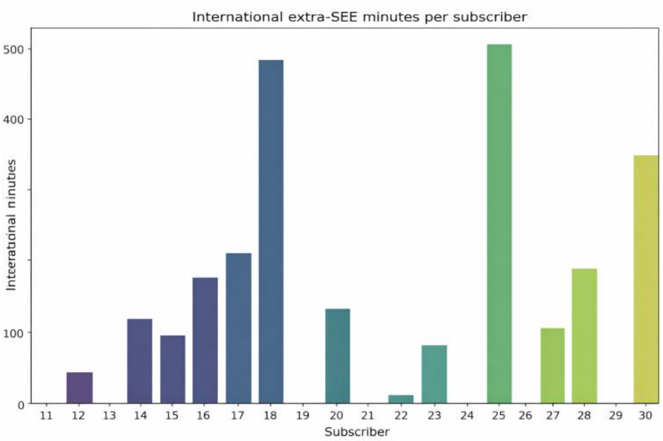


**FIGURE 4. INTERNATIONAL MINUTES OUTSIDE SEE PER SUBSCRIBER**
Source: Author

3. Bar chart – extra SEE international minutes

The bar chart dedicated to extra-SEE international minutes highlights significant differences among users regarding international calls. This visualization is critical for identifying heavy users and preventing extra costs. The chart in Figure 4 clearly shows that a small group exceeds 200–500 international minutes, which justifies Type E subscriptions or dedicated add-ons. These users generate the highest risk of extra costs, and monitoring them is essential for maintaining budget control. At the same time, most subscribers



Business Excellence and Management
Volume 16 Special Issue 6 / 2026

have little to no international usage, indicating that the minutes included in the higher plans are often unused. The bar chart thus allows for quickly spotting imbalances between usage and included resources, making it easier to adjust subscriptions on an individual level.

4. Total cost–consumption analysis

The total cost–consumption view in Figure 5 reveals two critical situations that affect portfolio efficiency: Users who pay little but consume a lot are in the upper part of the chart, where consumption is high but the subscription cost is low. They pose a major risk of overages since the resources included in their subscriptions do not cover actual usage. Identifying them allows for quick interventions, like upgrading to higher plans. Users who pay a lot but consume little are in the lower part of the chart, where the cost is high but consumption is low. They represent clear optimization opportunities. Downgrading these users can generate significant savings without impacting service. Cost–consumption analysis thus becomes a strategic tool for balancing the portfolio, highlighting both risks and opportunities for efficiency.

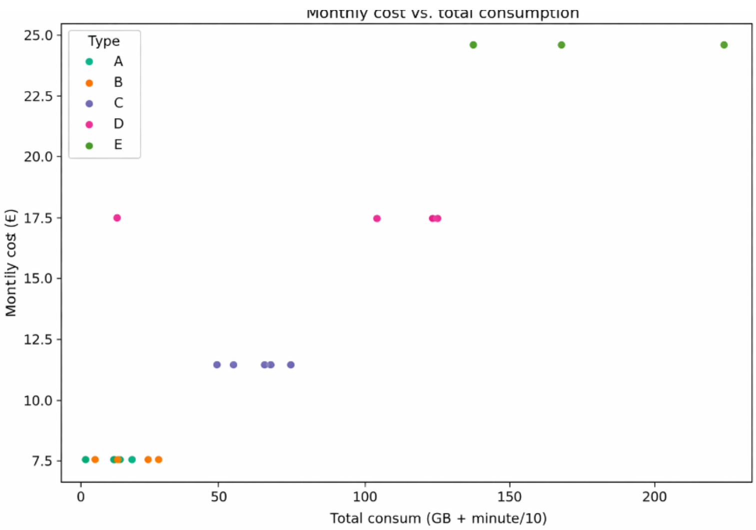


**FIGURE 5. TOTAL CONSUMPTION/MONTHLY COST**
Source: Author

5. Segmentation – K-Means Model

The K-Means IA model in Figure 6 confirms the existence of three natural consumption segments, each with specific tariff recommendations:

Low consumption cluster

Characteristics: under 15 GB national data, under 5 GB EEA, almost non-existent international minutes. Recommendation: Type A/B. Examples: subscribers 1, 9, 11, 16. Special case: subscriber 14 – uses Type D, but requires downgrade to Type B.

Medium consumption cluster

Characteristics: 15–45 GB national data, 8–16 GB EEA, 50–150 international minutes. Recommendation: Type C. Examples: subscribers 2, 4, 5, 10, 13, 17. Intermediate situations:

- subscriber 12 can oscillate between Type B and C,
- subscriber 19 approaches the average zone, but remains optimal for Type B.

High consumption cluster

Characteristics: over 60 GB national data, over 18 GB EEA, over 180 international minutes. Recommendation: Type D/E, depending on the intensity of consumption. Examples:

- Type D: subscribers 6 and 8,
- Type E: subscribers 7, 15, 20.

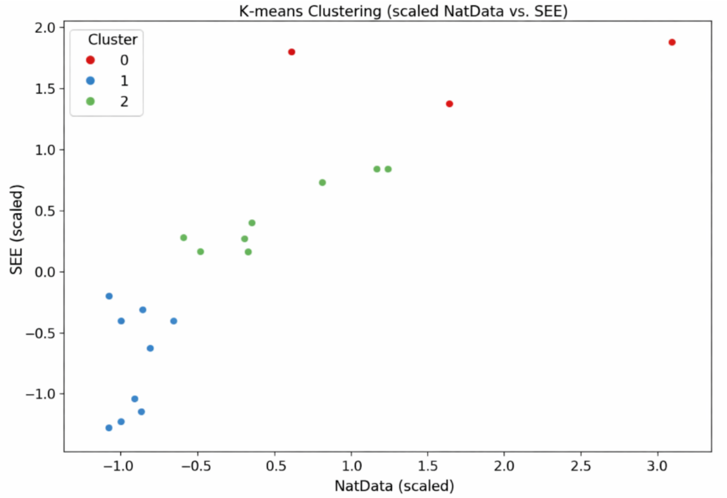


**FIGURE 6. THE K-MEANS MODEL**
Source: Author

Portfolio conclusions

AI analysis and dashboard visualizations lead to the following conclusions:

- 6 subscribers are oversized and can switch to Type A/B subscription.
- 8 subscribers are in the optimal zone for Type C.
- 6 subscribers have high consumption and require Type D/E.
- 4 subscribers are at risk of additional cost due to international minutes.
- 3 subscribers exceed EEA traffic and require upgrade.

This stage focuses exclusively on analysis and visualization, without automated actions or integration with the smart contract. The dashboard thus becomes a strategic tool, transforming raw data into useful insights for cost optimization and streamlining the subscription portfolio.

### 3.8 Stage 7 – Complete automation by integrating AI with the smart contract

The seventh stage introduces operational automation, in which AI not only analyses data, but also sends actions to the smart contract. This closes the automatic loop: contract → data → AI → recommendations → actions → contract.

Business Excellence and Management
Volume 16 Special Issue 6 / 2026

The smart contract provides real-time information about consumption, incidents, SLA times and costs. AI takes this data, identifies deviations and generates recommendations such as:

- downgrade for users who use less than 10% of resources,
- upgrade for those who constantly exceed the EEA limits,
- adjustment of international packages for heavy users.

These recommendations can be sent back to the contract in the form of automated actions (notifications, penalties, adjustments). The dashboard displays the AI results in real time: live consumption, predictive graphs, alerts for imminent exceedances and performance indicators.

Stage seven focuses exclusively on automation and actions, not on visualization or testing of the ecosystem. Overall, this stage transforms the ecosystem into an intelligent mechanism, capable of monitoring, analysing and acting in real time, reducing operational risks and optimizing costs.

### 3.9 Stage 8 – Testing the integrated ecosystem (Blockchain → API → AI → Automation → Dashboard)

Stage eight focuses exclusively on testing the integrated flow, not on individual visualization or automation. It validates the functioning of the integrated ecosystem, in which the blockchain, APIs, AI and dashboard collaborate in a unified flow. The smart contract implemented in Solidity becomes the core of the system, recording consumption, incidents, costs and SLA indicators. Web3 scripts extract this data and transmit it to the AI modules and automation mechanisms. Testing begins with automatic monitoring of the international pool. The contract stores the total available minutes and current consumption, and a scheduled script periodically queries the contract and calculates the utilization percentage. If the set threshold (e.g., 80%) is exceeded, the system automatically generates an alert sent via email, Teams, or SMS, warning the operational team before resources are exhausted. In parallel, the system checks compliance with SLAs. The contract records the opening, response, and resolution times for each incident, and the scripts listen for IncidentResolved events. Upon completion of an incident, the response and resolution times are automatically calculated and compared with the contractual limits. If the SLA is violated, the system sends an alert recommending the application of penalties. The AI component adds a higher level of analysis. Based on the data collected – consumption, subscription types, monthly costs, incidents – the AI applies clustering and anomaly detection algorithms to identify usage patterns and significant deviations. Recommendations are formulated automatically, for example:

- “Subscriber 17 uses only 3% of the included traffic. I recommend a downgrade.”
- “Subscriber 18 exceeds the SEE traffic monthly. I recommend an upgrade.”

For reporting, the system automatically generates PDF documents that include consumption, incidents, SLAs, costs, and AI recommendations. These reports are automatically sent to the responsible departments. Testing confirms that the integrated ecosystem works coherently: blockchain ensures data immutability, APIs allow communication between components, AI optimizes decisions, automation reduces risks, and the dashboard provides total transparency. The result is a scalable and intelligent platform (Figure 7), which transforms data into decisions and decisions into value for the organization.


FIGURE 7. AUTONOMOUS AUTOMATED ECOSYSTEM WORKFLOW
Source: Author

## 4. CONCLUSIONS

The implementation of a smart contract for the acquisition of mobile telephony services in public institutions represents a relevant contribution from both a scientific and a practical perspective, demonstrating how blockchain technologies and artificial intelligence can transform a field in which transparency, auditability and cost optimization are essential. The project covered the entire technical flow: defining the architecture, creating the logic diagram, developing and testing the contract in Remix, integrating with an automated analysis system and building an interactive dashboard. This integrated approach allows for the automation of procurement processes, continuous monitoring of consumption, generating alerts and dynamically adjusting services, contributing to increasing operational efficiency. Androniceanu's (2024) statement, according to which the digitalization of communication and contracting processes significantly increases operational efficiency in public institutions in that modernization is



Business Excellence and Management
Volume 16 Special Issue 6 / 2026

Business Excellence and Management
Volume 16 Special Issue 6 / 2026

achieved by integrating emerging technologies, capable of automating processes, reducing risks, and increasing operational efficiency, is directly reflected in the automation module developed within the work. The original contribution of the research lies in the way in which the logic diagram of the procurement process was built, integrating technical, legal and operational requirements into a coherent model, compatible with automatic execution on the blockchain. Although the specialized literature highlights the potential of smart contracts in the public sector, their concrete application in the telecom field is still limited. The paper demonstrates the feasibility of these concepts through a functional implementation, adapted to a real and regulated context. Another novelty is the integration of blockchain with AI in a complete flow: on-chain data collection, intelligent analysis, insight generation and their visualization in an intuitive dashboard. Bashir (2020) emphasizes that blockchain provides a robust framework for process automation through smart contracts, an idea that underpins the technical architecture used in the project. The developed dashboard includes essential indicators for decision-making – real-time consumption, predictive graphs, risk indicators and automatic recommendations – strengthening the capacity of public institutions to efficiently manage telecom services. The integration of AI with smart contracts allows for the complete automation of processes, from consumption validation to service package adjustment, providing a practical tool for budget optimization and increased traceability. Battista et al. (2026) show that smart contracts can support predictive and transparent monitoring of public services, confirming the direction adopted in this research. At the same time, the specialized literature highlights the role of blockchain in increasing transparency and auditability. Casino et al. (2019) note that blockchain offers a high level of traceability and verifiability in administrative processes, an aspect that is found in the telecom consumption monitoring module implemented in the paper. Through this research, we strengthened the connection between academic theory and technological applicability, demonstrating that a modern ecosystem, based on blockchain and AI, can transform the way public institutions acquire and manage mobile telephony services. The results obtained confirm the relevance, utility and expansion potential of the proposed solution.

## DECLARATION OF COMPETING INTEREST

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The author declares that he has not used any Generative AI and/or AI-assisted technologies during the preparation of this work.

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