The future of engineering project contract development and administration using blockchain technology[1]

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Abstract

In recent years, engineering project complexity which is measured by the degree of novelty, its interdependencies, and the technology applied has increased leading to greater than before the need for contracting work to technical expects, mostly involving original equipment manufacturer (OEMs). Contracts are required by law when two or more companies wish to conduct business with each other to specific activities to be performed by both organizations and the terms through which they will fulfil their parts of the agreement. The most forms of contracts in the New Engineering Contracts (NEC), Federation Internationale Des Ingénieurs-Conseils (FIDIC), and building construction contracts (BCC).

The blockchain smart contract offers an opportunity for engineering firms to revitalize how contract management can be improved to meet the pace, complexity, and technology needs present in the 21st century. This article proposes that the use of smart contracts in engineering projects will reduce the contracting lead times, financial losses, allow automatic execution eliminating payment delays while improving contract administration.

Keywords: Engineering project contract, blockchain technology, smart contracts

Introduction

According to Cohn, West and Parker (2017-274), contract management is the process of managing contract creation, execution, and analysis to maximize operational and financial performance at an organization, all while reducing financial risk. Cong and He (2019-1756) understood that hiring contractors in engineering projects expressly increases the project execution risks if the project management team does not take essential measures. Blockchain smart contract, which is a digital contract that executes when set conditions are met potentially enlarges the contracting space mostly due to its ability to automate the contractual processes and paperwork underpinning these complex projects, which will save money, free up valuable resources, and speed up project delivery, whispered Bartoletti and Pompianu (2017-498). Blockchain is a secured trusted network where every stakeholder is involved to assure the validity of the shared information at all times. Smart contracts remove several meetings need and the involvement of trusted third parties to facilitate agreements over the initial requirements. Destefanis, Marchesi, Ortu, Tonelli, Bracciali and Hierons (2018-21) alleged that

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the distributed ledger technology (DLT) has capabilities to register every modification from the initial specification, and telling what to do when it happens from the beginning of the project and allows blockchain members to approve.

Background Concepts on Blockchain Technology

Cohn, West and Parker (2017- 273) held that Blockchain is a distributed ledger technology that is managed by different peers on a peer-to-peer network. This technology operates without any central administrator or centralized data storage management. Data is widely spread across several nodes and the quality of data is maintained by replication and encryption. The main idea was to develop a trustless system that solves the double-spending problem using a peer-to-peer distributed ledger technology through a computational proof of the chronological order of transactions

Cong and He (2019-1764) indicated that the blockchain network is, therefore, a decentralized information system that contains information about all past transactions and operates on a pre-selected protocol which defines the direction of performing and validating the transactions, as well as the functioning of the entire network and its members.

Bartoletti and Pompianu (2017- 498) believed that a transaction group in blockchain networks is combined into blocks of transactions connected in the chain using the hash of the previous block's record. Therefore, as a property of immutability, the basic security feature of blockchain networks is enforced. According to Goranović, Meisel, Fotiadis, Wilker, Treytl and Sauter (2017:6157), the further the block is along the chain (the older it is), the more the data included in it is protected from changes.

Tradition of contract management in projects

Adriaanse (2016-195) point out that contract life cycle management is the process of methodically and proficiently managing contract creation, execution, and analysis for maximizing operational and financial performance and minimizing risk. Jalil (2008-14) held that contracts are an integral part of everyday operations no matter the company scope, industry, or products and services sold. Contracts are living documents that need to be carefully constructed, stored, managed, and maintained, and as a company grows and changes, the number of contracts, complexity within those contracts, and overall contract processes tend to transform as well. Levin (2016-69) warned that organizational growth is often accompanied by contracts growing pains.

Project contract upstream or pre-award activities

Chong, Balamuralithara and Chong (2011-24) supposed that contracts pre-award activities emphasis should be focused on why the contract is being established and on whether the supplier will be able to deliver in service and technical terms. However, careful consideration

must be given to how the contract will work once it has been awarded. The important upstream activities are:

1. **Requests initiation.** The contract process begins with identifying contracting needs which is a result of technical or financial capability, organization lack of know-how, or high efficiencies by other firms. The contract management process begins by identifying contracts and pertinent documents to support the contract's purpose. The step includes preparing the business case, securing management approval, assembling the team, developing contract strategy, developing contract risk assessment, and developing contract exit strategy.

2. **Authoring contracts.** The task of drafting a contract is a very important activity and time-consuming. This stage is streamlined by using automated contract management systems. The main task at this stage include developing a contract management plan, drafting specifications and requirements, establishing the pre-qualification/qualification & tendering procedures, and establishing the best form of contract to use.

3. **Negotiating the contract.** Contract negotiation allows both contracting parties to correct or align all areas that require attention from either technical specifications, project timeline, or desired quality. Responsible people identify any discrepancies to reduce negotiation time. The important activities include appraising suppliers, drafting documents, and evaluating tenders.

4. **Approving the contract.** This is the stage were tender evaluation is performed and the firm that can offer the best services in terms of the requested scope, period (time), cost, and quality is identified. To keep decisions moving at a rapid pace, tailored approval workflows are developed which include parallel and serial approvals. The most important task at this stage is to award a contract to a successful bidder.

Project contracts downstream or post-award activities

Harris (2013-87) specified that having carried out the pre-award activities associated with contract formulation and award, the process turns to post-award activities. Niraula, Goso, and Kusayanagi (2008-420) indicated that the management of construction project contracts requires flexibility on both sides and a willingness to adapt the terms of the contract to reflect changing circumstances. Surahyo (2018-231) warned that it is important to recognize that problems are bound to arise which could not be foreseen when the contract was awarded. Abdul-Malak and Naeem (2018-211) believed that downstream or post-award activities include:

1. **Contract execution**. Contract execution requires that terms of the contract agreed on be enforced. This includes all administrative work of managing contract key performance indicators (KPI) and key performance areas (KPA). Monthly contract reports are developed to monitor contract performance.

2. **Management obligation.** This stage requires that key stakeholders meet all deliverables so that the value of the contract can be realized. Relevant management meetings are initiated to resolve all problems experienced or foreseen. The main output of this stage is to ensure that contract correctly administered.

3. A**mendments and revisions.** When areas outside the contract affect the contract performance, amendments and contract revisions become necessary to ensure that contract performance is kept. Other important tasks include managing changes within the contract, service delivery management, and relationship management, which are important tasks to ensure that service delivery is kept at the levels agreed on.

4. **Reporting and auditing.** Contract management does not simply entail drafting a contract and then pushing it into the filing cabinet without another thought. Contract audits are important in determining both organizations' compliance with the terms of the agreement and any possible problems that might arise.

5. **Contract closure and renewal.** The contract closure is an important stage to review the performance of the contract as compared to the initial objectives. This analysis includes conformance to scope, time, cost, and quality. The most important task is to complete the performance and effectiveness review.

According to Turner and Townsend (2020-9), the post-award phase comprises a significant amount of work over the duration of the award dates, which includes implementing the grant, reporting progress, and completing the closeout requirements.

Common engineering construction contracts

There are several types of construction contracts used in the engineering, but there are certain types of construction contracts preferred by construction professionals. The figure below shows the four most contracts used in construction.

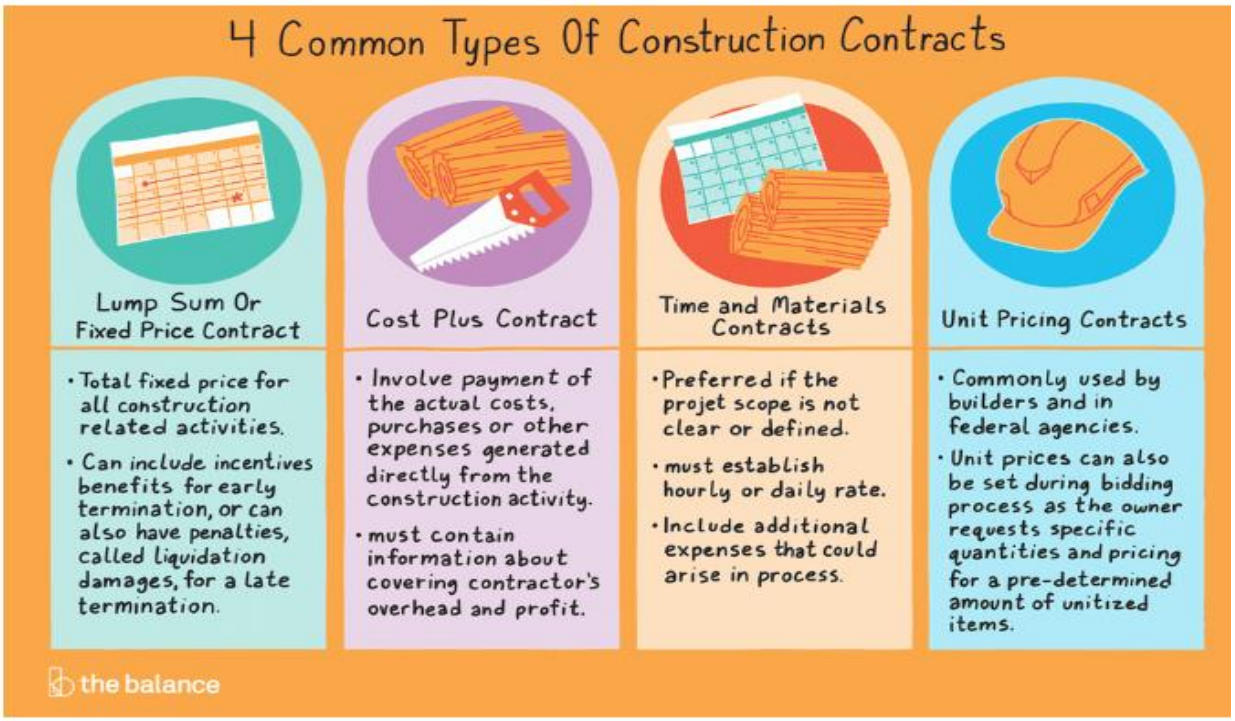

Figure 1 Four common types of construction contract (Rodriguez,2018-2)

New engineering contract (NEC) 3

According to Kilburn and Cornelius (2014-3), NEC is a family of contracts that facilitates the implementation of sound project management principles and practices as well as defining legal relationships. Kilburn and Cornelius (2014-44) alleged that NEC is suitable for procuring a diverse range of works, services and supply, spanning major framework projects through to minor works and purchasing of supplies and goods.

- Engineering and Construction Contract (ECC) - The NEC3 Engineering and Construction Contract (ECC) is the main construction contract within the NEC3 family, from which the options A-F are extracted.
- Engineering and Construction Short Contract (ECSC) - The Short Contract is an alternative to NEC3 engineering and construction contract and is for use with contracts that do not require sophisticated management techniques, comprise straightforward work and impose only low risks on both the employer and the Contractor.
- Engineering and Construction Subcontract (ECS) - The subcontract is intended for use in appointing a subcontractor where the contractor has been appointed under the NEC3 Engineering and construction options, the available secondary options, schedules of cost components, and contract data.
- Engineering and Construction Short Subcontract (ECSS) - The short subcontract can be used as a subcontract to NEC3 Engineering and Construction Contract (ECC) and NEC3 Engineering and Construction Short Contract (ECSC).

- Term Service Contract (TSC) - The Term Service Contract is an entirely new NEC document and is intended to be used for the appointment of a supplier for some time to manage and provide a service.
- Term Service Short Contract (TSSC) - The NEC3 Term Service Short Contract should be used for the appointment of a supplier for some time to manage and provide a service.
- Professional Service Contract (PSC) - The Professional Services Contract (PSC) is intended for use in the appointment of a supplier to provide professional services. It can be used for appointing project managers, supervisors, designers, consultants
- Professional Service Short Contract (PSSC) - The Professional Services Short Contract (PSSC), is intended for use in the appointment of a supplier to provide professional services on smaller-scale projects where sophisticated management techniques are not required.
- Supply Contract (SC) - The NEC3 Supply Contract (SC) is used for the local and international procurement and supply of high-value goods and associated services.
- Supply Short Contract (SSC) - This contract should be used for local and international procurement of goods under a single order or on a batch order basis and is for use with contracts that do not require sophisticated management techniques and impose only low risks on both the Purchaser and Supplier.

According to Kilburn and Cornelius (2014-36), the NEC family of contract documents is an innovative manner of procuring and managing projects. The NEC approach is based on a project management system that provides a means of maintaining contemporary records and dealing with issues in a short space of time.

FIDIC contracts

According to Turner and Townsend (2020-2), the FIDIC (Federation Internationale des Ingenieurs-Conseil) suite of construction contracts is written and published by the International Federation of Consulting Engineers. Employers benefit from utilizing FIDIC conditions where potential bidders are from different countries. In such cases, the bidders may perceive the use of the familiar FIDIC conditions as increasing the attractiveness of contract format.

- Green Book (Short Form of Contract) - The short form of contract is recommended for engineering and building work of relatively small capital value.
- Red Book - Conditions of Contract for construction for building and engineering works designed by the employer. The Red Book provides conditions of contract for construction works where the design is carried out by the Employer.
- Yellow Book - Conditions of contract for plant and design-build. The Yellow Book provides conditions of contract for construction works where the design is carried out by the Contractor.
- Orange Book - Conditions of contract for design-build and turnkey. The Orange Book is drafted for use where the contractor carries total liability for design.

- Silver Book - Conditions of Contract for EPC/Turnkey Projects - The Silver Book is suitable for use on process, power, and private-infrastructure projects where a Contractor is to take on full responsibility for the design and execution of a project.
- Design-build and operate (DBO) Contract - Conditions of design contract, build, and operate projects. This contract combines a design-build obligation with a long-term operation commitment. Turner and Townsend (2020-6)

According to Turner and Townsend (2020-8), all FIDIC Contracts have certain common features and recognize the need for a balanced approach between the roles and responsibilities of the parties involved, as well as a balanced allocation and management of risks. All FIDIC Contracts also include rules for the adaptation of agreed contract amounts and rules for the extension of time for completion and variation procedures. They all require experience and skillful staff, both on behalf of the Employer as well as on behalf of the Contractor.

Blockchain smart contracts

Destefanis, Marchesi, Ortu, Tonelli, Bracciali, and Hierons (2018-23) indicated that smart contracts are a digital code that runs atop of a blockchain platform. This type of contract contains specific rules, which both parties in that contract must agree. Smart contract automatically execute or implement itself once the contract conditions are met. According to Bartoletti and Pompianu (2017- 501), smart contracts can be used to manage interdependent of project tasks in complex project management workflows. Porru, Pinna, Marchesi, and Tonelli (2017:173) whispered that the smart contract code is responsible for facilitating, verifying, and enforcing the negotiation or performance of a transaction or an agreement. This means that the project owner could set smart contracts that will only notify the construction crew to come on the scheduled date when all required material is delivered. Goranović, Meisel, Fotiadis, Wilker, Treytl and Sauter (2017- 6157) believed that smart contracts offer numerous advantages and are more capable of tracking performance in real-time consequently bringing tremendous cost savings, improving compliance and control. These contracts are self-executing, self-verifying, and Samper-resistant. Swan (2016-196) understood that the blockchain smart contract lower the cost of transactions, guarantee more security, reduce the reliance that is placed on trusted intermediaries, and can help turn legal obligations into automated processes. The following is the smart contract process:

- Pre-defining the contract - This stage requires that terms of engagement regarding the contract are established and conditions of execution are set which include time, date, cost, specification, and other variables, with interest rate at a given.

- Events – Events trigger the implementation of the contract using the information acknowledged and the beginning of the transaction agreements.

- Transfer of value and execution - based on if the contract conditions have been met, the contract will dictate the movement of value, which is based on if the conditions have been met.

- Settlement of the contact – This is the contract execution part which happen either on-chain assets (digital) in the case of virtual assets where accounts are automatically settled or off-chain assets (physical) for assets like stocks and fiat of which the changes to accounts on the ledger will match the off-chain settlement instructions.

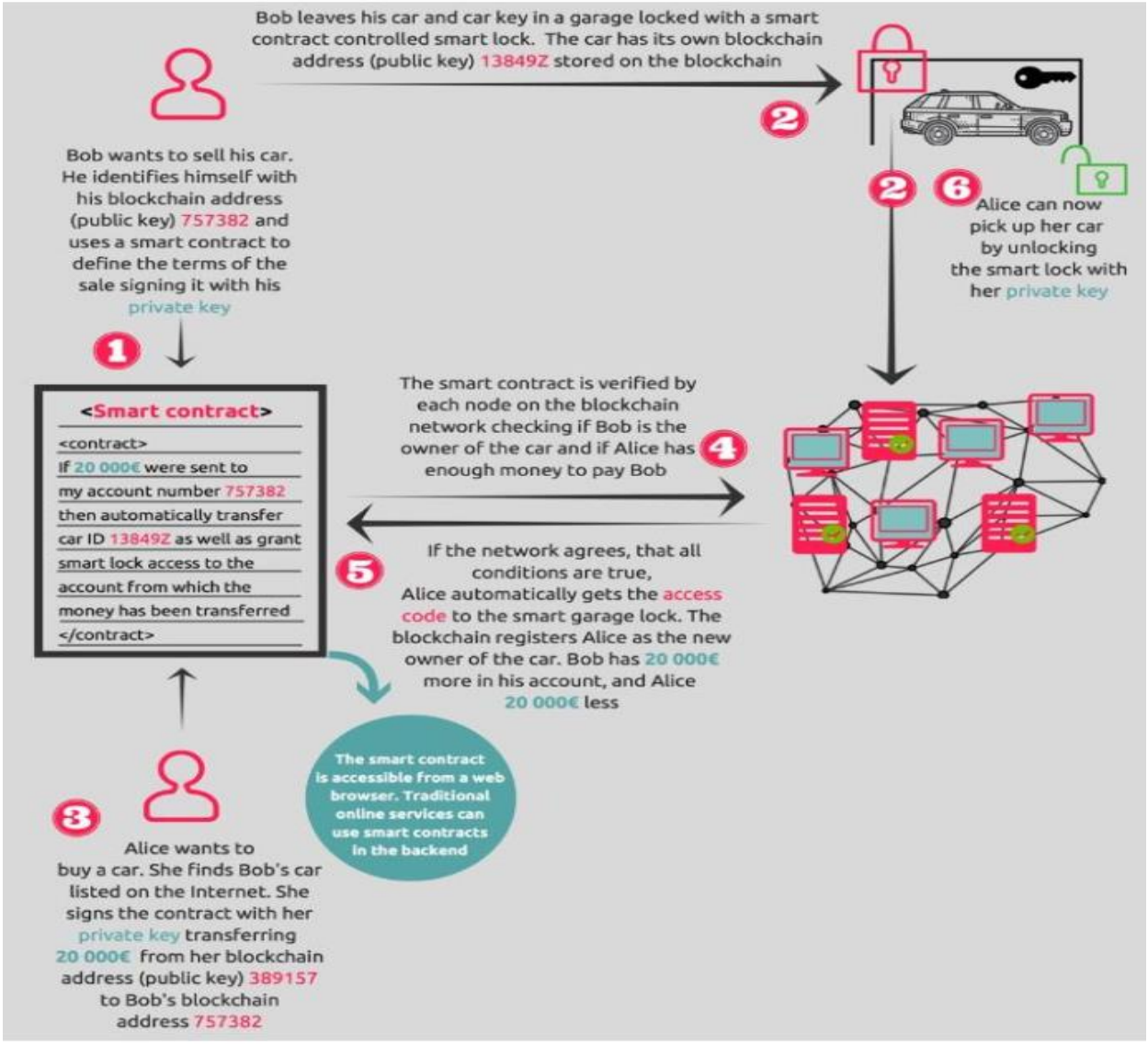

Figure 2 Example of a smart contract (http://ethereumswarmgirushin.blogspot.com/2017/04/smart-contract-ethereum-example.html,Viewed 17 April)

Research study

Empirical research is based on observed and measured phenomena and derives knowledge from experience rather than from theory or belief.

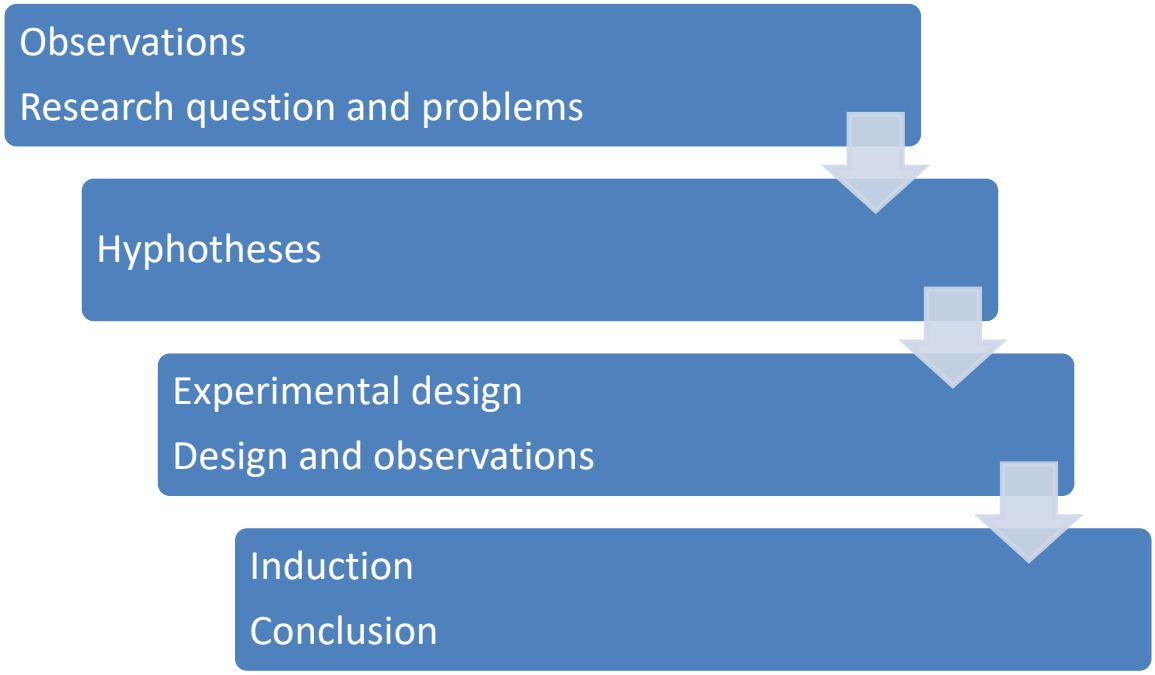

Figure 3 Empirical scientific research cycle (Kumar and Krob, 167).

Observations

In all engineering and construction projects, contracts are taken seriously because they are the source of so many business and legal conflicts. However, most contracts end up being a burden to contracting parties often because they were not drafted well or because of a massive communication breakdown that lead to oversight issues. Business and law professionals are looking at ways to revolutionize business arrangement, which still holds the force of law. The emergence of blockchain smart contracts will revolutionize the contract management discipline and bring efficiencies that have never been realized before. In this case study, we are comparing the use of both traditional and smart contracts in construction projects, so that we can determine the future of contracts in this sector.

Written contracts, which have been signed and accepted, are considered binding, however; most law experts doubt the enforceability of internet contracts or smart contracts. Although the internet is just emerging, the contracts formed over the internet are generally well governed by the principles set out for written generally. As previously discussed, two or more parties must mutually assent to the terms of the contract and the contract itself must be supported by some consideration.

Research hypothesis

The following are the research hypothesis for this study:

1. Smart contracts will reduce contracting lead-time, bringing total transparency and accountability to contracting parties, which will improve project contract management.
2. Smart contracts will eliminate cumbersome administrative burden and allow project teams to resolve issues quicker, which will improve contract administration
3. Smart contracts will reduce contract data tempering while improving timely recording and digital storage.

Experimental design

A research survey targeting engineering and construction senior contract managers, which are mostly lawyers and engineers, was developed for the experiment. According to Chaudhry and Khan (2016:573), a survey is a procedure in which data is methodically composed from a population through some form or direct solicitation such as questionnaires, face to face interviews, telephone interviews or mail. Because of the emergence of smart contracts is a new topic to most contracts professionals in the South African engineering and construction industry, senior contracts manager who are exposed or knowledgeable about smart contracts were selected for this research population. A survey (primary data source) was conducted on a randomly sampled group in the population to investigate the objectives of this study of which findings will be used to draw conclusions and make recommendations. The table below shows the survey layout:

Table 1 Survey layout

Survey question groups	**Number of questions**
Contract development	13
Contract administration	6
New features	7

Part one: Contract development

This part of the questionnaire focused on contract development. The respondents were asked to specify their responses to questions by indicating, using a Likert scale from one to five, and their degree of agreement or disagreement. The purpose is to discover if the existing framework is logical, robust, and repeatable to determine if there is a need to improve. The simple definition of the parameters are:

- Business case - The ease and need to develop a business case
- Team size - How big should the team size, and how skilled should they be, 5 = highly skilled and less, 1 = less skilled and more
- Strategy - is there a need for a detailed contract strategy
- Risk assessment - is there a great need for risk assessment
- Exit strategy - is there a need for an exit strategy and the easy of exit
- Contract plan - is there a need for a detailed contract plan
- Specification - is there a need for a detailed specification

- Contract type (Flexibility) – is there a need to contract flexibility
- Tendering procedure – is there a need for a detailed tendering process
- Supplier selection – the need and ease for supplier selection
- Evaluate – the need and ease for contract evaluation
- Negotiate - the need and ease for contract negotiation
- Award - the need and ease for contract award

Part two: Contract administration

This part of the questionnaire focused on contract administration. The respondents were asked to specify their responses to questions by indicating, using a Likert scale from one to five, and their degree of agreement or disagreement. The purpose is to understand the ease or difficulty of each contract type. The simple definition of the parameters are:

- Contract changes - the need and ease for contract changes
- Service delivery management - the need and ease of service delivery management
- Relationship management - the need and ease of relationship management
- Assessment of risk - the need and ease of assessment of risk
- Contract compliance - the need and ease to enforce contract compliance
- Performance effectiveness - the need and ease to enforce performance effectiveness

Part three: Smart features

This part of the questionnaire focused on evaluating key features of the smart contracts and if those can be easily applied in traditional contracts. The respondents were asked to specify their responses to questions by indicating, using a Likert scale from one to five, and their degree of agreement or disagreement. The simple definition of the parameters are:

- Simplicity - the ease to simply contracts
- Cost – the ease to reduce cost
- Expertise required – The ease or required level of knowledge
- Automation – the ease of automation
- Reliability – ease and level of reliability
- Trustability - ease and level of trustability
- Reporting - ease and level of reporting

A Likert scale was used to measure the level of performance of a contract feature defined as follows:

- Not needed at all = 1
- Not needed = 2
- Neutral = 3
- Needed = 4

- Very needed = 5

Results

A stratified random sample was used to separate the research population, which includes engineers and lawyers from companies owning the construction and the contracting company (Principal contractors). The table below shows the population stratified random sample**:**

Table 2 Survey demographic

		Survey	
Category	**Owner**	**Population proportion**	**Sample size N = 27**
Lawyers	Owner	30%	8
	Contractor	15%	4
Engineers	Owner	33%	9
	Contractor	22%	6
Total		100%	**27**

The survey data collection was completed utilizing the online google form. The survey aimed to be completed in two minutes. The respondents were sent survey links via emails and statistical data was collected using the online software, which produce statistical results. The survey data was analyzed according to provided demographics. The overall score was used to determine the importance of each factor. Each factor's average was calculated and was used for ranking the importance level. The table below shows a summary of the survey results

Table 3 Survey results

	Contract task	Traditional					Average	Smart contract					Average
Contract development		**1**	**2**	**3**	**4**	**5**		**1**	**2**	**3**	**4**	**5**	
	Business case		3	4	6	14	4,15	2	9	10	4	2	2,81
	Team size	2	3	10	5	7	3,44		2	6	15	4	3,78
	Strategy		1	3	10	13	4,30	1	9	7	4	6	3,19
	Risk assessment		8	5	12	2	3,30		9	9	8	1	3,04
	Exit strategy		2	5	9	11	4,07	2	3	12	5	5	3,30
	Contract plan			7	14	6	3,96		8	15	4		2,85
	Specifications			5	18	4	3,96		6	19	1	1	2,89
	Contract type (Flexibility)	1	3	2	11	10	3,96		4	6	13	4	3,63
	Tendering procedure			5	13	9	4,15		2	9	11	5	3,70
	Supplier selection			6	16	5	3,96	3	7	10	4	3	2,89
	Evaluate	2	1	5	9	10	3,89	2	7	8	10		2,96
	Negotiate			4	14	9	4,19	1	8	12	6		2,85
	award			5	10	12	4,26		9	8	8	4	3,48
Contract administration	Contract changes	2	4	10	8	3	3,22	5	10	3	4	5	2,78
	Service delivery management	1	2	12	10	2	3,37		1	4	7	15	4,33
	Relationship management		8	9	4	6	3,30			8	6	13	4,19
	Assessment of risk		7	10	10		3,11			9	12	6	3,89
	Contract compliance		9	3	13	2	3,30		1	2	8	16	4,44
	Performance effectiveness		4	12	7	4	3,41			8	14	5	3,89
Smart Features	Simplicity	4	7	10	6		2,67			5	8	14	4,33
	Cost	3	8	13	3		2,59		1	4	5	17	4,41
	Expertise required	2	7	8	8	2	3,04			1	12	14	4,48
	Automation	3	5	11	6	2	2,96			3	6	18	4,56
	Reliability	1	7	11	4	4	3,11	1	2	4	7	13	4,07
	Trustability	3	5	5	9	5	3,30		2	3	5	17	4,37
	Reporting	1	6	10	7	3	3,19			1	6	19	4,52

The results indicated that contraction experts prefer to use traditional contracts for contract development as compared to smart contracts. The reason for that was that smart contracts are currently not recognized by most courts and will be difficult to enforce. The results show that contract administration can easily be enforced using smart contracts than when using traditional contracts. The reason for that was that smart contracts automatically execute when conditions on the contract are met. It was also indicated that the traditional contracts incorporate some features of a smart contract, but could not perform some features at all. The figure below shows a summary of the results.

Table 4 Results summary

Contract stages	**Traditional (NEC/FIDIC)**	**Blockchain(Smart contracts)**
Contract development	3,97	3,18
Contract administration	3,28	3,92
Smart Features	2,98	4,39
Average	**3,41**	**3,83**

The overall results indicated that project engineering and construction professionals view the use of blockchain smart contract as an important discovery which will drastically reduce the amount of work, time, and cost required to manage contracts.

Statistical analysis

Spearman's correlation coefficient

Spearman's correlation coefficient, which is an analysis that measures the strength of association between two variables and the direction of the relationship was performed. The table below summarizes the results.

Table 5 Spearman's correlation coefficient results

Contract stages	r_s	***p* (2-tailed)**	**Statistical significance**
Contract development	0.85869	0	The association between variables would be considered statistically significant.
Contract administration	0.79373	0.00206.	The association between the two variables would be considered statistically significant.
Smart Features	0.8463	0.00014	The association between the two variables would be considered statistically significant.

Independent T-test

Simplified independent T-test calculations were performed, which include sample means, sums of squares and standard deviations calculated for groups' responses to determine whether there are similarities or differences between the two populations

Table 6 Independent T-test results

Contract stages	**t-value**	**p-value**	**Statistical significance**
Contract development	-0.63012	0.265743	The result is not significant at p < .05.
Contract administration	-1.3689	0.092424	The result is not significant at p < .05

Smart Features	-0.23434	0.408446	The result is not significant at p < .05

Findings

This research used survey methodology to identify and rate contract development, administration, and smart features in construction projects. The research findings for each research hypothesis as outlined in the research hypothesis, are analyzed in the following paragraph.

Hypothesis 1

H_0 : Smart contracts will not reduce contracting lead-time, bringing total transparency and accountability to contracting parties, which will improve project contract management.

H_1 : Smart contracts will reduce contracting lead-time, bringing total transparency and accountability to contracting parties, which will improve project contract management.

The survey results indicated that smart contracts could not be fully utilized for contract development and award because, although smart contracts are quicker to develop, transparent to all parties and bring accountability to the responsible person, it will be difficult to enforce until such time governments start to recognize them as legal contracts.

The survey results also show that a smart contract can be developed easily and its transparency streamlines the complex process that involves several intermediaries because of a lack of trust among participants in the transaction. Smart contracts also allow terms and conditions of the contracts to be accessible and visible to all the relevant parties and once the agreement is established, it is not disputable. Smart contracts also perform automatic data recoding which ensures that business approvals are done in real-time avoiding pitfalls that are associated with manually filling out heaps of forms. The results also indicate that smart contracts also improve trust between contracting parties by eliminating intermediary and allow contracting parties to act, which will improve lead-time to take decision.

From the above results H_1 : Is accepted - Smart contracts will reduce contracting lead-time, bringing total transparency and accountability to contracting parties, which will improve project contract management.

Hypothesis 2

H_0 : Smart contract will not eliminate cumbersome administrative burden and allow project teams to resolve the issue quicker, which will improve contract administration

H_1 : Smart contract will eliminate cumbersome administrative burden and allow project teams to resolve the issue quicker, which will improve contract administration

The results indicated that smart contracts can be fully utilized for contract administration purposes because they execute transactions very fast, which will save more time and reduce cost when compared to traditional contract administration processes. The secure, autonomous and transparent nature of this agreement takes away the possibility of bias, manipulation, or error. The weekly, monthly, and annual contract project report can be available immediately within a need for human intervention, bringing much-needed transparency in contract management. This will also improve the efficiency of the project management office (PMO) concerning task monitoring, payment management, management authorizations, and project governance. This is because they are permanently stored for future reference and are easily retrievable if there is data loss. The results also emphasize that smart contract has the potential to eliminate the need for litigation because employing self-executing contracts means parties commit themselves to operate by the rules of the underlying code. Smart contracts eliminate the need for lawyers, banks, witnesses, and any other intermediaries because all transactions happen automatically as agreed conditions are realized.

From the above results H_1 : Is accepted - Smart contracts will reduce contracting lead-time, bringing total transparency and accountability to contracting parties, which will improve project contract management.

Hypothesis 3

H_0 : Smart contracts will not reduce contract data tempering while improving timely recording and digital storage

H_1 : Smart contracts will reduce contract data tempering while improving timely recording and digital storage

The survey results indicate that smart contract makes data tempering impossible because the information is stored in a blockchain network, which employs the highest level of data encryption that is currently available. The results also show that with advances in construction electronic data and cloud storage applications, new opportunities are emerging to the management of construction contracts. This will improve data security, storing, transactions, and managing their smooth integration is tremendously valuable to any data-driven organization, particularly in the construction industry where blockchain technology has the potential to solve critical issues robustly and effectively. The blockchain technology use trusted timestamping, which is a process of securely keeping track of the creation and modification time of a document. The results show that timestamp is unnecessary because every block has a previous block hash and these are enough to check if a transaction contained in a block is

double-spending or not. Blockchain-based timestamps are made automatically integrated with a single line of code.

From the above results H_1: Smart contracts will eliminate cumbersome administrative burden and allow project teams to resolve issues quicker, which will improve contract administration.

Conclusion

The results from this research indicated that although most contract management professionals within the construction industry do no doubt proclaim smart contracts as future waves. This study shows that smart contracts will never completely replace the traditional versions, but will gain popularity mostly for once of traction. The normal traditional contract affords contracting parties legal recourse, which is mostly needed for dispute resolution, not offered by smart contracts because smart contracts are not recognized by most courts of law as a legal agreement.

The survey results indicated that it will be best for the organization to use traditional contracts for developing and awarding contracts, but use a smart contract for contract administration which will mean that all contract requirements will be coded in a blockchain network and will automatically perform the transaction when the requirement is met. This will ensure that all contract key performance areas (KPA), key performance indicators (KPI), and specification compliance are administered in real-time creating an opportunity for contracting parties to timely resolve issues. The future of contracts according to this research is a mixed contract method that will realize some amalgamating of the two agreements to allow easier, faster, simpler arrangements to be established digitally which will also provide an avenue for judicial review.

Recommendation

Future researchers examining construction contracts should consider the following recommendations:

- Further research needs to be made to look at the project quality management system. The automatic execution of the quality management system will flag the contractor's performance and attract the required attention, which will improve the overall duration management.

- Future research must be made on the requirements to legitimize smart contracts. This will lead to a situation where a smart contract can be fully implemented with the required legal recourse offered by traditional contracts.

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