Research Article

Adoption of Smart Contracts in the Philippine Government Construction Industry

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ABSTRACT

Poor payment practices continue to plague not only the private construction industry but also the government construction sector. According to recent studies, conditions and instructions can be encoded into smart contracts to allow automatic payments. The construction industry in the Philippines is slow to adapt to new technologies. This research proposes the adoption of smart contracts for implementing Philippine government infrastructure projects. By analyzing datasets from the Cordillera Administrative Region, this study determined the willingness of government employees and contractors to adopt smart contracts for government projects and identified factors causing doubt among contractors and government employees about its implementation. A total of 218 professionals responded to a Google Form questionnaire, and 20 participants were involved in unstructured interviews, which supported the data and results from the questionnaire. To interpret and validate the data gathered, a two-tailed t-test analysis was used. The study revealed that the Philippine government construction industry, specifically in the CAR region, is not yet ready to adopt smart contracts. It was also found that smart contracts will only be effective with proper introduction through seminars and training.

Keywords: *Adoption, Government infrastructures, Implementation, Smart contract*

Introduction

The term "smart contract," sometimes referred to as an "intelligent contract," was coined by Nick Szabo in 1994. He defined it as a computer-based protocol for executing contract clauses. The primary objectives of smart contracts are to fulfill common contractual conditions, such as payment terms, reduce ambiguities, and minimize the need for trusted intermediaries (Szabo, 1994).

Barriers to Implementing Smart Contracts

In a study conducted by Rathnayake et al. (2022), the most frequently identified

barriers to smart contract implementation were a lack of compatibility, inactive government collaboration, and storage capacity limitations. Similarly, Shang et al. (2023) focused on institutional factors influencing the adoption of smart contracts in the Singaporean industry.

Many contractual issues arise in engineering, procurement, and construction projects, including insufficient project goals and scope, and poor compliance with contractual obligations by project parties. The McKinsey Global Institute highlights that issues with the structure of contract documents and misalignment are the main causes of low productivity in construction projects (Mutikanga et al., 2022).

Silas Mutie N. (2019) outlined various applications and benefits of smart contracts, which are also considered their parameters. The execution steps and input parameters of smart contracts need to be objective and specific. For example, if "x" occurs, execute step "y."

Ameyaw et al. (2022) investigated the drivers for blockchain-based smart contract applications in construction projects. Based on expert opinions, the researchers identified several critical factors: the ability to test and have a trial period before full adoption, transparency in project delivery, payment facilitation, and secure payment processes.

The research article "Blockchain Smart Contracts: The New Rebar of the Construction Industry?" by Bjorklun & Vince et al. (2019) provides valuable insights into how digital maturity challenges the feeding, and utilization of blockchain smart contracts with sufficient data.

Payments can be automatically processed once the criteria for a construction milestone are met. This approach could benefit the Philippine government's construction industry by reducing the paperwork and delays in terms of payment submissions.

In 2017, Mason attempted to predict how smart contracts might be applied to construction. Mason concluded that a semi-automated approach was the likely outcome in the short to medium term.

Smart contracts facilitate the triggering of obligations once associated tasks are fulfilled. Unlike traditional contracts, smart contracts are written as software and hardware code and are accessed through an agreed-upon data source. The use of smart contracts in the government construction industry has the potential to elevate industry standards. Smart contracts are self-executing and operate on the "when/if, then" principle. These conditions are encoded in software, and when predetermined conditions are verified and met by nodes or computer networks, the actions specified in the contract are automatically executed.

Methods

Research in construction often integrates various managerial and technical disciplines. This review conducted a comprehensive search into the adoption of smart contracts within the Philippine government construction industry.

Given the technology's novelty in the Philippines, the researcher employed a mix of quantitative and qualitative research designs to gain a thorough understanding and complete overview of smart contract adoption in the Philippine government construction sector, Mixed-method research, as broadly defined by Tashakkori and Creswell (2007), involves collecting and analyzing data, integrating findings, and drawing inferences using both qualitative and quantitative approaches. This study required a systematic procedure to achieve its objectives.

The research process began with identifying the focus of the problem, followed by defining the objectives and problem statement. A literature review was conducted to establish an understanding of the functions and theories relevant to the identified problem. The study adhered to the steps and guidelines of the Systematic Literature Review (SLR) methodology, which was initially proposed by Kitchenham in 2009.

Identifying the Objectives of the research

Determining the objective and goals of the research was crucial for defining the study's purpose, which served as a roadmap for the research procedure. This phase involved brainstorming and clarifying the study's objectives, which helped outline the focus and boundaries of the research. and clarifying the study's

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Review of Inclusion and Exclusion Criteria

After identifying the research objectives, the researcher reviewed the inclusion and exclusion criteria to set boundaries for searching references, ensuring they aligned with the study's objectives. This step was crucial in preventing the research from becoming too broad.

Establishing Research questions

Identifying the research goals was crucial for defining the study's purpose, serving as a roadmap for the research journey. During this phase, brainstorming and clarifying the study's goals and objectives were essential for outlining its focus and scope.

Data Collection

This stage is crucial as it forms the foundation for analysis. Data collection provided the essential information needed to address the research inquiries, test the hypothesis, and draw conclusions based on the gathered data.

Data Analysis

The online survey identified the predominant responses from participants regarding the implementation of smart contracts in Philippine government infrastructure. Semi-structured online interviews were based on the survey questionnaire that allowed the researcher to ask follow-up questions and gain deeper insights into the respondents' perspectives.

Figure 1 shows that, among the 218 survey respondents using Google Forms, 42% are uncertain about the readiness of the CAR Region government construction industry to adopt smart contracts. Additionally, 24% believe the Philippine construction industry is prepared, while 34% feel the country is not yet ready.

The Results and Discussion sections can either be combined into one or presented separately. Alternatively, they can be subdivided into brief, informative titles.
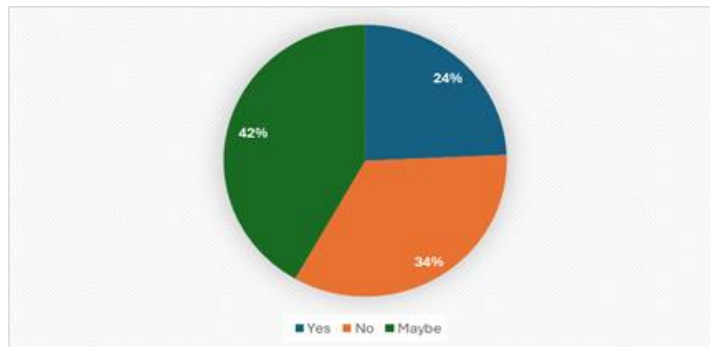

Figure 1. Readiness to Adopt Smart Contract

Despite Figure 1 indicating a general lack of readiness to adopt smart contracts among respondents, Figure 2 reveals that 51% are unaware of smart contracts, 46% have some understanding, and only 3% are well-informed.
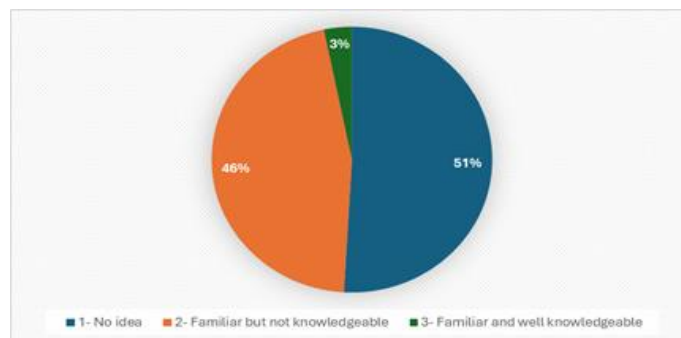

Figure 2. Familiarity with Smart Contract

The survey began with a brief explanation of smart contracts for the participants. Despite not fully understanding the concept, most respondents believe that smart contracts will be beneficial for implementing government projects in the construction sector.
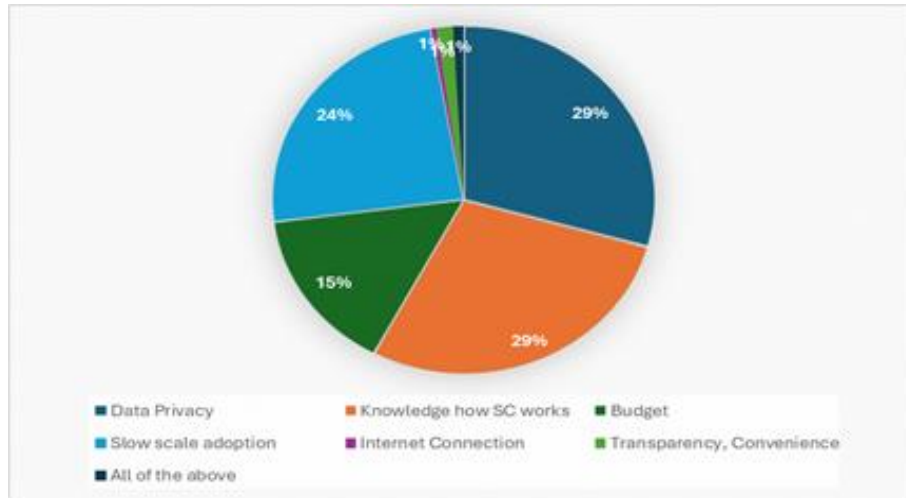

Figure 3. Familiarity with Smart Contract

The respondents were also asked about potential obstacles to using smart contracts in the Philippine government construction sector. They expressed an understanding of smart contract functionality and emphasized the importance of data privacy.
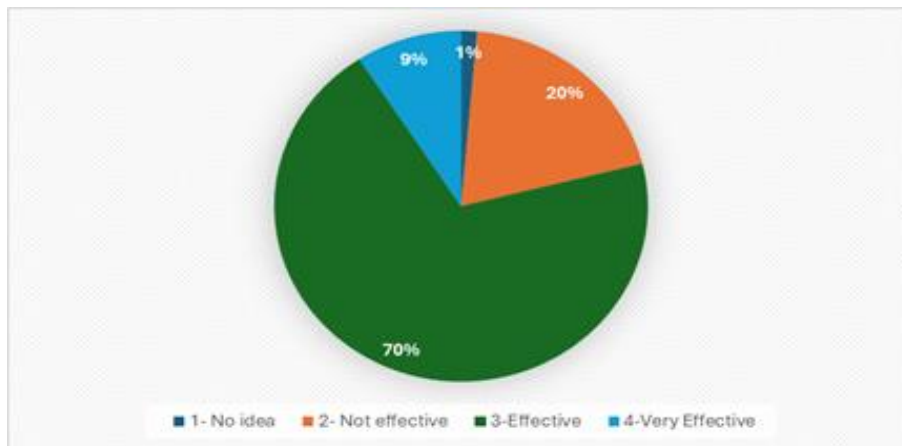

Figure 4. Smart Contract Barrier

After a brief overview and discussion of smart contracts during the informal interview, 14 out of 20 participants expressed a preference for using smart contracts. This finding aligns with the Google Forms survey results shown in Figure 2, where many participants expressed confidence in the effectiveness of smart contracts. However, the primary concern is the readiness to adopt smart contracts, largely due to a lack of understanding of their functionality—an issue also highlighted by the survey participants. Despite being unfamiliar with the mechanics of smart contracts, most participants preferred them over traditional contracts.

Table 1. Summary of findings from unstructured interviews

RESPONDENT	PROFESSION	YEARS OF EXPERIENCE IN GOVERNMENT	CONCERN	PREFERENCE
GOVERNMENT EMPLOYEE				
A	ENGINEER	30	readiness to adopt SC, takes time to learn	Traditional Contract
B	ENGINEER	6	readiness to adopt SC, Privacy	Smart Contract
C	ENGINEER	5	Budget, readiness to adopt SC	Smart Contract
D	ENGINEER	4	Budget, readiness to adopt SC	Smart Contract
E	ENGINEER	3	Budget, readiness to adopt SC, Procurement Law	Smart Contract
F	ARCHITECT	20	Cryptocurrency & budget	Smart Contract
G	ARCHITECT	5	Effectivity	Smart Contract
H	ARCHITECT	1	Document organization, Privacy of SC	Smart Contract
I	ADMIN	2	readiness to adopt SC	Smart Contract
J	IT	1	readiness to adopt SC	Smart Contract
CONTRACTOR SIDE				
K	OWNER	10	approvals	Smart Contract
L	OWNER	2	readiness to adopt SC, takes time to learn	Traditional Contract
M	OWNER	5	readiness to adopt SC, takes time to learn	Traditional Contract
N	OWNER	2	readiness to adopt SC, takes time to learn	Traditional Contract
O	ENGINEER	3	approvals	Smart Contract
P	ENGINEER	2	approvals	Smart Contract
Q	ADMIN	4	Knowledge on how SC Works	Traditional Contract
R	ADMIN	3	Knowledge on how SC Works	Traditional Contract
S	ARCHITECT	2	approvals	Smart Contract
T	ARCHITECT	4	approvals	Smart Contract

Despite explaining and introducing the concept of Smart Contracts to the participants, 35 % of the total participants still prefer Traditional Contracts. While some of the participants prefer Traditional Contracts, 65% of the total participants responded that they prefer Smart Contracts.

A summary of the findings from the observation in the structured interview is shown in Table 1. Most of the participants in the unstructured interview preferred smart contracts compared to Traditional Contract Despite having comments about the readiness of the Philippine Government Construction Industry to engage in digitalizing transactions in Government infrastructure projects, the researcher observed that Smart Contract is still an option for them if it will be introduced well.

Compared to traditional contracts, smart contracts represent a revolutionary development by offering enhanced privacy, cost savings, and efficiency in construction projects. However, despite their application in various industries, few countries have fully embraced them, particularly in the construction sector.

The Philippine government construction industry faces challenges due to slow technological development. Adopting smart contracts in this sector will be a long process, not only because of the slow adoption of technology but also due to budgetary constraints and the reluctance of future users to move away from traditional project management methods.

Understanding various codes, regulations, and specifics is crucial in the industry, as smart contracts act as legally binding, self-executing

rules. Trust and familiarity are essential for potential users to feel comfortable with this technology, especially if they are not well-versed in cryptocurrency and smart contracts.

Conclusion

This study reveals that most participants from the government sector were professionals aged 21-30, working as engineers and architects. In contrast, contractors involved in government projects are typically aged 30 and older. The impact of implementing smart contracts in the construction sector of the Philippine government, specifically in the CAR region, was acknowledged among various government agencies.

The challenges related to the implementation of smart contracts in selected government institutions include readiness to adopt innovative technologies, financial concerns, understanding of smart contract functionality, the use of cryptocurrency for smart contract payments, and the lack of real-world examples of smart contracts in the construction field, particularly within the government sector. These issues complicate the data collected. The research findings are largely theoretical, based on participants' perspectives and the observations made by the researcher.

In practice, the difficulties and benefits of smart contracts in the construction sector can differ. Different groups of participants' views influence the outcomes and discoveries of this study. Many participants believe that smart contracts will greatly benefit government infrastructure employees and contractors. However, a lot of people believe it is premature to embrace this technology. Some participants believe that this will be successful. However, a comprehensive understanding of implementing this is necessary, particularly in government procurement, to effectively introduce this technology to users, as various factors need to be considered, including not only the budget but also the amendments to certain procurement laws related to the use of smart contracts.

This research demonstrates that a lack of understanding and skills required to implement smart contracts is a significant issue. As smart contracts are new and involve a different infrastructure compared to conventional contracts, it is easy to overlook important elements that are typically present in traditional contracts.

Recommendation

Based on the conclusions and findings of this study, the researcher recommends that future researchers propose a Smart Contract Process and structure in the construction industry based on the standard Smart Contract program process and propose different guidelines and test methods that can be useful in the adoption of Smart Contracts.

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