

# Adoption of Blockchain for Decentralized Execution Agreements: Empirical Evidence of Usability and Acceptance

Iago Fernandes<sup>1</sup>, Pamella Soares<sup>1</sup>, Raphael Saraiva<sup>1</sup>, Ana Klyssia M. Vasconcelos<sup>1</sup>,  
Matheus Paixao<sup>1</sup>, Allysson Alex Araújo<sup>2</sup>, Jerffeson Souza<sup>1</sup>

<sup>1</sup>Graduate Program in Computer Science (PPGCC)  
State University of Ceara (UECE) – Fortaleza, Ceará – Brazil

<sup>2</sup>Center for Science and Technology (CCT)  
Federal University of Cariri (UFCA) – Juazeiro do Norte, Ceará – Brazil

**Abstract.** *The management of Decentralized Execution Agreements (TEDs) by the Secretariat for Coordination and Governance of Federal Assets (SPU) faces transparency and traceability challenges that hinder access to contractual information. This study evaluates the integration of SPU systems with blockchain through a blockchain-based API, adapted for the management of public processes, using Celo blockchain and IPFS for immutable and auditable registration of TEDs. We conducted usability and acceptance evaluations with 15 Java developers and 10 external users of the SEI platform, applying the Think-Aloud method. The results indicated 87% success in the tasks, an average of 4.2 (1-5) for documentation clarity, 90% acceptance, and 80% agreement regarding the contribution to transparency, suggesting the importance of considering factors such as the technology learning curve and citizens' digital familiarity when designing blockchain-based solutions for the public sector.*

## 1. Introduction

The Secretariat of Coordination and Governance of Union Assets (SPU) enters into Decentralized Execution Agreements (TEDs) with governmental bodies for the development of programs and projects of national interest [BRASIL 2020]. The formalization and processing of these instruments occur through the Electronic Information System (SEI), the official electronic process management platform of the Federal Public Administration. Managing these instruments involves multiple stages, documents, and strict deadlines, yet lacks mechanisms that ensure clear, traceable, and auditable access to contractual information, a limitation that undermines public transparency and hinders process follow-up.

In this context, blockchain technology stands out for recording digital events in an immutable and transparent manner, acting as a distributed ledger protected by cryptography [Beck et al. 2017]. Prior studies highlight its potential in the public sector [Ølnes et al. 2017, Moron and Bourguignon 2023, Silva and Marques 2021], particularly regarding transparency, data integrity, and auditability. In a previous study, an architecture was proposed for integrating the SPU's SEI system with blockchain through a blockchain-based API [Fernandes et al. 2023], an interface that abstracts blockchain complexity for document registration, adapted to the management of generic public sector processes. The solution enables the immutable recording of TED process stages and their respective documents, combining blockchain and distributed storage to ensure traceability and verifiability of information.

The adoption of blockchain in the public sector faces barriers related to human factors, such as the learning curve for developers [CasperLabs 2023] and citizens' unfamiliarity with concepts such as digital wallets [Giraldo et al. 2025]. Recent studies reinforce that human and social aspects are inadequately explored in the blockchain-based software literature [Li et al. 2023]. Thus, blockchain-based solutions in governmental environments depend not only on their technical implementation, but also on empirical evidence regarding their integrability and acceptability [Ølnes et al. 2017]. In legacy public sector systems, technology adoption involves two complementary vectors: the developer experience in technical integration and the usability perceived by end users. Despite the growth of blockchain initiatives in government, the literature still lacks studies that simultaneously assess both dimensions in real-world contexts.

This work therefore represents the empirical validation stage of the previously proposed architecture, investigating its feasibility from two complementary perspectives: the developer experience in integrating a blockchain-based API and the usability of the transparency prototype by SEI end users in the context of SPU's TED processes. To guide the investigation, encompassing human factors critical for public-sector adoption, the study addresses the following Research Questions (RQ): **(RQ1)** *In the context of integrating SPU's TED processes with blockchain, does a blockchain-based API offer clarity, comprehensibility, and ease of integration for developers with no prior experience in this technology?* **(RQ2)** *Does the transparency prototype offer adequate usability for SEI end users when consulting TED processes?*

The main contributions consist of the empirical validation of the architectural solution through evaluation with developers with no prior blockchain experience and SEI end users, generating evidence on technical feasibility and practical acceptability in the public sector, as well as insights for its refinement and large-scale adoption. The paper is structured as follows: related work (Section 2), methodology (Section 3), results (Section 4), and final remarks (Section 5).

## 2. Related Work

Ølnes et al. (2017) analyze real-world cases of blockchain adoption in governments, highlighting benefits such as transparency, operational efficiency, and fraud reduction, alongside technical challenges of scalability and interoperability with legacy systems. Moron and Bourguignon (2023) investigate federal blockchain networks in Brazil, concluding that the initiatives generated public value in administrative efficiency and transparency. Silva and Marques (2021) map applications in global governmental contexts, real estate registries, digital authentication, and financial processes, highlighting reductions in bureaucracy and improvements in auditing and compliance.

Although these works demonstrate the potential of blockchain in the public sector, none conducts an empirical usability evaluation of technical integration from a developer perspective, nor investigates the acceptance by end users of governmental platforms, a gap this work addresses by combining validation with Java developers and SEI users in the context of SPU's TED processes.

### 3. Method

This section briefly describes the architecture of the proposed solution (Section 3.1) and the usability study design (Section 3.2) conducted to evaluate it, as illustrated in Figure 1.

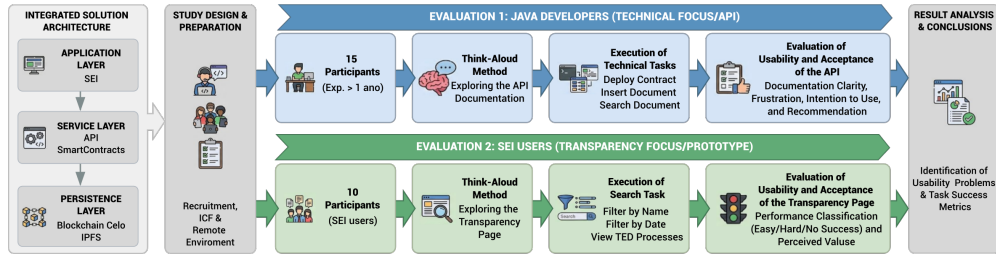


Figure 1. Usability study methodology and overview of the architecture.

#### 3.1. Overview of Solution Architecture

The architecture organizes into three layers: the **Application Layer** integrates the Electronic Information System (SEI); the **Service Layer** executes a Smart Contract that manages the “Process” entity, linking documents to ensure chronological traceability; and the **Persistence Layer** uses the *Celo* blockchain (Ethereum-based), integrated with the *Inter-Planetary File System* (IPFS), a decentralized media storage system. The transparency prototype, built in *React* with a SEI-inspired design, allows searching TED processes by ID with filters by date, document name, or transaction hash.

#### 3.2. Study Design

As summarized in Table 1 and illustrated step-by-step in Figure 1, an observational usability study was conducted with two participant profiles, justified by the fact that blockchain adoption in governmental systems depends on both technical integration and user acceptance [Ølnes et al. 2017].

Table 1. Participant profile and tasks per evaluation.

Criterion	Developers (n=15)	End Users (n=10)
Mean age	29.3 years	44.1 years
Education	Higher ed. (bachelor’s/master’s)	Higher ed. complete
Experience	Java $\geq$ 1 year (mean 2.3y)	Prior SEI usage
Blockchain	No experience	Not assessed
Duration	30–48 min (mean 35 min)	10–19 min (mean 14 min)
<b>Tasks</b>	T1: POST/contracts; T2: POST/documents; T3: POST/documentRead; T4: POST/documentsRead	T1: Filter by name; T2: Filter by date; T3: Search process documents
<b>Metrics</b>	Documentation Clarity, Frustration, Intention to use and Recommendation	Easy/Difficult/Unsuccessful [Winckler and Pimenta 2002] and Perceived Value

The methodological design captured aspects of documentation comprehension, frustration, trust, intention to use, and recommendation. Recruitment occurred via *snowball sampling* by e-mail, and sessions were conducted remotely via Google Meet (March–April/2025), mediated by one of the authors. Participants signed informed consent, completed characterization questionnaires, and executed tasks using Think-Aloud [Nielsen 1994]. Data collection included task scripts and Likert-scale post-task questionnaires, available in a replication package [Fernandes et al. 2026], including a

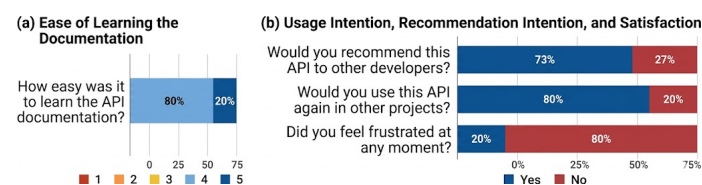
demonstration video of the prototype<sup>1</sup>. We carried out the data analysis using descriptive statistics for quantitative metrics to identify patterns and improvement suggestions.

## 4. Preliminary Results and Discussion

This section presents the results organized by participant profile, addressing each RQ.

### 4.1. Evaluation of Usability and Acceptance of the API by Developers (RQ1)

Figure 2 presents the results of the evaluation of the 15 developers. *Documentation clarity* obtained a mean of 4.2 (scale 1–5), with 80% of participants rating it 4 or 5. Despite the overall positive clarity, some developers pointed out the need for further detail on specific methods and parameter requirements. Regarding *intention to use*, 80% stated they would use the API in future projects, highlighting its simplicity and practicality after initial understanding. *Recommendation intention* was slightly lower (73%), as 27% preferred to wait for improvements in documentation and clearer signaling of initial usage flows. Regarding *satisfaction*, feelings of confidence predominated at the end of the tasks, although 20% reported occasional frustration due to unclear API error messages.



**Figure 2. Doc. Clarity, Frustration, Intention to Use, and Recommendation questions.**

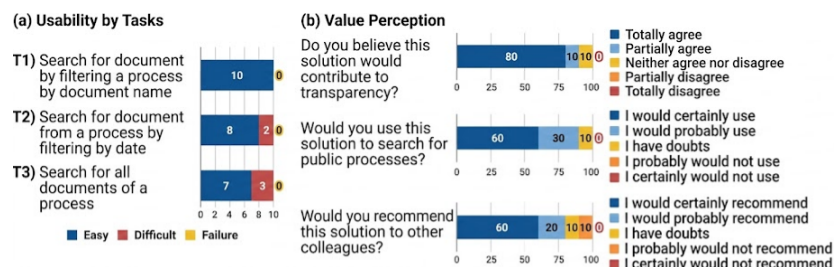
**Discussion – RQ1:** The literature points to the learning curve as one of the main challenges for blockchain adoption by developers [CasperLabs 2023]. The results respond positively to RQ1, as the documentation demonstrated adequate clarity and ease of integration for developers with no prior blockchain experience through the blockchain-based API. The gap between intention to use (80%) and immediate recommendation (73%) indicates that confidence in the solution is still conditioned on accumulated experience during use, signaling the need for a quickstart guide with end-to-end examples and more descriptive error messages. API usability studies suggest that documentation with executable examples significantly reduces integration time [Nielsen 1994], an improvement especially critical in governmental teams with heterogeneous profiles and high turnover, where this gap may represent a real obstacle to large-scale adoption.

### 4.2. Evaluation of Prototype Usability by End Users (RQ2)

Figure 3 presents the results of the 10 end users across the proposed tasks. Overall, 87% of tasks were completed on the first attempt, evidencing strong usability. Task T1 (filter by name) achieved 100% immediate success, indicating an intuitive flow. T2 (filter by date) obtained 90% ease, with the deviation related to the non-identification of the filter button. T3 (search all documents) showed greater variation, 70% easy and 30% difficult, due to ambiguity in the search field signaling, suggesting the need for prototype refinement. Regarding **perceived value**, results were expressive, with 80% fully agreeing

<sup>1</sup>End-user interface video demonstration available online at this [link](#).

that the solution contributes to transparency and traceability of public processes; 90% would use the solution for process consultation (60% certainly, 30% probably); and 80% would recommend it to SEI colleagues (60% certainly, 20% probably), with no rejection.



**Figure 3. Usability Analysis and Perceived Value of the solution by participants.**

**Discussion – RQ2:** The results respond positively to RQ2, as the transparency prototype demonstrated adequate usability for SEI end users when consulting TED processes. The overall 87% immediate completion rate is particularly relevant given the participant profile, mean age of 44.1 years, with no familiarity with blockchain concepts, indicating that the solution successfully abstracted the underlying technological complexity and offered an accessible experience to the general citizen. The only underperforming task (T3, 70% easy) reflected a human factor challenge, as ambiguous search fields generated divergent behaviors among users with lower digital literacy. This finding aligns with usability principles highlighting system status visibility and error prevention as critical heuristics in query interfaces [Shneiderman 2010]. From a perceived value standpoint, the most expressive result is that 80% of users believe the solution contributes to public transparency, signaling perceived legitimacy. This 90% acceptance rate surpasses typical e-government adoption benchmarks [Ølnes et al. 2017], indicating blockchain-based transparency can overcome historical resistance when abstracted through familiar interfaces such as SEI.

## 5. Final Remarks

This work presented the integration of SPU systems with blockchain via a blockchain-based API, adapted to public sector processes, with a focus on transparency and traceability of TEDs. The empirical validation with 25 participants responded positively to both research questions, with the blockchain-based API demonstrating adequate clarity for developers with no prior blockchain experience (RQ1), and the prototype demonstrating adequate usability for SEI end users (RQ2). The Think-Aloud method identified targeted improvements, such as clearer signaling of required fields and more descriptive error messages, guiding refinement without compromising adoption.

The main contributions include the usability evaluation of the API with developers and of the transparency prototype with SEI end users, generating findings that support solution refinement and viability in the public sector. As limitations, the sample size restricts generalization of results, observer bias may have been introduced by author-mediated sessions, and satisfaction metrics rely on self-report, subject to social desirability bias; results should thus be interpreted as preliminary evidence. Future work should expand validation, evaluate blockchain infrastructure costs, and test other public sector processes.

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