SRI LANKA NATIONAL CONSTRUCTION RESEARCH JOURNAL 2022 -2025

MINISTRY OF HOUSING, CONSTRUCTION, AND WATER SUPPLY
CONSTRUCTION INDUSTRY DEVELOPMENT AUTHORITY

SRI LANKA NATIONAL CONSTRUCTION RESEARCH JOURNAL

2022 - 2025

CIDA

MINISTRY OF HOUSING, CONSTRUCTION, AND WATER SUPPLY

CONSTRUCTION INDUSTRY DEVELOPMENT AUTHORITY

VOL : XIX, 2022-2025, ISSN: 2012 – 8509

ACKNOWLEDGEMENT
CIDA wishes to thank:

- Authors of articles
- Editorial Board
- CIDA staff who were helpful very much in the publication of this journal.

CONTENTS **PAGE No**

"Savsiripaya"
123, Wijerama Mawatha
Colombo 07.

Telephone :0112686089
Fax: 0112686089, 0112699738
Email: info@cida.gov.lk
Website: www.cida.gov.lk

Notes:

- All published articles have been refereed in anonymity by subject specialists.
-

MESSAGE FROM THE DIRECTOR GENERAL
CONSTRUCTION INDUSTRY DEVELOPMENT AUTHORITY

Being among the first five largest industries in the country, Construction Industry had recorded over a 26% unprecedented growth around a decade, despite the recent fallback recording minus figures, owing mainly to 03 disruptions; Easter Sunday attacks in 2019, Global pandemic situation due to the eruption of Corona virus during the years 2020 and 2021, followed by the economic crisis in the year 2022. This situation forced the successive governments to introduce certain policy changes such as low capital infusion for development of infrastructure in the aftermath.

As such until the year 2024, where there was an upsurge in the entire economy, the industry shows negative growth trajectories as the disruptions to the industry were noteworthy during the period.

Since the construction sector has demonstrated a convincing growth since the year 2024, according to the Central Bank report of 2024, it is high time to focus effort to develop the domestic construction industry using concepts that are in par with global principles.

The global climatic concerns have also pressurized us to open eyes and comply for various measures that can be adopted to save the planet by basically saving energy and water. Use of renewable energy sources and careful use of water resources reducing wastage have become essential features of a sustainable lifestyle of any habitat or society.

Circular economic principles coupled with the Clean Sri Lanka national initiative has a major role to play in securing these sustainable features by adopting the so-called sustainable techniques in the industry.

The objective of this Journal is to create a platform where professionals can exchange and share their knowledge, expertise and experience in relation to the new developments in the construction field with the construction community and the other stakeholders.

This journal will also disseminate new approaches and knowledge among the general public making them beneficiaries of these new trends and developments

That being said, continuous flow sufficient amount of works will also be what is essential for the sustenance of the industry. While recovering from the 03 disruptions devastated the industry, large number of employment opportunities has been lost due to the low or no volume of works among the all levels of contracting and consultancy organizations.

However, it is promising to see that GOSL has approved allocations for important projects despite a painful recovery of the economy is taking place. As such it will be the fervent hope of the construction community including the Authority CIDA that the Government can successfully overcome those challenges, for the betterment of the industry. This will only be possible with aggressive programs such as developing investment friendly culture within and opening avenues for opportunities in overseas for domestic players, in order to bring about normalcy in the coming years.

ENG. S. K. S. AMARASEKARA
Director General
CIDA

THE ROLE OF THE ENGINEER TO THE CONSTRUCTION CONTRACTS AS A MEDIATOR FOR MITIGATING THE CONSTRUCTION DISPUTES

U.G.D.I. Bandara[1], B.A.K.S. Perera[1] and K.D.M. Gimhani[2*]
Department of Building Economics, University of Moratuwa, Sri Lanka[1]
School of Architecture and Built Environment, Deakin University, Australia[2]

Abstract:

Alternative Dispute Resolution (ADR) methods avoid the high cost and time of the litigation process while enhancing the efficiency and the quality of dispute resolution. Thus, the purpose of this study is to investigate the suitability of the Engineer to construction contracts as a mediator for the mitigation of construction disputes. A qualitative research approach was employed, which comprised two rounds of semi-structured interviews with the use of the Delphi technique. Purposive sampling was used to determine the interviewees for the semi-structured interviews. The manual content analysis was used to analyze the collected data. The findings of this study revealed the suitability of certain roles of the Mediator, such as directing the parties to construct an outcome that meets their needs and accommodating the communication among the disputant parties to be performed by the Engineer to the contract while providing possible contradictory situations. Despite that, thirteen (13) opportunities and eleven (11) barriers to the Engineer to involve in the contract as a mediator were found. Moreover, ten (10) barrier management strategies were identified as suitable for avoiding those barriers. The outcomes of this investigation can influence the engagement of the Engineer in tackling the mediation process within the construction sector by bringing a new paradigm to the industry.

Keywords: Alternative Dispute Resolution, Construction Disputes, Contracts, Mediator, The Engineer

1. Introduction

Construction is a project-based sector, and projects are by their very nature frequently the subject of costly disagreements that might lead to drawn-out legal proceedings and suitable methods for resolving these conflicts are referred to as dispute resolution (Faghih & Akhavian, 2019). Alternative Dispute Resolution (ADR) procedures are known to be more expedient, less formal, and less expensive than conventional litigation procedures (Balzer & Schneider, 2021). According to (Surahyo, 2018), ADR techniques such as arbitration, conciliation, and mediation can also be used to settle disagreements, rather than following conventional litigation procedures. As stated by Lee, Lee and Thurasamy (2020), when a third party intervened in a conflict between two parties, it was possible to resolve it. This is the fundamental kind of mediation that dates back to the dawn of human civilization. Moreover, the Engineer proves his role by action, he stands in the middle position even though he represents the Employer (Ndekugri, Smith, & Hughes, 2007). Pursuant to clause 3 in FIDIC Conditions of Contract for Construction (1999), the Engineer has the authority to determine his decision and as well as according to Nabatova (2017) the Mediator is unable to determine his decision. These two statements imply that Engineer has more authority than the mediator to determine his decision as well as guide parties throughout the construction process (Nabatova, 2017). In most situations,

when both professionals were scrutinized in depth, the consultant acted as a mediator (Bulckaen & Devos, 2020). Therefore, bringing roles of the both professionals into one platform may be more effective than individual practice. In such instances, when the Engineer acts as a mediator, he cannot consider a third party and it aids in avoiding pointless waste of time and money in resolving disputes in construction projects (Mello, Strandhagen, & Alfnes, 2015). Thus, it is important to study the suitability of the Engineer to the contract as a mediator to mitigate disputes in construction projects. Moreover, there are several studies conducted on the role of the Engineer (Abdul-Malak, Bou Hamdan, & Demachkieh, 2020; Mello et al., 2015) and the role of the Mediator (Kim & Kim, 2021; Kurt, 2020) and Mediation (Lee et al., 2020; Saeed, 2020). Nevertheless, none of the studies has discussed interconnecting both professions under a single theme. Thus, considering above mentioned literature gap and the industrial requirement, it is utmost of importance to investigate the suitability of the role of the Engineer to construction contracts as a mediator for mitigating construction disputes. Hence, this study aims to investigate the suitability of the role of the Engineer to construction contracts as a mediator for mitigation of construction disputes. Henceforth, to accomplish the aim of this investigation, several objectives were established; (1) identify the role of the mediator Vs the Engineer to the contracts in a construction project, (2) identify opportunities to the Engineer to the contract as a mediator, (3) identify barriers to the Engineer to the contract as a mediator, (4) propose strategies to occupy the Engineer as a mediator for construction dispute resolution. The aftermath of this investigation has the potential of minimizing the unnecessary costs related to hiring a neutral, third party as a mediator and other litigation costs in the construction sector.

2. Literature Review

2.1. Nature of the Construction Disputes and their Impact

Construction projects encounter disputes as a result of the involvement of many parties and their diverse interests (Dissanayake, Abeynayake, & Pandithawatta, 2018). Due to the construction industry's ongoing complexity growth, disagreements between the stakeholders are likely to continue for the foreseeable future (Bakhtawar, Thaheem, Arshad, & Qadeer, 2018). A plethora of causes for such issues was highlighted by Sameh et al. (2020), such as defective design or specifications, abnormally harsh weather, change orders, and additional work. Moreover, Sameh et al. (2020) stated that claims stemming from varying site circumstances, delays, design flaws or adjustments, work acceleration or suspension, construction failures, and extra or eliminated work are the major causes of disputes. According to Ayhan et al. (2021), project uncertainty, opportunistic conduct, and contractual issues are the major causes of disagreements. Contractual disputes contribute to 50% or more of the legal expenses incurred by the construction sector (Thusharika & Abeynayake, 2016). Moreover, disputes consume time and money while diverting attention away from construction projects (Oswald, Scholtenhuis, Moore, & Smith, 2021). Further according to the author construction project disputes are viewed as obstacles to the effective execution of the project. As stated by Bulckaen and Devos (2020), conflicts are considered to be unpleasant, costly, and resource-intensive.

2.2. Resolving the Construction Disputes

Since conflicts are inescapable, it is essential to lessen their adverse effects by employing an appropriate technique of settlement (Ayhan et al., 2021). According to Illankoon et al. (2022) when a disagreement arises, the contract's parties focus on resolving it following the contract's terms. The issue proceeds to Alternative Dispute Resolution (ADR), nevertheless, if the entities are still unable to reach a compromise (Thusharika & Abeynayake, 2016). Alternative procedures are employed as the initial step to resolve disagreements (Faghih & Akhavian, 2019). Examples of ADR include arbitration, conciliation, and mediation. It is well-recognized that ADR procedures are less formal, quicker, and less expensive than conventional litigation procedures (Lee et al., 2020). The last resort for settling construction disagreements is litigation and ADR serves as a "substitute" for litigation (Balzer & Schneider, 2021). Litigation costs time, money and the reputation of both parties compared to ADR (Zheng, Liu, Jiang, Thomas, & Su, 2021). ADR methods are relatively informal, but the range is very wide and many countries are tempted to use different types of ADR methods to get solved their disputes (Awwad, Barakat, & Menassa, 2016).

2.3. Mediation as a Dispute Resolution Method

In such cases where parties could not resolve the dispute through negotiating, a third party who is impartial facilitates dialogue between the parties in conflict and helps them understand each other and come to a mutually acceptable settlement of their disagreement without making the ultimate decision or imposing their will (Thusharika & Abeynayake, 2016). The third-party who is impartial is known as the “Mediator” and the process is named “Mediation”. Mediation is the most popular ADR technique and nearly 82% of disputes in the construction industry are settled through mediation (Lee et al., 2020). Mediation is a voluntary and non-binding process and the mediator is an impartial third party who facilitates the negotiation without expressing his determination to the parties (Cheung, 2010). Confidentiality is the primary responsibility of the mediator and according to the mediation act, all the statements given by the parties including all communications between parties and the mediator during the whole mediatory process, are confidential and evidence presented during the mediatory process are not admissible in litigation (Lee et al., 2020).

2.4. Roles of a Mediator

Roles, Rights and Responsibilities of the Mediation Participants (2018), defined the main role of a mediator as to facilitate dialogue among parties to negotiate a resolution to a dispute. In addition to that, various responsibilities of a mediator can be identified through the past literature. Mediation Training Manual for Refresher Course (2018) categorized the responsibilities of a mediator into two distinct sets; facilitative responsibilities and evaluative responsibilities. Facilitative responsibilities include producing a conducive atmosphere for proceeding with the mediation process, explaining the mediation process and its regulations, accommodating the communication among the disputant parties by employing various communication techniques and eliminating the possible obstacles to effective communication, collecting information regarding the dispute and identifying the hidden interests of parties, maintaining the control over the mediation procedure, handling the interaction among the parties and facilitating the disputant parties generate possible solutions (Kim & Kim, 2021; Mediation Training Manual for Refresher Course, 2018).

2.5. Role of the Engineer to the Construction Contracts as a Dispute Resolver

In many standard forms of contracts, including FIDIC, SBD, and NEC, the role of the Engineer is indicated. The NEC contracts (2020) divide the roles of the Engineer to contract into three segments: project manager, supervisor, and adjudicator. More specifically, the Engineer manages the contract, makes decisions in the capacity of a manager, supervises the work in the capacity of a supervisor, and decides on disputes. According to the contract agreement the Engineer has to study the stability and reliability of the project's financial status and cost estimate, scrutinize drawings and design, invite tenderers and select a suitable procurement system, feasibility study, supervision and maintain the quality of works and cross-checking overall project based on time, cost and quality (Ghaswala, 2020). It is acknowledged that engineering experts may be expected to perform a variety of different responsibilities in connection with the handling of claims and disputes (Abdul-Malak et al., 2020). Moreover, the authors stated that these roles are appointed either by the project owner (such as the engineer or contract administrator) or by both the owner and the contractor, and they are positioned at crucial turning points or gates in the claim-dispute development process. Nevertheless, within the common law structure, the Engineer's role might be viewed as involving, on the one hand, activities to be undertaken as an employee of the owner and, on the other hand, actions requiring the giving of a professional judgment (Jaeger & Hök, 2009

2.6. Opportunities and Barriers of the Engineer to the Construction Contracts as a Mediator

The Engineer of a contract is a qualified individual with substantial experience and in-depth contract expertise (Gillies & Henry, 2018). This statement is further supported by Ghaswala (2020), by emphasizing that the Engineer to the contract is knowledgeable about both the contract and the project. According to Dymond (2013), when disagreements do develop, the engineer's sound judgment is crucial in guiding the parties to an unambiguous resolution. Hence, it is considered to be a major opportunity for the Engineers involved in the mediation process. Nick (2018) identified that the Engineer having a sound knowledge of the Contract is an opportunity of using the Engineer as a Mediator. Moreover, the Engineer works as an intermediate person between the Employer and the Contractor (Jayasena & Kavinda, 2012). Therefore, the relationship between the parties can provide a comprehensive understanding of the underlying interests of the parties.

Despite the numerous opportunities that come with occupying the Engineer as a mediator, several barriers lie according to several scholars (Lee et al., 2020; Saeed, 2020). Thereby, Galloway (2013) indicated the appointment of the Engineer by the Employer has the ability to generate loyalty to the Employer while further highlighting the characteristics of Principle – Agent relationship that lies among them. Therefore, Saeed (2020) stated that the Employer can direct and give instructions to the Engineer while using his authority to approve and disapprove in an unethical manner. Moreover, Lee et al. (2020) further elaborated that loyalty that lies along with the principle–agent relationship can be a critical barrier to the impartiality of the Engineer and all these factors thereby interconnected to one another by this common factor.

2.7. Barrier Management Strategies to Occupy the Engineer as a Mediator for Construction Projects

Improvements to the ethics & personal qualities of the Engineer to the contract were mainly highlighted by several scholars as major strategies for occupying the Engineer to the mediation process (A.Ranasinghe & Korale, 2011; Cheung, 2010; Lingasabesan & Abenayake, 2022; Saeed, 2020). Despite that, the importance of including the mediation process in the conditions of the contract earlier to the adjudication process was highlighted by Bulckaen and Devos (2020). Moreover, the significance of including and elaborating the mediation as a duty of the Engineer was also highlighted by the author. Ismail et al. (2010) have discussed in their study the major requirements that lie for the amendments of the existing payment procedures for the mediator to safeguard and secure the impartiality of the process to both parties. However, according to the Mediation Guide - the Basics (2016), only a handful of scholars have expanded their studies on finding suitable strategies for avoiding possible barriers. Therefore, it has proven the importance of this study in pursuit of fulfilling the existing knowledge gap.

3. Research Methodology

This study aimed at investigating the suitability of the Engineer to the contract as a mediator to mitigate disputes in construction projects. A qualitative research strategy provides responses based on personal perspectives and experience (Hammarberg, Kirkman, & De Lacey, 2016). Moreover, the suitability of the Engineer should be assessed based on the opinions, attitudes, and behaviours of well-experienced professionals in the construction sector and not upon a quantitative analysis (Kothari, 2004). Hence, this study has adopted a qualitative strategy that consists of two- rounds of semi-structured interviews that followed the Delphi technique to critically investigate the suitability of the Engineer to the contract as a mediator to mitigate disputes in construction projects. The Delphi method is a systematic conversation and consensus-building procedure that involves a panel of specialists who are questioned to respond to statements that are unambiguous and non-leading in order to reach an agreement (Strasser, 2018). In order to reach a consensus in the fields of policy, practice, or organizational decision-making, the Delphi approach stresses organized anonymous conversations between people with knowledge on a particular issue (Brady, 2015). Thus, the qualitative Delphi method is employed for serving the purpose of this study to reach a consensus with anonymity among people with expert knowledge. The majority of research on Delphi in construction engineering and management suggests that consensus occurs in rounds two or three (Ameyaw, Hu, Shan, Chan, & Le, 2016). Thus, two rounds of semi-structured interviews were undertaken, and the findings were confirmed by respondents with experience as Engineers, interest in, and understanding of, the particular research area.

3.1. Delphi Round 1

First-round participants in the Delphi research participated in a series of semi-structured interviews with experts who had in-depth expertise and experience in conflict resolution. During these interviews, the experts recognized and discussed the findings from the literature review. The experts' readiness to take part in the interviews has also been taken into account. All of the experts were chosen by using the purposive sampling method. Despite this, as all three sectors have experience playing the role of the Engineer, the specialists were chosen from the engineering, quantity surveying, and architecture professions. Galvin (2015) asserted that data saturation in semi-structured interviews is mainly accomplished after twelve (12) interviews. However, conducting another four (4) interviews did not add or change the results indicating that data saturation was achieved.

Coding for Interviewee	Profession	Designation	Type of Organization	Experience (Number of Years)	Selection Criteria								Participation	
					Compulsory qualifications			Additional qualifications (expert must satisfy at least 3 qualifications)					R1	R2
					least 10 years of e xperience in construction industry	At least 5 years of experience as the Engineer for construction projects	Approachability	Having Construction Related Degree	Having Construction Related Professional Qualification	Having Construction Related Post Graduate Degree	Experience in dispute resolution as a neutral third party for construction projects	Interest in dispute resolution		
I01	Chartered Architect	Managing Director	Contractor	45 Years	√	√	√	√	√		√	√	√	√
I02	Chartered Architect	Managing Director	Contractor	25 Years	√	√	√	√	√		√	√	√	√
I03	Quantity Surveyor	Deputy Manager	Contractor	17 Years	√	√	√	√	√		√	√	√	
I04	Chartered Quantity Surveyor	Senior Quantity Surveyor	Contractor	15 Years	√	√	√	√	√	√	√	√	√	
I05	Chartered Quantity Surveyor	Contract Administrator	Contractor	16 Years	√	√	√	√	√	√	√	√	√	√
I06	Chartered Civil Engineer	Managing Director	Contractor	35 Years	√	√	√	√	√	√	√	√	√	√
I07	Civil Engineer	General Manager	Contractor	18 Years	√	√	√	√	√		√	√	√	√
I08	Quantity Surveyor	Senior Quantity Surveyor	Contractor	45 Years	√	√	√		√		√	√	√	√

Coding for Interviewee	Profession	Designation	Type of Organization	Experience (Number of Years)	Selection Criteria								Participation	
					Compulsory qualifications			Additional qualifications (expert must satisfy at least 3 qualifications)						
					least 10 years of e xperience in construction industry	At least 5 years of experience as the Engineer for construction projects	Approachability	Having Construction Related Degree	Having Construction Related Professional Qualification	Having Construction Related Post Graduate Degree	Experience in dispute resolution as a neutral third party for construction projects	Interest in dispute resolution	R1	R2
I09	Quantity Surveyor	Senior Quantity Surveyor	Contractor	15 Years	√	√	√	√			√	√	√	
I10	Chartered Quantity Surveyor	Senior Quantity Surveyor	Contractor	15 Years	√	√	√	√	√	√	√	√	√	
I11	Quantity Surveyor	Senior Quantity Surveyor	Contractor	12 Years	√	√	√	√	√	√	√	√	√	
I12	Quantity Surveyor	Project Quantity Surveyor	Contractor	10 Years	√	√	√	√			√	√	√	
I13	Chartered Quantity Surveyor	Senior Lecturer	Consultant & Lecturer	16 Years	√	√	√	√	√	√	√	√	√	√
I14	Quantity Surveyor	Senior Quantity Surveyor	Contractor	17 Years	√	√	√	√	√		√	√	√	√
I15	Chartered Quantity Surveyor	General Manager	Contractor	12 Years	√	√	√	√	√		√	√	√	√
I16	Chartered Civil Engineer	Senior Project Surveyor	Contractor	12 Years	√	√	√		√		√	√	√	√

Table 3 1: Profiles and Selection Criteria for the Interviewees of Delphi Rounds 1 and 2

Thus, sixteen (16) interviews were conducted by employing online Zoom technology and each interview was limited to 60-80 minutes. During the first phase, interviewees were requested to identify or moderate the Engineers' roles, opportunities and barriers for the Engineer to act as a mediator and strategies to overcome those barriers that were identified through the literature survey. In the second phase, interviewees were requested to identify or moderate the mediators' roles that were identified through the literature survey. Further, interviewees were asked to suggest other additionally known Engineers' and mediators' roles, opportunities and barriers for the Engineer to act as a mediator and strategies to overcome those barriers.

3.2. Delphi Round 2

Ten (10) interviews were successfully performed in Delphi round two reaching the consensus of the findings. This round's interviews were also conducted via online Zoom sessions. The first round's outcomes influenced the questions for the second round, which served as a chance for experts to evaluate, confirm and remark on the previous round's factors. During the first phase of the second round, identified roles of the Engineers and mediators were compared and confirmed by the experts. Moreover, during the second phase of the second round, the interviewees were asked to list out and confirm the most relevant opportunities and barriers for the Engineer to act as a mediator and to suggest the most suitable strategies to overcome those barriers.

By carefully defining the selection criteria for the experts, the problem of choosing a reliable expert panel in this study was resolved. Additionally, experts were picked for the expert interviews based on their capacity to fulfil both compulsory and optional requirements. The specialists were evaluated based on a variety of credentials. In Table 1, the profiles of the interviewees and the applied selection criteria are shown. As per the claims made by Dawson (2020), manual coding helps to focus on the sets of data and minimizes the variation between the data's contextual meanings and the analytical approach, thus the manual content analysis technique was employed to facilitate the summarizing of expert data and the fitting of replies to criteria.

4. Research Findings

4.1. Roles of the Mediator and the Engineer in Construction Projects

The interviewees agreed with fifteen (15) of the roles identified in the literature for a mediator and removed one role namely Sensitively and firmly managing the process because of its very repetitious nature acknowledged by more than 75% of the respondents. Additionally, based on the findings of the literature, the respondents have completely accepted all eight (8) roles of the Engineer. Additionally, four (4) roles of the mediator were amalgamated by experts, as noted in bold italics (E.g.: Producing a conducive atmosphere for proceeding with the mediation process). At the conclusion of phases 1 and 2 of round 1 obtaining 75% agreement among respondents, respondents identified eight (8) roles for the Engineer and thirteen (13) roles for the mediator.

The interviewees agreed that role of the Engineer is explained in several standard forms of contracts around different contexts. Moreover, during phase 1 of the Delphi round 1,

interviewees supported the fact of the engineer being empowered under the contract to perform their duties. Besides, the interviewees emphasized that according to the contract agreement the Engineer has to study the stability and reliability of the project's financial status and cost estimate, scrutinizing drawings and design, invite tenderers and select a suitable procurement system, feasibility study, supervision and maintain quality of works and cross-checking overall project based on time, cost and quality. I3 highlighted that, project planning and guiding the parties is the role of the Engineer. In other words, following up the project running in a given time frame. I5, I6 and I8 have stated that the Engineer should always be strict with the time, cost and quality of the project and he must follow up on whether the Contractor is within the given cost, time and maintaining the quality of the works. Furthermore, I12, I14 and I15 mentioned that the Engineer shall coordinate the project works and communicate clear information regarding the project between the Contractor and the Employer.

I3 alleged that the Engineer advised the Employer on matters related to the cost, design and technical details and the Engineer is a person who deals fairly with financial and business procedures. In addition to that, the Engineer assists the Employer to interpret the contract document and preparing agreements, reviewing bonds and guarantees for direct contracts which are the works done by the Employer separately. Moreover, I3 stated that the Engineer supports maintaining the cash flow while certifying the monthly interim payment certificates with fair evaluations. I7 have also stated that fair determination and instructions are crucial as an Engineer to the contract.

Despite that, during phase 2 of the Delphi round 1 the interviewees, the highest number of respondents agreed with the “Facilitating parties to overcome deadlock and towards a settlement”. In addition to that, the next majority of the respondents selected “Directing the parties to construct an outcome that meets their needs” as a mediator’s role. I2 stated that “At present, the mediator does not know how to firmly and sensitively manage the mediation process” and “facilitating parties to overcome deadlock and towards a settlement” either. Thereby, sensitively and firmly managing the process was removed from the role of the Mediator due to not being able to achieve 75% acceptance from the respondents. Furthermore, I3 stated that “the mediator provides a platform for the parties to negotiate”. Consent of the respondents is presented positively on “directing the parties to construct an outcome that meets their needs” except I11.

I1 stated that the “Involvement of the Mediator is important due to the lack of knowledge of the parties regarding contact administration”. Opinion of the I2 regarding the involvement of the Mediator is different and I2 stated that “the impact of the involvement of the Mediator for resolving disputes is very low in Sri Lankan construction industry compared to other countries”. Moreover, many interviewees suggested amalgamating the “acting as a settlement supervisor and checking whether the settlement agreement has been implemented”, and “helping the parties to avoid further problems”. Therefore, according to the interviewee's suggestions, these two spate roles were amalgamated into a single role.

Table 4-1:Roles of the Engineer and Mediator

Role of the Mediator to the Contract	I01	I02	I03	I04	I05	I06	I07	I08	I09	I10	I11	I12	I13	I14	I15	I16
Encouraging the disputant parties for settlement	√	√	√	√	x	√	√	√	√	x	√	√	√	√	√	√
Broadening the parties' vision of the problem and developing positive approaches to the problem	√	x	√	√	√	√	√	√	√	√	√	√	√	√	√	x
Facilitating parties to overcome deadlock and towards settlement	√	√	√	√	x	√	√	√	√	x	√	√	√	√	√	√
Directing the parties to construct an outcome that meets their needs	√	x	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Identifying the common goals of the parties based on gathered information	√	√	√	√	√	√	√	√	√	√	x	√	√	√	√	√
Assisting the parties to understand reality of the dispute by being reality tester	√	x	√	x	√	√	√	√	√	√	√	√	√	√	√	√
Sensitively and firmly manage the process	x	√	√	√	x	x	√	√	√	x	x	x	√	√	x	√
Act as a settlement supervisor and checking whether the settlement agreement has been implemented and help the parties to avoid further problems	√	x	x	√	√	√	√	√	√	√	√	√	√	√	√	x
Producing a conducive atmosphere for proceeding the mediation process	√	√	√	√	√	√	x	√	√	√	√	√	√	√	√	√
Explaining the mediation process and its regulations	√	√	√	√	√	√	√	√	x	√	√	√	√	√	√	√
Accommodating the communication among the disputant parties by employing various communication techniques and eliminating the possible obstacles for effective communication	√	√	√	√	√	√	√	x	√	√	√	√	√	√	√	√
Collection of information regarding the dispute and identifying the hidden interests of parties	√	√	√	x	√	√	√	√	√	x	√	√	√	√	x	√
Maintaining the control over the mediation procedure	√	√	√	√	x	√	√	√	√	√	√	√	√	√	√	√
Handling the interaction among the parties and facilitating the disputant parties generate possible solutions	√	√	√	√	√	x	√	√	√	√	√	√	√	√	√	√

Table 4-1:Roles of the Engineer and Mediator - Contt

Role of the Engineer to the Contract	I01	I02	I03	I04	I05	I06	I07	I08	I09	I10	I11	I12	I13	I14	I15	I16
Issuing instruction and Fair determination	√	x	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Managing Time, Cost and Quality of the project	√	√	√	√	√	√	x	√	√	√	√	√	√	√	√	x
Administration of the Contract	√	√	x	√	√	x	√	√	√	√	√	√	√	√	√	√
Project planning and guide the parties	√	x	x	√	√	√	√	√	x	√	√	√	√	√	√	√
Supervision of works	x	√	√	√	√	√	x	√	√	√	√	x	√	√	√	√
Advising the Employer on the matters related to the cost, design and technical details	x	x	√	√	√	√	x	√	√	√	√	√	√	√	√	√
Coordinating the project works	x	x	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Dealing fairly with financial and business procedures.	x	x	√	√	√	√	x	√	√	√	x	√	√	√	√	√

Despite that, several more roles were amalgamated into three (3) separate roles as illustrated in Table 2.

4.2. Mediator Vs the Engineer to the contract in Construction Projects (Findings of the Delphi Round 1 Phase 1, 2 and Delphi Round 2 Phase 1)

At the conclusion of phases 1 and 2 of round 1 obtaining 75% agreement among respondents, respondents identified eight (8) roles for the Engineer and thirteen (13) roles for the mediator. Despite that, the respondents have compared and further elaborated the finalized eight (8) roles for the Engineer and thirteen (13) roles for the mediator at the end of phase 1 of the Delphi round 2. Table 3 illustrates the mediator's and the Engineer's finalized roles.

According to Table 3, I1 highlighted that, "the Engineer to the contract is the person who stands between the two parties and handles the Employer's money. The role of the Engineer has been explained under standard forms of contracts and "Issuing instruction and Fair determination" is among them. All respondents agreed with the above statement except I2. I2 emphasized that 50%, 25%, 15% and 10% of the disputes that arise during construction projects are centred towards the Engineer, Employer, Contractor and unforeseen circumstances. According to the I4, the Engineer is an individual who follows up on the project plan and provides guidance to the project parties. According to I3, I4, I5, I6 and I7, the Engineer can observe the actual progress relative to the given program and assist in maintaining the cash flow while avoiding any interruption that can occur. I11 claimed that "contract administration works starts with calling for tenders. Only a handful of respondents agreed with the statement "the Engineer is coordinating the project works". I2 stated that "coordination is a significant job role but unfortunately in current practice, no proper coordination can be seen from the present Engineers". While supporting the above statement I16 highlighted that "the Engineers requirement for effective communication with project parties regarding contractual issues for obtaining win-win solutions". According to I3 "the Engineer should actively engage in providing correct interpretations to contractual terms in the resolution of contractual disputes among the project parties". Despite that, reviewing the drafted guarantees and bonds before final endorsement of the bank was also considered a role of the Engineer by I2 and I7. However, I1 and I3 Strictly stated that "the preparation of agreements does not include the role of the Engineer".

Table 4-2: Comparison of the roles of the Engineer to the Contract and the Mediator

Role of the Engineer to the contract	Role of the Mediator
Issuing instruction and Fair determination	Directing the parties to construct an outcome that meets their needs
	Act as a settlement supervisor and check whether the settlement agreement has been implemented and help the parties to avoid further problems
	Handling the interaction among the parties and facilitating the disputant parties generate possible solutions
	Explaining the mediation process and its regulations

Role of the Engineer to the contract	Role of the Mediator
Managing Time, Cost and Quality of the project	Broadening the parties' vision of the problem and developing positive approaches to the problem
	Accommodating the communication among the disputant parties by employing various communication techniques and eliminating the possible obstacles to effective communication
	Maintaining control over the mediation procedure
	Sensitively and firmly manage the process
Administration of the Contract	Facilitating parties to overcome deadlock and towards settlement
	Encouraging the disputant parties for settlement
	Collection of information regarding the dispute and identifying the hidden interests of parties
	Identifying the common goals of the parties based on gathered information
Project planning and guiding the parties	Assisting the parties to understand the reality of the dispute by being a reality tester
	Producing a conducive atmosphere for proceeding with the mediation process
Supervision of works	
Advising the Employer on matters related to the cost, design and technical details	
Coordinating the project works	
Dealing fairly with financial and business procedures.	

All the interviewees supported the fact of the Engineer performed certain roles of the mediator in the attempt of avoiding any possible disputes and minimizing the legal costs related to dispute resolution. In above Table 3, the roles of the Mediator that can be performed by the Engineer to the contract are demonstrated. Depending upon the comments of the respondents during Phase 1 of the Delphi round 2, the Engineer has the capability in performing in issuing instructions regarding the fair determination. Thereby, the Engineer to the contract can direct the disputant parties to construct an outcome that meets their needs while performing the duties as the Engineer. Despite that, as the Engineer to the contract, he can issue instructions to the parties explaining the mediation process to handle the interactions among the parties and facilitate the disputant parties generate possible solutions. Moreover, acting as a settlement supervisor and checking whether the settlement agreement has been implemented and helping the parties to avoid further problems can also be performed as the Engineer to the contract due to the immense resemblance between the two roles.

Despite that, the Mediator is urged to pay attention to communication if the entities do not often take it seriously for several reasons. This will establish a dynamic between the parties that will help the mediator better grasp the conflict's many facets, encouraging the creation of paths and possibilities leading to an appropriate resolution". Moreover, I1 and I2 stated that "The Engineers' role heavily depends on effective communication that promotes through a conducive environment since it permits projects to move forward smoothly and on schedule. It guarantees that team members are clear on the objectives of the project and understand precisely what is deemed necessary of themselves. Hence, accommodating the communication among the disputant parties by employing various communication techniques and eliminating the possible obstacles to effective communication is deemed to be suitable for the Engineer to the contract to be performed. Along with that, broadening the parties' vision of the problem and developing positive approaches to the problem also moves parallel with enabling effective communication. Thus, the suitability of the Engineer performing roles related to communication resembles one of the major roles of the Engineer "Managing Time, Cost and Quality of the project".

Moreover, I8 stated, "the Engineer can control the mediation procedure while handling the interaction among the parties and facilitating the disputant parties generate possible solutions due to his or her previous experience with project management". Nevertheless, I6 claimed that the Engineer is having to deal with controlling the mediation procedure as an extra burden. Since the Engineer to the contract is continuously dealing with project parties throughout the project period. Moreover, I4 stated that "The Engineer can understand the hidden interests and common goals of the project parties rather than any other professional due to constant interactions with the project stakeholders. Therefore, the Engineer possesses the capacity to broaden the parties' vision of the problem and to develop positive approaches to the problem and direct the parties to construct an outcome that meets their needs". Moreover, administration of the contract can be regarded as a major role that lies upon the Engineer to the contract. Thus, roles such as facilitating parties to overcome deadlock and towards settlement, encouraging the disputant parties for settlement, collecting information regarding the dispute and identifying the hidden interests of parties, and identifying the common goals of the parties based on gathered information are all inter-related to the administration of the contract. Since all of the above-mentioned aspects are covered under the conditions of the FIDIC 2017, it is visible that these roles are best suitable to be performed by the Engineer to the contract.

4.3. Opportunities for the Engineer to Involve as a Mediator (Findings of the Delphi Round 1 Phase 1 and Delphi Round 2 Phase 2)

Generic opportunities for the Engineer to involve as a mediator in dispute resolution were identified through a comprehensive literature survey and modified through the Delphi Round 1: Phase 1 and it was confirmed in depth at the Delphi Round 2: Phase 2 as demonstrated in Figure 1. During the Delphi Round 1 Phase 1, the experts accepted all eight (8) opportunities for the Engineer to involve as a mediator. Furthermore, the experts proposed five (5) additional opportunities for the Engineer to involve as a mediator, which is displayed in bold & italic letters (E.g.: Close association with the Employer). Additionally, opportunities that obtained more than 75% of responses during Delphi Round 2 are depicted in the following Figure 1. More than 75% of the evaluated opportunities were considered substantial, according to the respondents.

As per the claims made by the experts, well understanding of business cases and business aspects, close association with the Employer, knowledge about the all positive and negative details of both parties, knowledge of the real barriers of the project and ability to apply previous lessons learned to new projects were the proposed five (5) additional opportunities for the Engineer to involve as a mediator. All interview respondents agreed that the Engineer to the contract having sound knowledge of the contract and the project was a valuable opportunity. Moreover, the respondents such as I3, I4 and I6 have proclaimed that contract administration is considered to be the main duty that lies upon the Engineer even from an employer perspective. I13 validated that the Engineer has an impartial character while quoting sub-clause 3.7 in FIDIC 2017 Red book. Respondents such as I1, I2, I5, I7, I8, I12, I14, and I16 did not provide a keen explanation to the statement of "Complying with the terms of the contract" while others have argued that compliance to the contract does not have a visible effect to the role of the mediator. Delegation of authority by the Employer through the Contract terms did not consider an opportunity for the Engineer to act as a Mediator. Furthermore, few respondents only agreed with the statement that "The Engineer is not a single person and act as a team" and considered an enabler for the Engineer to act as a Mediator. In consideration to the Engineer is not a single person but a team has been emphasized as a major opportunity for acting as the mediator to the contract by all the interviewees except I14. I14 mentioned that "If the engineer is a single person, the impact that he/she can make to the contract is minimal compared to a team. Therefore, it cannot be considered as an opportunity". However, I15 argued the statement of I14, by saying that "Even though the engineer is not a single person but a team, only a single person among them is selected to administer and handle the mediation process. Hence, the collective impact is minimized".

Despite the opportunities collected through the comprehensive literature synthesis, interviewees highlighted some additional opportunities that may also be helpful to the Engineer to act as a Mediator. I2 perceived that "Well understanding of business cases and business aspects" as an opportunity and designated that "A comprehensive awareness regarding the construction business can be a positive encouragement for the Engineer to handle the mediation process while understanding and addressing interests of both parties". According to I3, "Close association that lies upon the Employer and the Engineer will also aid in effective communication among the parties by eventually leading to understanding the inner objectives of the Employer". Understanding the true interests of the parties is essential for any dispute resolver in order to aid in achieving an effective resolution. Hence, this can be regarded as a major opportunity for the Engineer to enter into the contract as a mediator. I7 added, knowledge about the all positive and negative details on both parties as an additional opportunity for the existing list while emphasizing the importance of having a holistic idea regarding both parties by dispute resolver. Despite that, the Engineer in the contract acts as an intermediate person between the Contractor and the Employer. Therefore, the Engineer is the person who communicates with both parties and conveys his opinion to the parties in case of arising inconsistencies. The engineer continuously deals with the project works and has a comprehensive idea regarding the present situation. Thus, I4 stated that "The Engineer has well awareness of the real-world barriers that occur during the construction project and it can be considered as a great opportunity." Additionally, I10 highlighted lessons learned from previous contracts that can be applied to the new projects as an enabler for the engineer to involve in the mediation process. It was further explained that past project experiences can be employed effectively for future dispute resolution scenarios.

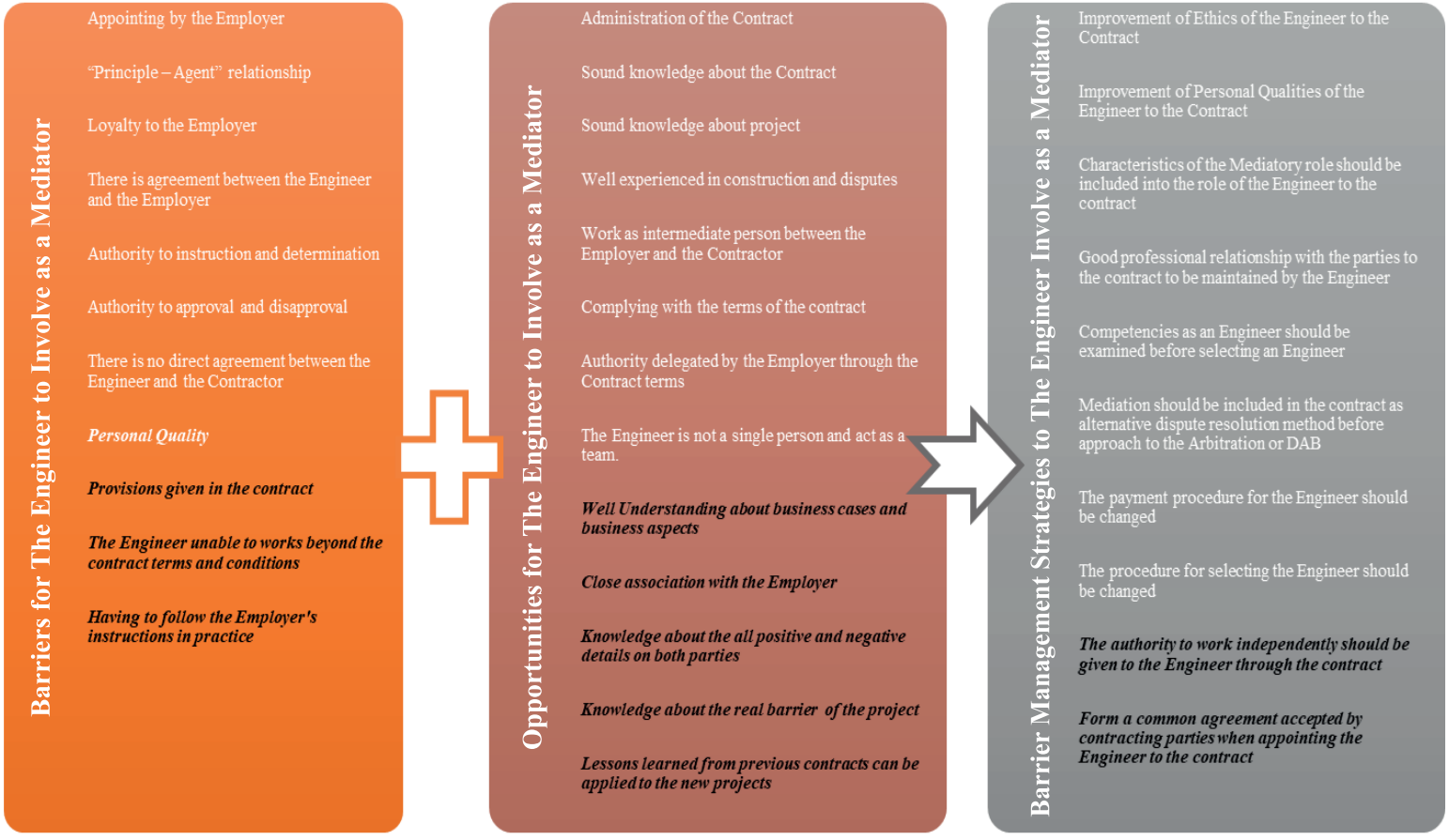


Table 4-1: : Framework for the Involvement of the Engineer in the Contract as a Mediator

4.4. Barriers to the Engineer to Involve in the Contract as a Mediator (Findings of the Delphi Round 1 Phase 1 and Delphi Round 2 Phase 2)

Generic barriers for the Engineer to involve in the contract as a mediator in the dispute resolution were initially identified through a comprehensive literature survey and modified through the Delphi Round 1: Phase 1 and it was confirmed in depth at the Delphi Round 2: Phase 2 as demonstrated in Figure 1. During the Delphi Round 1 Phase 1, the experts accepted all seven (7) barriers for the Engineer to involve as a mediator. Additionally, experts proposed four (4) additional barriers for the Engineer to involve as a mediator, which are displayed in bold & italic letters (E.g.: Having to follow the Employer's instructions in practice). Additionally, barriers that obtained more than 75% of responses during Delphi Round 2: Phase 2 are depicted in the following Figure 1.

Appointment of the Engineer by the Employer has been considered a major indicator of whose side the Engineers' loyalty lies upon according to the claims made by I1, I2, I5, I6, and I14. Despite that, I13 has claimed that the principle-agent relationship that lies between the parties further demonstrates the Engineers' incapability to make decisions as an independent party. Hence, I13 and I12 both have concluded the interconnectivity that lies upon the appointment of the Engineer by the Employer, the principle-agent relationship and loyalty to the Employer. I01 stated that the Engineer to the contract has to follow the instructions given by the Employer on most occasions. Thereby, I16 highlights that "The Engineer to the contract is generally appointed by the Client and paid by the Client. Accordingly, in practice, Contractors usually complain that the Engineer to the contract makes decisions much more favourable to the Client". As an example I01 presented that," In case the Contractor request from the Employer to defer the deduction of recovering advances from the current payment certificate, the Employer may instruct to the Engineer to proceed the payment certificate without deduction of recovering of the advance for the current payment certificate". However, deferring of recovering of advance may issue for the future payment certificate and it is an overlapping the contract terms. Further, the I6 provided a comprehensive response for "Authority to approval and disapproval" by mentioning that few of "The Engineers are attempting to protect the Employer due to his expectation of receiving any future construction projects from the Employer. On that basis, it is professionally inappropriate that the Engineer utilizes his authority to approval and disapproval from an angle where the Employer receives the benefits and the contractor has to suffer". However, I13 stated that "Duties of the Engineer are mentioned in the contract and decision making of the Engineer to be fair and reasonable". I1 highlighted that, "The Engineer has the authority to give instructions and determination under the contract and therefore, it will not become a barrier to the Engineer to absorb characteristics and duties of a Mediator. Since the role of the Engineer is further polished with absorbing qualities of the Mediator". Most of the respondent's opinions on the statement "There is no direct agreement between the Engineer and the Contractor" was, the agreement between the Engineer and the Employer is not affected to the Contract and duties and responsibilities to the Engineer is specified in the Contract. I2 further stated that "There is no necessity in signing a direct contract between the Engineer and the Contractor and duties are properly defined in the Contract". According to the I2, "Personal qualities of the Engineer to the contract considered significant. Because the pattern of thinking, the ability to take responsibility, ability to make impartial decisions, foresight and obey to the

ther's decisions are depending on the personality of a person". Thus, depending upon the qualities of a person and it can be a barrier to act as a mediator in the dispute resolution process. Moreover, according to the I13, "The provisions given in the contract can be a barrier to merge and perform the duties of both the Engineer and the mediator. Therefore, it is necessary to amend some of the terms of the contract to bring those features of the Mediator into the characteristics of the Engineer". Further, the I3 and I6 agreed with the opinion of the I13 stating that "The Engineer is incapable to perform the works beyond the contract terms and conditions". Additionally, I9 highlighted that "The Engineer having to follow the Employer's instructions in practice fully demonstrates the Engineers' incapacity in performing the mediators' role while being independent".

4.5. Barrier Management Strategies to Occupy the Engineer as a Mediator for Construction Dispute Resolution Process (Findings of the Delphi Round 1 Phase 1 and Delphi Round 2 Phase 2)

Nonspecific barrier management strategies for the Engineer to involve in the contract as a mediator in the dispute resolution process were initially identified through a comprehensive literature survey and modified through the Delphi Round 1: Phase 1 and it was confirmed in depth at the Delphi Round 2: Phase 2 as illustrated in Figure 1. During the Delphi Round 1 Phase 1, the experts accepted all eight (8) barrier management strategies for the Engineer to involve as a mediator. Additionally, experts proposed two (2) additional barrier management strategies for the Engineer to involve as a mediator, which are displayed in bold & italic letters (E.g.: The authority to work independently should be given to the Engineer through the contract). Additionally, all the listed barrier management strategies at the end of phase 1 of the Delphi Round 1 were able to obtain more than 75% of responses and as depicted in Figure 1.

Improvement of Ethics of the Engineer to the Contract was able to obtain more than 75% of the responses during the Delphi Round 2. Moreover, I2 and I3 have emphasized the importance of professional ethics to the Engineer by expressing their views as "Engineers must have integrity and honesty throughout their profession, just like those in all other professions. Codes of ethics hold people accountable for their acts. They serve as guidelines for judging what is proper or wrong". Despite that, I6 has stated that "The Engineer must adhere to a code of ethics to make sure they are always truthful in their encounters. When people follow the code of ethics, they will continue to be honest regardless of pressures or quandaries they may encounter while performing their duties. Engineers may be honest with their employer and guarantee that they always have their best interests in mind by abiding by the code of ethics". In spite of the code of ethics, many interviewees have stressed the importance of improving the personal qualities of the Engineer to the Contract to cater for responsibilities as a mediator to the contract. I8, I10, and I13 mentioned the importance of personal qualities to the Engineer if he has to play the role of a mediator under contract conditions. Nevertheless, I15 pointed out that "If characteristics of the mediatory role are not included in the contract, it won't be possible for the Engineer to eventually adjust and perform the duties of a mediator". Even if the parties "trust" one another, a written condition offers a precise path of how the Engineer will move to complete the operation at the beginning of the project while resolving any possible disputes as a mediator. Reducing the possibility of potentially fatal issues helps to assure that the project will go without

incident. In the absence of documented conditions, each party may assume things about what the agreement is or how the other would respond in a certain scenario. These presumptions are frequently wrong and can be disastrous for a project".

I02 and I13 stated that the "Skill level of the Engineer is utmost of importance when it comes to tactically handling numerous issues. Therefore, that particular individual must consist with a variety of skills not only related to dispute resolution but also human resource management". Mediation is a better ADR mechanism compared to the other methods when comparing the cost, time and privacy of the parties. I9's statement indicates that the mediator's characteristics and the techniques used to resolve disputes are up to a satisfactory level and therefore, it has to be included as the initial step of ADR rather than moving straightly to the Adjudication or Arbitration. Moreover, according to I15, "The payment procedure of the Engineer to the contract should be changed". Additionally, I16 proposed that "Payments to the Engineer to the contract should be done via an agreed payment method that has an equal contribution from both contracting parties". I11 highlighted, the payments of the ADR approach should be done by the parties collectively and it may benefit the parties to get the absolute answer without any biases that may occur based on the payment. Despite these above-mentioned strategies, I14 and I12 have stressed the importance of giving the authority to the Engineer to work independently through the contract. Thereby, it has been added as an additional strategy for managing the barriers. Further, I16 emphasized that "With the independency that gains with the job role, the Engineer can freely make decisions. I9, I10 and I12 have emphasized the importance of forming a common agreement accepted by contracting parties when appointing the Engineer to the contract during their interviews. I9 have stated that "Through a mutually accepted common agreement, the appointment of the Engineer to the contract will be an impartial decision. Thus, the mediation process can be carried out without any obstacles that may occur due to the questioning of the impartiality or the independent nature of the Engineer.

5. Discussion

The Process of a qualified, neutral third party being appointed by the disputant parties to aid them in the settlement of their disagreement is known as mediation (Mediation Guide - the Basics, 2016). Moreover, according to Haning and Kaesmetan (2022), the Latin word mediare means to be in the midst, which is where the phrase mediation derives its etymology. Being at the centre point also implies that the mediator must take an objective, unbiased stance while settling conflicts (Sabri & Torp, 2022). In order to gain the trust of the conflicting parties, he must be able to protect the interests of each party fairly and equitably (Illankoon et al., 2022). In most circumstances, a separate neutral third party who has no direct relationship with disputants has acted as the mediator. However, none of the previous scholars' has paid attention towards employing a very familiar person in the construction process as a mediator to improve the efficiency of the dispute resolution process.

Further, this study has been able to finalize eight (8) roles for the Engineer and thirteen (13) roles for the mediator in the Contract. According to Cheung (2010), encouraging the disputant parties to settle while broadening the parties' vision of the problem and developing positive approaches to the problem was emphasized as a major role that lies upon the mediator. Further, this study

also supports the statement by Cheung (2010) while claiming its importance according to the experts' interviews conducted. It is acknowledged by Abdul-Malak et al. (2020) that engineering experts may be asked to perform a variety of different responsibilities in connection with the handling of claims and disputes. Further, Kurt (2020) also stated in line with this study these roles are positioned at crucial turning points or gateways in the claim-dispute evolutionary procedure and are performed upon nomination by the Employer, the Employer and contractor, or both. Further, Kalach and Srour (2019) also mentioned that the engineer position has usually been performed by the design consultancy service provider organization. Meaning, in addition to planning the project and technically overseeing the construction activities, such a company is also assisting the adjudication and/or arbitration processes when claims turn into disputes.

Moreover, Nick (2018) identified that the Engineer having sound knowledge about the Contract is an opportunity of using the Engineer as a Mediator. The Engineer works as an intermediate person between the Employer and the Contractor (Jayasena & Kavinda, 2012). Hamadneh (2016), stated that the Engineer should consist with sound knowledge regarding the process of the project. Hence, the results of this study were validated through the literature findings. "FIDIC Conditions of Contract" (2017) includes the terms and conditions describing the delegation of authority by the Employer through the Contract terms to the Engineer in contracts designed by the Employer. Similarly, in this study also, the delegation of authority by the Employer through the Contract terms is identified as one of the enablers to the Engineer to the contract to act as a Mediator. Sayed-Gharib et al. (2010) stated that the Engineer has to comply with the terms of the contract. Similarly, respondents in this study also agreed with the above statement and considered it as an opportunity. Gould (2012) also defined that the Engineer is not a single person and acts as a team due to various groups working collectively and calling an Engineer to the contract. The findings of this study also confirmed that the Engineer is not a single person and treated it as an opportunity of using the Engineer as a Mediator.

Galloway (2013) supported the findings of this study while indicating the appointment of the Engineer by the Employer has the ability to generate loyalty by the Engineer to the Employer while further highlighting the characteristics of Principle – Agent relationship. Therefore, the Employer can direct and instruct the Engineer while using his authority to approve and disapprove in an unethical manner. The newly added barriers during the Delphi rounds were not directly expressed in any of the previous scholarly work and Saeed (2020) has somewhat vaguely expressed these barriers in his study.

It was proven during the literature synthesis that, there is a visible gap that exists in the barrier management strategies for occupying the Engineer as a mediator in the construction process. However, few scholars have indirectly expressed that improvements are essential for the personal qualities and ethics of the Engineers' role to occupy him in the dispute resolution process (Lee et al., 2020; Saengchai, Jermsittiparsert, & Joemsittiprasert, 2020). Moreover, many scholars such as Cheung (2010); Ismail et al. (2010) and Roles , Rights and Responsibilities of the Mediation Participants (2018) have stated the importance of including mediation in the contract as an ADR method before Arbitration or DAB. Despite that, scholars have highlighted that the characteristics of the mediatory role should be included in the role of the Engineer to the contract

to initiate the process. Additionally, Faghih and Akhavian (2019) have emphasized the major requirement that exists with changing payment procedure for the Engineer in order to maintain the impartiality during the process. Therewith, the previous scholarly works fully aligned with the findings of this study while further emphasizing the aim of this study.

6. Conclusions And Recommendations

Through a comprehensive comparison that was conducted, it was identified the suitability of performing several roles of the Mediator by the Engineer to the contract. Among these roles, directing the parties to construct an outcome that meets their needs, acting as a settlement supervisor and checking whether the settlement agreement has been implemented and helping the parties to avoid further problems were identified as major roles related to a mediator that can be performed by the Engineer under his responsibilities related to issuing instruction and fair determination. Moreover, broadening the parties' vision of the problem and developing positive approaches to the problem, accommodating the communication among the disputant parties by employing various communication techniques and eliminating the possible obstacles for effective communication, and maintaining control over the mediation procedure also recognized through findings of this research as major roles related to a mediator that can be performed by the Engineer under his responsibilities related to managing time, cost and quality of the project. Despite that, facilitating parties to overcome deadlock and towards settlement and encouraging the disputant parties for settlement were also recognized as suitable to be performed as the Engineer's roles. Generic opportunities for the Engineer to involve as a mediator in dispute resolution were identified through a comprehensive literature survey and modified through the Delphi Round 1: Phase 1 and it was confirmed in depth at the Delphi Round 2. In achieving the second objective, thirteen (13) opportunities for the Engineer to involve as a mediator in dispute resolution were finalized by including four (4) additionally stated opportunities, well understanding of business cases and business aspects, close association with the employer, knowledge about the all positive and negative details on both parties, knowledge about the real barriers of the project, and lessons learned from previous contracts can be applied to the new projects. By following the same mechanism as the earlier objective, the experts have accepted all seven (7) barriers for the Engineer to involve as a mediator that were identified through the literature synthesis. Additionally, experts have proposed four (4) additional barriers for the Engineer to involve as a mediator including, personal quality, provisions given in the contract, the Engineer's unable to work beyond the contract terms and conditions and having to follow the employer's instructions in practice. Despite that, the findings of this study were able to generate specific barrier management strategies to enrich the ability of the Engineer to involve in the dispute resolution process as a mediator. The experts accepted all eight (8) barrier management strategies for the Engineer to involve as a mediator that were identified through the literature synthesis and proposed two (2) additional barrier management strategies including, the authority to work independently should be given to the Engineer through the contract and forming a common agreement accepted by contracting parties when appointing the Engineer to the contract

.

Identification of the possible opportunities for the Engineer to involve in the contract as a mediator while diminishing possible barriers in order to enhance the efficiency of the dispute resolution process while minimizing the cost of litigation is the major industrial contribution of this study. Though, the construction sector is employing mediation as an ADR technique for

dispute resolution none of them has addressed the perspective of employing the Engineer as a mediator, even though he is the most well-attentive individual regarding the construction project. Therefore, this study can be regarded as a motivational factor for construction employers across the world to extend the Employer's role towards construction dispute resolution. Despite that, reduction of issues among the project stakeholders can also be considered a major implication for both society and the construction industry due to the avoidance of such project suspensions or terminations. Furthermore, this study can be deliberated as the only scholarly work that ought to be discussed on employing the Engineer to the contract as a mediator. Hence, it can be considered a fresh theoretical contribution to the existing knowledge in the arena of dispute resolution. Moreover, this research also serves as a reference point for any forthcoming studies carried out in the arena of dispute resolution. Furthermore, this study can reckon for amendments in the conditions of contracts around the world to improve the efficiency of the construction dispute resolution process.

This study is limited to building projects considering FIDIC second edition 2017 conditions of construction contract. Therefore, the outcome of this research cannot be applied to infrastructure projects and projects prepared based on another type of condition of contracts. The sample size for the Delphi rounds was only sixteen (16) respondents and it is a major limitation of this study due to the COVID- 19 restrictions.

6.1 Disclosure statement

The authors report there are no competing interests to declare.

7. References

1. A.Ranasinghe, & Korale, J. C. (2011). Adjudication in Construction Contracts. Engineer: Journal of the Institution of Engineers, Sri Lanka, XXXXIV(02), 73–82.

2. Abdul-Malak, M.-A. U., Bou Hamdan, S., & Demachkieh, F. S. (2020). Enhanced Roles and Traits of the Engineer in Assessing Claims. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 12(3), 1–15. https://doi.org/10.1061/(asce)la.1943-4170.0000398

3. Ameyaw, E. E., Hu, Y., Shan, M., Chan, A. P. C., & Le, Y. (2016). Application of Delphi method in construction engineering and management research: A quantitative perspective. Journal of Civil Engineering and Management, 22(8), 991–1000. https://doi.org/10.3846/13923730.2014.945953

4. Awwad, R., Barakat, B., & Menassa, C. (2016). Understanding Dispute Resolution in the Middle East Region from Perspectives of Different Stakeholders. Journal of Management in Engineering, 32(6), 05016019. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000465

5. Ayhan, M., Dikmen, I., & Talat Birgonul, M. (2021). Predicting the Occurrence of Construction Disputes Using Machine Learning Techniques. Journal of Construction Engineering and Management, 147(4). https://doi.org/10.1061/(asce)co.1943-7862.0002027

6. Bakhtawar, B., Thaheem, M. J., Arshad, H., & Qadeer, A. (2018). How to embrace the stakeholder in public private partnership decision-making? A theoretical discourse. Proceeding of the 34th Annual ARCOM Conference, ARCOM 2018, (September), 373–382.

7. Balzer, B., & Schneider, J. (2021). Managing a conflict: optimal alternative dispute resolution. RAND Journal of Economics, 52(2), 415–445. https://doi.org/10.1111/1756-2171.12374

8. Brady, S. R. (2015). Utilizing and Adapting the Delphi Method for Use in Qualitative Research. International Journal of Qualitative Methods, 14(5), 1–6. https://doi.org/10.1177/1609406915621381

9. Bulckaen, L., & Devos, R. (2020). The engineer as mediator in complex architectural projects at the turn of the nineteenth century: the case study of Louis Cloquet. Construction History Society Conference Paper, 405–418.

10. Cheung, S. O. (2010). Mediation for Improved Conflict Resolution. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 2(3), 135–135. https://doi.org/10.1061/(asce)la.1943-4170.0000035

11. Dawson, C. (2020). A-Z of digital research methods. Retrieved from https://www.routledge.com/A-Z-of-Digital-Research-Methods/Dawson/p/book/9781138486805

12. Dissanayake, D. M. A. ., Abeynayake, M. D. T. ., & Pandithawatta, T. P. W. S. . (2018). Perception of Contractors On Usage of Alternative Dispute Resolution Methods in Construction Industry of Sri Lanka. "Sustainability for People - Envisaging Multi Disciplinary Solution": Proceedings of the 11th International Conference of Faculty of Architecture Research Unit (FARU), 457–464. University of Moratuwa, Sri Lanka.

13. Dymond, T. (2013). The Engineer's Role in Contract Management. International Law Study.

14. Faghih, A., & Akhavian, R. (2019). A Game-Theory Approach to Construction Dispute Resolution through Mediation. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 11(4), 1–6. https://doi.org/10.1061/(asce)la.1943-4170.0000325

15. FIDIC Conditions of Contract. (2017). Fédération Internationale des Ingénieurs-Conseils (FIDIC).

16. FIDIC Conditions of Contract for Construction. (1999).

17. Galloway, P. D. (2013). Engineering a Successful Negotiation. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 5(1), 6–12. https://doi.org/10.1061/(asce)la.1943-4170.0000097

18. Galvin, R. (2015). How many interviews are enough? Do qualitative interviews in building energy consumption research produce reliable knowledge? Journal of Building Engineering, 1, 2–12. https://doi.org/10.1016/j.jobe.2014.12.001

19. Ghaswala, S. K. (2020). The Role and Efficacy of Consulting Engineers in Construction. Retrieved September 21, 2022, from https://www.nbmcw.com/article-report/infrastructure-construction/project-management-arbitration/the-role-and-efficacy-of-consulting- engineers-in-construction.html

20. Gillies, N., & Henry, H. (2018). Is this dual role working? Retrieved from https://cloudcdn.nz/_heskethhenry_/assets/uploads/2018/04/We-Need-to-alk-About-the-Engineer- Nick- Gillies-External-....pdf

21. Gould, N. (2012). RICS Conflict Avoidance and Dispute Resolution in Construction. In RICS QS & Construction Standards (1st ed.). Quantity Surveying and Construction Professional Group of the Royal Institution of Chartered Surveyors. Retrieved from www.ricsbooks.com

22. Hamadneh, A. F. (2016). Legal liability of the Mediator. Journal of Law, Policy and Globalization, 46, 102–118.

23. Hammarberg, K., Kirkman, M., & De Lacey, S. (2016, March 1). Qualitative research methods: When to use them and how to judge them. Human Reproduction, Vol. 31, pp. 498–501. Oxford University Press. https://doi.org/10.1093/humrep/dev334

24. Haning, S., & Kaesmetan, R. M. (2022). The role of the village head as mediator in resolving land disputes. Journal of Social Sciences, 4(1), 78–86. Retrieved from https://growingscholar.org/journal/index.php/TIJOSSW/article/view/183%0Ahttps://growingscholar.org/ journal/index.php/TIJOSSW/article/download/183/159

25. Illankoon, I. M. C. S., Tam, V. W. Y., Le, K. N., & Ranadewa, K. A. T. O. (2022). Causes of disputes, factors affecting dispute resolution and effective alternative dispute resolution for Sri Lankan construction industry. International Journal of Construction Management, 22(2), 218–228. https://doi.org/10.1080/15623599.2019.1616415

26. Ismail, Z., Abdullah, J., Hassan, P. F., & Mohamad Zin, R. (2010). Mediation In Construction Industry? Journal of Surveying, Construction & Property, 1(1), 1–22. https://doi.org/10.22452/jscp.vol1no1.1

27. Jaeger, A.-V., & Hök, G.-S. (2009). FIDIC-A Guide for Practitioners. New York: Springer. https://doi.org/10.1007/978-3-642-02100-8

28. Jayasena, H. S., & Kavinda, Y. H. (2012). World Construction Conference 2012-Global Challenges in Construction Industry 28-30. World Construction Conference 2012 – Global Challenges in Construction Industry, (June), 180–187.

29. Kalach, M., & Srour, M.-A. I. A.-M. (2019). Liability Exposure and Indemnity for Architecture and Engineering Professionals Acting as Independent Consultants or Design Subcontractors. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 11(4). https://doi.org/https://doi.org/10.1061/(ASCE)LA.1943-4170.0000306

30. Kim, J., & Kim, M. (2021). Intelligent Mediator-based Enhanced Smart Contract for Privacy Protection. ACM Transactions on Internet Technology, 21(1), 1–16. https://doi.org/10.1145/3404892

31. Kothari, C. R. (2004). Research Methodology: Methods & Techniques (2nd ed.). New Delhi: New Age International (P) Ltd.

32. Kurt, H. S. (2020). Psychological contract violation and turnover intention: Employee-perceived loyalty as a mediator. Global Journal of Psychology Research: New Trends and Issues, 10(2), 160–169.

33. Lee, C. K., Lee, M. S., & Thurasamy, R. (2020). Using Mediation in Project Disputes Based on Theory of Planned Behavior and Technology Acceptance Model. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 12(1), 1–10. https://doi.org/10.1061/(asce)la.1943-4170.0000361

34. Lingasabesan, V., & Abenayake, M. (2022). Opportunities and Challenges in Conducting Virtual Alternative Dispute Resolution (Adr) Methods in the Sri Lankan Construction. Proceedings of the 10th World Construction Symposium, (June), 657–667.

35. Mediation guide - the basics. (2016). Retrieved from https://www.lexology.com/library/detail.aspx?g=43a7d3aa-2cef-427c-b22a-25a1f1f903de%0Ahttps://www.fenwickelliott.com/research-insight/articles-papers/alternative-dispute-resolution/mediation-guide-basics

36. Mediation Training Manual for Refresher Course. (2018). New Delhi. Retrieved from https://main.sci.gov.in/pdf/mediation/Mediation Training Manual for Refresher Course.pdf

37. Mello, M. H., Strandhagen, J. O., & Alfnes, E. (2015). The role of coordination in avoiding project delays in an engineer-to-order supply chain. Journal of Manufacturing Technology Management, 26(3), 429–454. https://doi.org/10.1108/JMTM-03-2013-0021

38. Nabatova, V. (2017). Alternative dispute resolution in the construction industry. Czech Technical University in Prague.

39. Ndekugri, I., Smith, N., & Hughes, W. (2007). The engineer under FIDIC's conditions of contract for construction. Construction Management and Economics, 25(7), 791–799. https://doi.org/10.1080/01446190701411216

40. Nick, G. (2018). We Need to Talk about the Engineer: A New Zealand Perspective. Building and Construction Law Journal, 34, 179–190. Retrieved from https://www.heskethhenry.co.nz/assets/uploads/2018/10/We-Need-to-Talk-about-the-Engineer- A-New-Zealand-Perspective.pdf

41. Oswald, D., Scholtenhuis, L. olde, Moore, T., & Smith, S. (2021). Construction defects, danger, disruption and disputes: a systemic view of the construction industry

post-Grenfell. Construction Management and Economics, Vol. 39, pp. 949–952. Routledge. https://doi.org/10.1080/01446193.2021.2015973

42. Roles , Rights and Responsibilities of the Mediation Participants. (2018). Retrieved from https://www.otc-cta.gc.ca/sites/all/files/was/Mediation-Roles-EN.pdf

43. Sabri, O. K., & Torp, O. (2022). Corrective and Preventive Action Plan (CAPA) for Disputes in Construction Projects: A Norwegian Perspective. Infrastructures, 7(5). https://doi.org/10.3390/infrastructures7050063
44. Saeed, M. (2020). Mediation effect of psychological contract between personality dimensions and turnover intention. Journal of Economics, Finance and Administrative Science, 25(50), 205–219. https://doi.org/10.1108/JEFAS-06-2019-0101

45. Saengchai, S., Jermsittiparsert, K., & Joemsittiprasert, W. (2020). Human Resource Development and Success of Engineering Procurement Construction Project: What Role Engineering Education and Human Resource Competency can play? TEST; Engineering & Management , 82(January-February 2020), 3476–3487. Retrieved from https://www.researchgate.net/publication/338720036
46. Sameh, E.-S., Irtishad, A., Malak, A., Rawan, H., Samuel, M., & Omar, E.-A. (2020). Construction Disputes in the UAE: Causes and Resolution Methods. Buildings, 10(171), 267–272.

47. Sayed-Gharib, T., Price, A., & Lord, W. (2010). Improving Dispute Resolution on Construction Projects in Kuwait. 18th CIB World Building Congress, 514–526. Retrieved from http://www.irbnet.de/daten/iconda/CIB19032.pdf

48. Strasser, A. (2018). Delphi Method Variants in Information Systems Research: Taxonomy Delphi Method Variants in Information Systems Research: Taxonomy Development and Application. (October 2017).

49. Surahyo, A. (2018). Understanding Construction Contracts. In Understanding Construction Contracts (pp. 215–224). https://doi.org/10.1007/978-3-319-66685-3

50. Thusharika, A. P. J. N., & Abeynayake, M. (2016). Framework for Mitigating Contractual Disputes in The Sri Lankan Construction Industry. The 5th World Construction Symposium 2016: Greening Environment, Eco Innovations & Entrepreneurship, 221–230. Colombo. Retrieved from http://dl.lib.uom.lk/bitstream/handle/123/17269/FRAMEWORK FORMITIGATING CONTRACTUAL.pdf?sequence=1

51. Zheng, X., Liu, Y., Jiang, J., Thomas, L. M., & Su, N. (2021). Predicting the litigation outcome of ppp project disputes between public authority and private partner using an ensemble model. Journal of Business Economics and Management, 22(2), 320–345. https://doi.org/10.3846/jbem.2021.13219

PAYMENT AUTOMATION IN BLOCKCHAIN ENABLED SMART CONTRACTS: SRI LANKAN CONSTRUCTION INDUSTRY PERSPECTIVE

R. H. N. Abeywardena[a], Anuradha Waidyasekara[b] and Diyana Sheharee Ranasinghe[c]
Department of Building Economics, University of Moratuwa, Sri Lanka[abc]

Abstract

Conventional contracts and payment systems require significant information that depends heavily on manual processes, resulting in delays or non-payment for project stakeholders. Therefore, this study aimed to investigate the adaptability of payment automation in blockchain-enabled smart contracts for the Sri Lankan construction industry. The research adopted an interpretivism stance to collect the data through eleven semi-structured interviews with experts, selected through selective and snowball sampling. Manual content analysis was used to analyse the collected data. The findings revealed the importance of payment automation, challenges in traditional payment procedures, and the potential benefits of implementing blockchain-based smart contracts to automate payment processes in the Sri Lankan construction industry. The study presented a framework for overall findings. The findings add to the body of knowledge by revealing the viability of payment automation using blockchain-based smart contracts for the first time for the Sri Lankan construction industry by highlighting its ability to enhance transparency, security, and control through automated financial transactions.

Keywords: Blockchain; Construction Industry; Payment Automation; Smart Contracts; Sri Lanka

1. Introduction

The construction industry has always been one of the leading economic sectors in a country (Kudryavtseva & Vasileva, 2021). However, Peshkov (2019) highlighted that the continuing technological backwardness, energy consumption, and high consumption of materials are constraints to the development of the construction industry and the economy. Mishra (2017) revealed that the construction industry, as a multifaceted field, relies on the expertise of various industries to ensure successful project delivery. Thus, constantly increasing competition and challenges for construction enterprises, combined with the rapid development of information and communication technologies, require digitalising business processes related to this industry (Stoyanova, 2020). The use of cutting-edge technologies, such as robotics, artificial intelligence, computer vision-based monitoring, and Building Information Modelling (BIM), is becoming increasingly prevalent in the construction industry to capture, analyse, and monitor the construction process (Omar & Nehdi, 2016; Ham et al., 2016). For instance, by incorporating automation and BIM, different stakeholders can collaborate more effectively, identify potential issues, and execute tasks efficiently on-site (Chui & Mischke, 2019). The same authors elaborated that these innovations are transforming the construction industry and improving how projects are planned, designed, and constructed. Furthermore, Li et al. (2020) elaborated that the importance of Distributed Ledger Technology (DLT), such as blockchain, for collaborative efforts and smart contracts for streamlining the administration process is gradually gaining recognition

in the construction industry. Blockchain is considered a potential disrupter of the status core in the commercial sector, innovating in transactions, revolutionising industries and driving economic change on a global scale (Perera et al., 2020a).

Blockchain technology's traceability characteristic has encouraged collaboration among stakeholders in the Architecture, Engineering, and Construction (AEC) industry while enhancing the trustworthiness of data used in construction management systems (Turk & Klinc, 2017). In fact, Li et al. (2020) introduced a framework that leverages the Internet of Things (IoT), BIM and blockchain-based smart contracts to improve the tracking capabilities of maintenance and operation records for physical assets. Raslan et al. (2020) emphasised that the significant advantage of blockchain for asset information management systems is the ability to track modifications. The above studies represent a significant step toward establishing a shared and transparent view of information in the AEC industry.

Nonetheless, payment disputes stemming from poor payment practices present risks to stakeholders and projects (Luo et al., 2019a). Peters et al. (2019) considered that adequate cash flow management is imperative for construction and engineering organisations to ensure project success and financial stability. The introduction of smart contracts and blockchain technology to the AEC industry has introduced viable options for automating project management and contract administration, as noted by Mason (2017). In addition, Salleh (2020) has explained that eliminating third-party intermediaries and reducing manual work in payment processes have led to increased attention toward blockchain-based automation in recent years. Lauslahti et al. (2018) defined smart contracts as digital programs based on the blockchain consensus architecture, which will self-execute when the agreement terms are met. Since smart contracts are often put on and secured by blockchain, they have advantages over traditional contracts in terms of lowering transaction risk, reducing management and service costs, and enhancing business process efficiency (Xu et al., 2021).

Despite many studies that recognise the potential of smart contract base solutions in construction (Ahmadisheykhsarmast & Sonmez, 2018; Li et al., 2020; Hamledari & Fischer, 2021; Effah et al., 2023), there have been few past studies, namely Chaveesuk et al. (2020) and Azmi et al. (2022) on the adaptability of payment automation in developing countries. However, there is a lack of research to prove how payment automation can be adapted in the Sri Lankan construction sector using blockchain technology. Thus, this study aims to investigate the adaptability of payment automation in blockchain-enabled smart contracts for the Sri Lankan construction industry.

The rest of the paper is organised as follows: In Section 2, a comprehensive literature review is conducted. Section 3 discusses the methodologies adopted for the study. Section 4 covers data collection and analysis. The discussion of the collected data is presented in Section 5, and Section 6 offers the study's conclusions and recommendations.

2. Literature Review

2.1. Blockchain Based Smart Contracts in Construction Industry

Construction projects have always been a collaborative process involving a larger or smaller group of stakeholders working together (Turk & Klinc, 2017). Therefore, communication issues,

delays in payments, and disputes between parties are two of many issues in the construction industry (Rathnayake et al., 2022). To reduce this issue, Ye et al. (2022) suggested implementing blockchain-based smart contracts as one of the critical solutions. On the other hand, a study by Zaky and Nassar (2021) elaborated that most construction planning and design activities are now conducted digitally, with information being shared and transferred in digital form. Using their advantages, the blockchain and smart contracts could create a secure environment for payments and contractual activities (Mason, 2017).

Moreover, according to Hunhevicz et al. (2022), smart contract technology is highly desired to resolve contractual disagreements and payment issues due to the construction industry's heavy reliance on contracts. Cardeira (2017) claimed that it is possible to automate the progress interim payments by the system because of the integration of blockchain-based smart contracts and BIM. Additionally, the same author demonstrated a smart contract-based payment platform for use in multi-party contracts, in which the instructions for payments between the parties are written into the software.

2.2. Smart contracts for payment processing

One of the first practical applications of smart contracts and blockchain technology in industries is the automation of contract administration, payment process and project management activities (Ye et al., 2018). Due to the technology's elimination of third-party intermediaries and the human labour associated with payment processing, this study area has attracted more attention in recent years (Perera et al., 2020). Another application of smart contracts mentioned by Wang et al. (2017) was the ability to embed resources or cryptocurrencies inside the contract to protect against the insolvency of late payments and terminate payment and cash-flow problems. In an analysis of blockchain and smart contracts, Penzes (2018) determined that the main benefits of smart contracts were the improvement of payment transparency and the reliability of cost and schedule data. Figure 1 elaborates on the payment process through smart contracts.

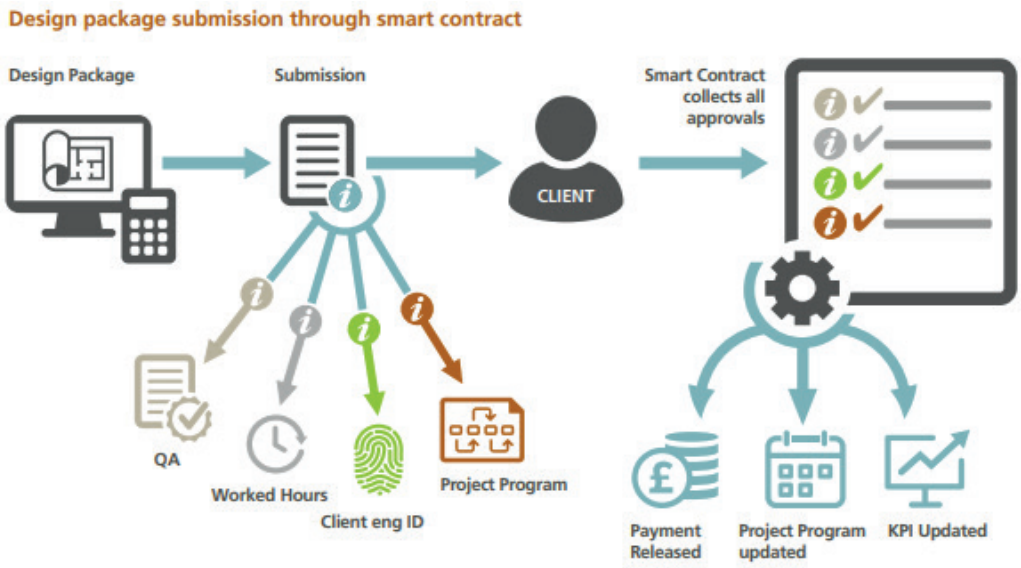


Figure 2 1: Payment process through smart contracts _ Source:(Penzes, 2018)

As shown in Figure 2-1, when a design is finished, the document control system can inform the smart contract that a design package has been submitted. The necessary parties are then notified to check the document, and as their ID is registered on the blockchain with their trustworthy digital signature, the document can be signed off. Further to Penzes (2018), all of these interactions are registered on the same blockchain platform; hence, smart contracts can initiate payments and project performance measure updates.

In the healthcare industry, a study by Omar et al. (2021) proposed a framework for automating procurement contracts using blockchain-based smart contracts; the authors suggest a decentralised Ethereum network that links manufacturers, distributors, group purchasing organisations, and healthcare providers through a blockchain-based contract. Furthermore, incorporating smart contracts into E-commerce was focused on Singh (2022), and the author noted that it improves the purchasing experience for both consumers and businesses, brings value to sellers, buyers, and vendors by creating trust between these parties, and streamlines their procedures. The platforms provided by e-commerce are ideal for creating smart contracts that can communicate with tokens because consumers can freely interact with their tokens with the help of the token ID's connection to the things they buy (Udokwu et al., 2018).

2.3. Payment Automation in Construction Industry

The construction industry is known for its complex payment processes, with multiple parties involved in each project, and payments are often delayed due to a lack of transparency and efficiency (Luo et al., 2019). Ahmadisheykhsarmast and Sonmez (2020), also noted that although payments are a construction project's principal funding source, consistent fund flows are uncommon in practice, and payment issues result in unfavourable outcomes like delays, higher costs, decreased performance, disputes, and bankruptcy.

According to Hamledari and Fischer (2021), various payment workflow phases must be computerised as scripts and run-on computing resources for construction payments to be automated. Further to the same authors, these phases involve, among other things, analysing on-site observations, valuation of work done, and ultimately, contract execution and the issue of money transfers. Nonetheless, Cardeira (2015) initially mentioned the potential for smart contracts to safeguard main contractors, subcontractors, and suppliers from the insolvency of the principle or late payments by utilising its self-executing and self-enforcing nature. Smart contracts are executed automatically to check pre-defined conditions of standard prohibitions and obligations (Luo et al., 2019). In traditional payment methods, general contractors gather conditional lien waivers: a written commitment by a subcontractor to waive the right to the property upon receiving payment for submitted invoices 3qas they prepare today's payment applications (Peters et al., 2019). However, these facilities are unavailable in a decentralised automated payment system because of eliminating third parties and manual payment applications (Omar & Nehdi, 2016). Overall, payment automation in the construction industry can improve efficiency, reduce errors and disputes, increase payment process transparency, help build stronger relationships between parties and promote greater collaboration and trust in the industry (Xu et al., 202).

3. Research Methodology

Given the innovative nature of the research within the construction industry, it is crucial to address the research questions through the lens of experience. In this particular study, the involvement of experts is imperative due to the research's focus on implementing a novel process within the construction industry. Thus, the qualitative approach was chosen as the most suitable approach to the study. Expert interviews emerge as the most suitable method for gathering data grounded in the personal experiences and expertise of the interviewees (Doyle et al., 2009). Therefore, expert interviews are most suitable for investigating the adaptability of payment automation using blockchain-based smart contracts in the Sri Lankan construction industry. The adoption of blockchain-based smart contracts is relatively recent in the Sri Lankan construction context, so the data collection process commenced with a small cohort of easily accessible practitioners. Subsequently, the sample size was expanded using the snowball sampling method, guided by recommendations from each participant to identify additional potential interviewees.

Table 3 1: Profile of Interviewees

Interviewee Code	Discipline	Years of Industry Experience	Awareness About Blockchain Technology/Smart Contracts
E1	Quantity Surveyor	15 years	Well Aware
E2	Quantity Surveyor	<10 years	Well aware
E3	Quantity Surveyor	>10 years	Well aware
E4	Project Engineer	>10 years	Aware
E5	Project Manager	15 years	Aware
E6	Quantity Surveyor	10 years	Aware
E7	Quantity Surveyor	<10 years	Aware
E8	Software Engineer	14 years	Well aware
E9	Quantity Surveyor	>10 years	Aware
E10	Quantity Surveyor	12 years	Aware
E11	Software Engineer	8 years	Well aware

These experts were selected based on their extensive experience in the construction industry, knowledge of blockchain technology, and involvement with technologies such as BIM, which are integral to implementing the new automated payment process. The collected data underwent analysis through manual content analysis and the findings are presented by a framework.

4. Research Findings

4.1. Importance of Payment Automation along with Challenges Inherent with Traditional Payment Processing

Respondents were asked to express their opinion on the importance of payment automation in the construction industry due to the issues with traditional payment processing. In response, E1 expressed, "The implementation of payment automation holds potential benefits, as it can speed up various processes and mitigate many issues." Supporting that, E2, E5 and E7 pointed out that dealing with many complex contracts can cause problems in the payment process. Therefore, a system that can simplify and automate the payment process can help to resolve those problems. However, E4 elaborated, "With the current technological background in the construction industry and technological facilities available for construction companies, there are practical issues automating the payment process, especially with several stakeholders that need to be willing to participate actively". Respondents E6, E8, and E9 identified BIM as a potential technology for payment automation if applied in the construction stage.

Moreover, technologies such as digital twin, Virtual Reality (VR), and Augmented Reality (AR) can significantly help monitor progress and find the required information for payment automation in a digital platform, as noted by E9. Concurrently, E2 and E11 shared insights into their organisations' utilisation of 5D BIM for cost estimation, 3D modelling for design, and progress monitoring. They highlighted how these technologies seamlessly provide requisite data and foster collaboration with other software in a unified BIM collaborative platform. Additionally, E1 drew attention to adopting drones, laser scanners, and Unmanned Aerial Vehicles (UAVs) for progress monitoring, a trend observed in the broader global construction industry. E3 elaborated, "Sub-contractors typically are paid when the main contractor is paid by the client. This is what creates many problems related to payment delays and then sub-contractors going into administration or bankruptcy because inability to manage cash flow".

Moreover, experts E1 and E3 pointed out that disputes about payment claims can emerge due to several factors. These include clients' struggles in comprehending payment terms, inaccuracies in claims submitted by contractors, unfair contract terms, inappropriate selection of standard forms of contract, failures on the part of consultants in processing claims, and insufficiencies in supporting documentation. Furthermore, as explained by respondent E6, unethical or fraudulent conduct by the payer and inadequate supervision and financial oversight from management can cause issues within the traditional payment process.

Subsequently, respondents were invited to provide insights into the potential for payment automation to address these identified issues in traditional methods. Most respondents agreed that payment automation holds promise in alleviating payment delays. Their justifications included reasons such as automated systems' ability to decrease the person-hours that can take to documentation, record data manually, and reduce errors if we take progress data from a fully digitalised 3D model. Further, it can simplify the payment process. According to E10 opinion, "Implementing automation ensures that clients and contractors need not concern themselves with the timing of payments. They can ascertain precisely when payments will be processed, and the extent of work completed up to that point." The respondents' overall issues with traditional payment procedures are depicted in Figure 2.

4.2. Benefits of using an automated payment processing

The respondents were asked to share their opinions on benefits that can be acquired using automated payment systems. According to E4, "Initial cost of implementing an automated system is high, but in the long term with the reduction of cost for payment process it can be cost effective". Further to E5 and E1, the cost of paper-based payment operations, such as printing checks and mailing invoices, can be decreased by automating payments, and it can lessen the possibility of late payment fines, which can mount up rapidly over time. E8 mentioned, "Using an automated system can help organisations to get paid quickly by automating the process and automating payment reminders and payment applications". E2 explained, "An automated payment system streamlines the payment process, saving time and money compared to manually managing payments. This makes it possible for payments to be processed more quickly and accurately, which can enhance cash flow and lower the possibility of mistakes or delays". E1 pointed out that with the automation of payment progress, most steps become digitised, simplifying the documentation and reducing data entry errors. E7, E8, and E9 have indicated the capability of minimising human errors in a traditional payment method by automating the payment process. Supporting that, E10 mentioned, "By removing human data input and the requirement for paper checks, payment automation can lower the risk of mistakes in payments. Accuracy may be increased while lowering the possibility of expensive errors". A summary of the benefits of adopting automated payment systems is presented in Figure 2.

4.3. Driving Factors for Blockchain Based Smart Contracts

It is crucial to understand why researchers think blockchain-based smart contracts are a viable option for payment automation in the construction industry. Thus, the respondents were questioned about the driving factors for blockchain-based smart contracts. The following are the critical factors under analysis

.

- **Disintermediation**

E1 and E2 highlighted that disintermediation removes mediators or intermediaries from a deal or a process, and it also enables direct P2P transactions without the need for intermediaries like banks or other financial institutions, which is a crucial component of blockchain technology. Supporting that E5 & E7 explained, no intermediaries are required, transaction costs are decreased, and security and transparency are improved. Further, E3 elaborated on how smart contracts adopt this concept, "With smart contracts, the details of the agreement between the buyer and seller are directly encoded into lines of code. These contracts self-execute. They are kept on a blockchain network, a distributed ledger that is decentralised and records transactions across a network of computers. Without the use of middlemen, smart contracts enable automatic and transparent transaction execution".

- **Decentralization**

According to E2, "Instead of having a centralised authority or institution in charge, it alludes to the distribution of power and control over a network of users that have access to the blockchain". E1 and E11 elaborated by saying that decentralisation in the context of blockchain smart contracts refers to the fact that the execution of the contract is distributed across a network of computers (referred to as nodes) that collectively validate and carry out the terms of the contract as opposed to being controlled by a single organisation. As E6 demonstrated, a distributed ledger called a blockchain network, which records transactions and data across a network of computers, is used to create decentralisation, and each node on the network participates in the validation and execution of transactions and possesses a copy of the blockchain.

. • **Increased security**

Seven out of eleven respondents agreed that blockchain networks can provide a better security system for the transaction process. According to their opinion, blockchain technology's decentralised and immutable characteristics make it able to offer a high level of security. Every transaction in a blockchain is documented in a safe, impenetrable ledger dispersed throughout a network of nodes. However, according to E6, E8, E9, and E11, it is crucial to remember that a blockchain network's security depends on several elements, including the type of algorithm employed, the resilience of the cryptographic protocols, and the security procedures the users follow.

- **Transparency**

According to E1, as a distributed ledger system, blockchain keeps track of every transaction and stores it on a network of computers. Further to E5, as everyone using the network can view the same data in real time, it produces a transparent system. E8 stated, "The code of a smart contract becomes available to all network users the moment it is placed on a blockchain, and the transactions that result from its execution are likewise visible". However, according to E4's opinion, transparency is rare in the construction industry

.

- **Auditability**

E4 explained that audibility in the context of smart contracts is the capacity to confirm the accuracy and security of the program code and the information recorded on the blockchain. This is significant because, according to E1, "Smart contracts are frequently used to manage delicate or expensive transactions, such as financial exchanges or the transfer of valuable items. Hence, when auditing data it is important to verify that data have not been altered". Moreover, according to E11, "Auditability is crucial for complicated or high-stakes smart contracts since even one mistake or flaw might cause huge financial losses or harm to the organisation and organisation's reputation".

- **Veracity**

According to E3, the high degree of trust and transparency gained through the immutability of the data recorded on the blockchain is one of the key advantages of adopting blockchain technology for smart contracts because it increases veracity. Further, E7 & E6 explained that smart contracts built on the blockchain rely on a network of nodes to authenticate and verify transactions, ensuring that each one is correct, and the contract is carried out as planned. E1 and E5 further elaborated on this: several blockchain platforms, including Ethereum, include in-built programming languages and tools that enable the development of smart contracts with terms and conditions. Thus, the truthfulness and dependability of the system may be further increased by designing these smart contracts to execute in response to specific triggers or events automatically. However, according to E8 and E11, it is essential to note that the veracity of a blockchain-based smart contract is only as good as the quality and accuracy of the data that is input into the system.

4.4. Barriers of Implementing Payment Automation in Sri Lankan Construction Industry

According to respondents, even though this technology can be applied to improve the efficiency of the payment process, there can be barriers and practical issues when initiating this method in construction projects. E3 mentioned, "From company to company, their payment styles are different. And processes that are followed can be different from each company to company so it might have to develop a system that accommodates many changes". E9 explained, "Developing

one single system that is applicable for every scenario can be difficult, construction contracts are different from one another, therefore it will need to incorporate different conditions and different algorithms. Coding and developing algorithms for scenarios can be difficult". If the software development tools and programming languages used to create smart contracts are not up to par, it can slow down the process and make it harder for developers to create and deploy smart contracts, as noted by E8 and E11. According to E1, E2, E3, E7, and E11, data management and security may be difficult because smart contract systems can be less successful if there are problems with data quality or security problems. E2 further elaborated that the interactions between several stakeholders, including owners, contractors, subcontractors, suppliers, and regulators, are frequently complicated and dynamic in the construction business. Therefore, establishing a shared framework and uniform standards that all parties may accept to deploy smart contracts may be challenging. Referring to Figure 2, we can observe all the barriers found throughout the study.

4.5. strategies to mitigate barriers to implement payment automation in the Sri Lankan construction industry

Respondents were asked about the strategies to overcome the above barriers discussed to successfully implement payment automation using blockchain-based smart contracts in the Sri Lankan construction industry. A lack of knowledge about how it operates and the advantages it offers is among the most significant barriers to payment automation and smart contracts. The respondents identified substantial steps to overcome the lack of knowledge and experience regarding payment automation and blockchain technology in the construction industry. A suggestion brought forward by E2 was to "Develop educational materials such as brochures, flyers, infographics, and videos that explain the benefits of payment automation in simple language. Use case studies and real-life examples to illustrate how payment automation can improve efficiency and reduce costs". E8 suggested that standardising payment terms can help to ensure consistency and transparency in the payment process, making it easier to automate.

Further to E2, using strategies like standardising billing formats that clearly outline the project details, payment terms, and payment instructions helps avoid confusion and streamline the payment process. E5 elaborated that a thorough awareness of legal and contractual concerns, such as payment schedules, retention policies, and lien rights, is necessary for payment automation, and by addressing these barriers, automated payments may be carried out appropriately and legally. E11 recommended providing standardised smart contract templates to ensure everyone participating in a building project knows the contract's provisions and is on the same page. Moreover, E7 pointed out that including legal professionals in the smart contract development process is a good strategy. Figure 2 summarises the strategies found through the data collection and analysis.

4.6. Discussion

The construction industry only depends a little on digitalisation at the current stage of development because the adoption of new technologies is relatively low compared to other industries (Fonseca, 2018). Accordingly, many authors have reviewed the application of payment automation using blockchain-based smart contracts in the construction industry in different studies (Kamel et al., 2023; Sigalov et al., 2021; Xu et al., 2023). This study is also subjectively studied using expert opinions in the Sri Lankan construction industry.

When considering the importance of payment automation in the construction industry, respondents had an overall positive attitude towards the concept, and all the respondents agreed that it could be helpful for an organisation's payment process if it can be appropriately implemented. Regarding issues in traditional payment systems, ten interviewees have identified that payment delays can happen due to inefficiencies in traditional payment methods. Most

respondents identified dishonesty, improper supervision, financial control, and non-payments as issues in traditional payment. Moreover, as per the analysis, the most agreed benefits were timesaving and reduced human errors in automation. Simplified documentation and high security were the least agreed benefits of payment automation by the findings.

Similar to the literature findings that pointed out issues in traditional payment practices (Hamledari & Fischer, 2021; Ahmadisheykhsarmast & Sonmez, 2020; Ramachandra & Rotimi, 2015), as per the findings, most of the respondents from this study also agreed on the traditional payment issues that can arise due to payment delays, disputes over claims, non-payments, and complications in contract terms and other issues. However, most of the respondents disagreed that the lack of transparency between stakeholders and the attitude of the payer could cause any issues according to their professional experience in traditional payment procedures.

When considering the driving factors, all the respondents identified decentralisation as a critical feature of blockchain-based smart contracts. According to the results, regarding security as a driving factor, even while blockchain technology has the potential to offer a high level of security, it is not impervious to security risks. It has to be correctly planned and implemented to guarantee its security. This further confirms the non-agreement of high security as a benefit of payment automation by most respondents in analysing the benefits of payment automation. According to most respondents, transparency is one of the primary characteristics of blockchain technology, particularly smart contracts built on the blockchain. Further to the respondents, auditability is a crucial component of smart contracts built on blockchains since it protects all blockchain transactions' security, integrity, and transparency. Further, all respondents agreed on the veracity that it is a driving factor when choosing blockchain-based smart contracts for payment automation in the construction industry. Accordingly, in the Sri Lankan construction industry, driving factors in using blockchain-based smart contracts for payment automation in the construction industry were proven as Disintermediation, Decentralisation, Increased security, Transparency, Auditability and Veracity.

According to the data analysis, all the respondents agreed that high initial cost, resistance to change, cyber security, technical complexity, legal compatibility, difficulty in integration with the current structure, unavailability of technologies and slow technological advancement are the main barriers to implementation blockchain-based smart contracts in Sri Lankan construction industry. Nine out of eleven agreed that regulatory issues, scalability, lack of industry-wide adoption, complex payment structure and employee knowledge level constraints are barriers. Most of the respondents rejected the data storage capacity and giving Training and knowledge on blockchain technology for employees as barriers to implementation.

To address these barriers to successfully implementing payment automation strategies were suggested. The suggested strategies were the Standardisation of the payment process, Educating the construction industry, encouraging the adoption of new technologies, addressing legal and regulation issues, using digitalised applications, addressing high storage capacity issues in the blockchain network and the scalability of the blockchain network. According to respondents, technology is necessary for payment automation, including electronic invoicing, electronic payments, and automated workflows. The construction sector must invest in solutions that automate the payment process and embrace technology to overcome the above barriers.

The overall study findings are presented in Figure 2 as a framework. Therefore, according to the study, the Sri Lankan construction industry had a positive perspective on Payment Automation in Blockchain-enabled Smart Contracts. While payment automation can streamline the construction industry's payment process, many challenges must be addressed to achieve efficiency and accuracy. Implementing payment automation systems in the construction industry using blockchain-based smart contracts requires careful consideration of these barriers and thorough planning, testing, and communication to ensure successful adoption and implementation.

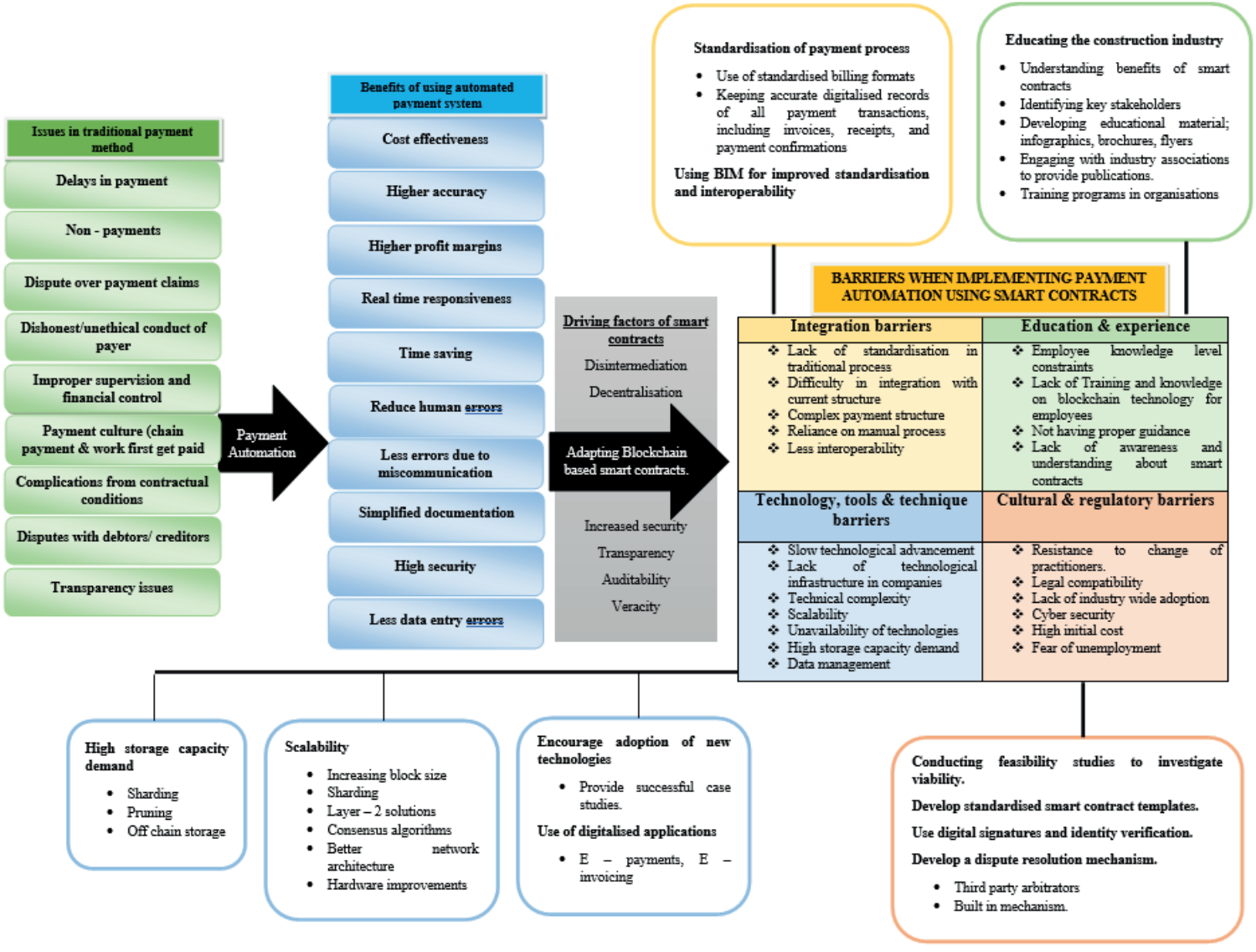


Figure 4 6 1: Payment Automation in Blockchain enabled Smart Contracts: Sri Lankan Construction Industry Perspective

5. Conclusions & Recommendations

The payment process in the construction industry is often characterised by manual and time-consuming procedures, leading to payment delays, disputes, and inefficiencies. Blockchain technology has emerged as a promising solution for streamlining payment processes in various industries in recent years. Blockchain-based smart contracts can automate payment processes, reduce transaction costs, and enhance transparency and accountability. This research investigated the adaptability of payment automation using blockchain-based smart contracts in the Sri Lankan construction industry.

A thorough literature review was conducted to identify the context to fulfil the study's aim. Then, the study explored the importance of payment automation and the challenges inherent in traditional payment processing. Accordingly, it was revealed that the Sri Lankan construction industry has a positive perspective towards this concept. Regarding issues in traditional payment systems, payment delays due to inefficiencies were identified. Moreover, the study identified significant benefits of payment automation as timesaving and reduced human errors in automation. The driving factors in using blockchain-based smart contracts for payment automation in the Sri Lankan construction industry were elaborated as Disintermediation, Decentralisation, Increased security, Transparency, Auditability and Veracity. Some key barriers to implementing blockchain-based smart contracts for payment automation are high initial cost, resistance to change, cyber security, technical complexity and legal compatibility. Finally, the study suggested strategies such as educating the construction industry, encouraging the adoption of new technologies, addressing legal and regulation issues, using digitalised applications and addressing high storage capacity issues in the blockchain network as suitable strategies to overcome those barriers. The study presented a framework for overall study findings to elaborate the findings.

Overall, from the perspective of the Sri Lankan construction industry, payment automation by blockchain-based smart contracts is adaptable with proper addressing of the barriers. This study contributed to the knowledge of the construction industry in Sri Lanka as well as in developing countries by exploring what needs to be done by the construction industry to implement payment automation using blockchain-based smart contracts successfully. It is recommended to educate the construction industry practitioners through training sessions, webinars, meetings and publications and encourage the adoption of new technologies and innovative ideas since the construction industry needs to catch up in digitalisation to adapt to novel technologies such as blockchain-based smart contracts. As further research direction, the payment automation process using blockchain-based smart contracts can be validated by evaluating a case study and following that approach in the construction industry.

6. References

1. Ahmadisheykhsarmast, S., & Sonmez, R. (2020). A smart contract system for security of payment of construction contracts. Automation in Construction, 120(October 2019), 103401. https://doi.org/10.1016/j.autcon.2020.103401

2. Azmi, N. Al, Sweis, G., Sweis, R., & Sammour, F. (2022). Exploring Implementation of Blockchain for the Supply Chain Resilience and Sustainability of the Construction Industry in Saudi Arabia. Sustainability (Switzerland), 14(11). https://doi.org/10.3390/su14116427

3. Baars, H., & Kemper, H.-G. (2015). Integration von Big Data-Komponenten in die Business Intelligence. Controlling, 27(4–5), 222–228. https://doi.org/10.15358/0935-0381 -2015-4-5-222

4. Bock, T. (2015). The future of construction automation: Technological disruption and the upcoming ubiquity of robotics. Automation in Construction, 59, 113–121. https://doi.org/10.1016/j.autcon.2015.07.022

5. Cardeira, H. (2015). Smart Contracts And Possible Applications To The Construction Industry. Romanian Construction Law Review, 1–6.

6. Cardeira, H. (2017). the Benefits of Integrating Smart Contracts and Bim Using an Xml Protocol. SoCLA The New Wave Annual Conference, 1–2. https://heldercardeira.com/1706P.pdf

7. Chaveesuk, S., Khalid, B., & Chaiyasoonthorn, W. (2020). Understanding Stakeholders Needs for Using Blockchain Based Smart Contracts in Construction Industry of Thailand: Extended TAM Framework. International Conference on Human System Interaction, HSI, 2020-June, 137–141. https://doi.org/10.1109/HSI49210.2020.9142675

8. Chui, M., & Mischke, J. (2019). Global Infrastructure Initiative The impact and opportunities of automation in construction Courtesy of Autodesk: Royal BAM Group's BAM Infra and Saint-Gobain Weber Beamix demonstrate the use of a 3-D printing robot for offsite manufacturing for construct. 4–7.

9. Effah, E. A., Edwards, D. J., Kumar, B., & Thurairajah, N. (2023). Northumbria Research Link. March.

10. Elghaish, F., Abrishami, S., & Hosseini, M. R. (2020). Integrated project delivery with blockchain: An automated financial system. Automation in Construction, 114(June), 103182. https://doi.org/10.1016/j.autcon.2020.103182

11. Fonseca, L. M. (2018). Industry 4.0 and the digital society: concepts, dimensions and envisioned benefits. Proceedings of the International Conference on Business Excellence, 12(1), 386–397. https://doi.org/10.2478/picbe-2018-0034

12. Ham, Y., Han, K. K., Lin, J. J., & Golparvar-Fard, M. (2016). Visual monitoring of civil infrastructure systems via camera-equipped Unmanned Aerial Vehicles (UAVs): a review of related works. Visualization in Engineering, 4(1), 1–8. https://doi.org/10.1186/s40327-015-0029-z

13. Hamledari, H., & Fischer, M. (2021). Construction payment automation using blockchain-enabled smart contracts and robotic reality capture technologies. Automation in Construction, 132(October), 103926. https://doi.org/10.1016/j.autcon.2021.103926

14. Kamel, M. A., Bakhoum, E. S., & Marzouk, M. M. (2023). A framework for smart construction contracts using BIM and blockchain. Scientific Reports, 13(1). https://doi.org/10.1038/s41598-023-37353-0

15. Li, J., Kassem, M., & Watson, R. (2020). A Blockchain and Smart Contract-Based Framework to Inrease Traceability of Built Assets. 347–362. https://doi.org/10.46421/2706-6568.37.2020.paper025

16. Luo, H., Das, M., Wang, J., & Cheng, J. C. P. (2019a). Construction payment automation through smart contract-based blockchain framework. Proceedings of the 36th International Symposium on Automation and Robotics in Construction, ISARC 2019, Isarc, 1254–1260. https://doi.org/10.22260/isarc2019/0168

17. Luo, H., Das, M., Wang, J., & Cheng, J. C. P. (2019b). Construction payment automation through smart contract-based blockchain framework. Proceedings of the 36th International Symposium on Automation and Robotics in Construction, ISARC 2019, May, 1254–1260. https://doi.org/10.22260/isarc2019/0168

18. Mason, J. (2017). Intelligent Contracts and the Construction Industry. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 9(3), 04517012. https://doi.org/10.1061/(asce)la.1943-4170.0000233

19. Mishra, D. (2017). Related Papers. In Over The Rim (191–199). Utah State University Press. https://doi.org/10.2307/j.ctt46nrzt.12

20. Omar, T., & Nehdi, M. L. (2016). Data acquisition technologies for construction progress tracking. Automation in Construction, 70, 143–155. https://doi.org/10.1016/j.autcon.2016.06.016

21. Penzes, B. (2018). Technology in the. BLOCKCHAIN TECHNOLOGY IN THE CONSTRUCTION INDUSTRY Digital Transformation for High Productivity, December.

22. Perera, S., Nanayakkara, S., Rodrigo, M. N. N., Senaratne, S., & Weinand, R. (2020). Blockchain technology: Is it hype or real in the construction industry? Journal of Industrial Information Integration, 17(July). https://doi.org/10.1016/j.jii.2020.100125

23. Peshkov, A. V. (2019). Digitalization of the economy, implementation of national projects and development of the construction industry. IOP Conference Series: Materials Science and Engineering, 667(1). https://doi.org/10.1088/1757-899X/667/1/012074

24. Peters, E., Subar, K., & Martin, H. (2019). Late Payment and Nonpayment within the Construction Industry: Causes, Effects, and Solutions. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 11(3), 04519013. https://doi.org/10.1061/(asce)la.1943-4170.0000314

25. Ramachandra, T., & Rotimi, J. O. B. (2015). Causes of payment problems in the New Zealand construction industry. Construction Economics and Building, 15(1), 43–55. https://doi.org/10.5130/ajceb.v15i1.4214

26. Raslan, A., Kapogiannis, G., Cheshmehzangi, A., Tizani, W., & Towey, D. (2020). Blockchain: Future Facilitator of Asset Information Modelling and Management? Proceedings - 2020 IEEE 44th Annual Computers, Software, and Applications Conference, COMPSAC 2020, January 2021, 523–528. https://doi.org/10.1109/COMPSAC48688.2020.0-199

27. Rathnayake, I., Wedawatta, G., & Tezel, A. (2022). Smart Contracts in the Construction Industry: A Systematic Review. Buildings, 12(12). https://doi.org/10.3390/buildings12122082

28. Sigalov, K., Ye, X., König, M., Hagedorn, P., Blum, F., Severin, B., Hettmer, M., Hückinghaus, P., Wölkerling, J., & Groß, D. (2021). Automated payment and contract management in the construction industry by integrating building information modeling and blockchain-based smart contracts. Applied Sciences (Switzerland), 11(16). https://doi.org/10.3390/app11167653

29. Singh, K. K. (2022). Application of Blockchain Smart Contracts in E-Commerce and Government. March, 1–38. http://arxiv.org/abs/2208.01350

30. Turk, Ž., & Klinc, R. (2017). Potentials of Blockchain Technology for Construction Management. Procedia Engineering, 196(June), 638–645. https://doi.org/10.1016/j.proeng.2017.08.052

31. Udokwu, C., Kormiltsyn, A., Thangalimodzi, K., & Norta, A. (2018). An Exploration of Blockchain enabled Smart-Contracts Application in the Enterprise. Technical, June, 1–28. https://doi.org/10.13140/RG.2.2.36464.97287

32. WANG, J., WU, P., WANG, X., & SHOU, W. (2017). The outlook of blockchain technology for construction engineering management Frontiers of Engineering Management, 4(1), 67. https://doi.org/10.15302/J-FEM-2017006

33. Xu, Y., Tao, X., Das, M., Kwok, H. H. L., Liu, H., Wang, G., & Cheng, J. C. P. (2023). Suitability analysis of consensus protocols for blockchain-based applications in the construction industry. In Automation in Construction (Vol. 145). https://doi.org/10.1016/j.autcon.2022.104638

34. Ye, X., Zeng, N., & König, M. (2022). Systematic literature review on smart contracts in the construction industry: Potentials, benefits, and challenges. Frontiers of Engineering Management, 9(2), 196–213. https://doi.org/10.1007/s42524-022-0188-2

35. Ye, Z., Yin, M., Tang, L., & Jiang, H. (2018). Cup-of-Water Theory: A Review on the Interaction of BIM, IoT and Blockchain During the Whole Building Lifecycle. ISARC 2018 - 35th International Symposium on Automation and Robotics in Construction and International AEC/FM Hackathon: The Future of Building Things, Isarc. https://doi.org/10.22260/ISARC2018/0066

36. Zaky, A., & Nassar, A. H. (2021). The Potentials Of Using Smart Contracts In The Construction Industry. International Journal of Scientific & Technology Research, 10(09). www.ijstr.org

THE CURRENT STATUS OF SMALL AND MEDIUM CONTRACTORS IN SRI LANKA: GOVERNANCE, LEGAL PROSPECTS AND INDUSTRY RETENTION OPPORTUNITIES

Lalith Ratnayake[1], MRDP Wijerathna[2] and KATO Ranadewa[2]
[1] VFORM Consultants Pvt. Ltd.
[2]Department of Building Economics, University of Moratuwa, Sri Lanka

Abstract

The governance and legal provisions for small and medium enterprise (SME) contractors in Sri Lanka remain an underexplored area, despite their critical role in driving economic growth and infrastructure development. This study addresses this gap by providing a comprehensive investigation into the current status of SME contractors in Sri Lanka, with a particular focus on reviewing the legal provisions related to them. The research adopts a qualitative approach, employing documentary and systematic literature reviews to derive key insights into this vital sector.

Findings reveal that SME contractors play a pivotal role in the construction industry, particularly in high-demand areas such as building and highway projects. They contribute significantly to meeting labour demands, efficient resource allocation, and the execution of national infrastructure projects. However, their potential is constrained by multiple challenges, including limited access to finance, inadequate business acumen, regulatory barriers, and low adoption of digital technologies. These issues are further exacerbated by economic instability, inconsistent policy support, and a fragmented legal framework that fails to address their specific needs effectively. Therefore, this study highlights critical shortcomings in governance and support systems for SME contractors, emphasizing the need for strategic interventions. Key recommendations include fostering policy coherence, enhancing financial facilitation, and promoting technological adoption to improve the sustainability and competitiveness of SME contractors. The research contributes to academia by expanding the knowledge base on SME contractors in emerging economies and offers actionable insights for policymakers and industry stakeholders. Furthermore, it emphasizes the potential for comparative analyses with global SME contexts to inform robust strategies tailored to local challenges and opportunities.

Keywords: Challenges, Construction industry, Legal provisions, SME Contractors, Sri Lanka

1. Introduction

Small and Medium Enterprises (SMEs) are pivotal to the economic structures of countries, contributing to employment creation, poverty alleviation, and national economic growth. SMEs are generally characterized by their size in terms of revenue, assets, or employee count, though these criteria vary widely across regions and industries (Madhavika et al., 2024; Tewari et al., 2013). In the construction industry, company classification as a SME is often determined by the number of employees and annual turnover (Makabate et al., 2022; Ranadewa et al., 2018). Despite their significant contributions, the lack of a universally accepted definition complicates SME-related research (Acar et al., 2005; Nowotarski & Paslawski, 2017). In Sri Lanka, the definitions and classifications of SMEs differ across institutions. The Inland Revenue Act No. 24

of 2017, for instance, defines SMEs based on gross turnover thresholds, while other organisations focus on employee counts or turnover. However, SMEs in Sri Lankan construction industry are categorised by the number of employees and their annual turnover as per the registration under the Construction Industry Development Authority (CIDA). According to Ranadewa et al. (2018), medium-sized contractors have an annual turnover between Rs. 250–750 million, while small-sized contractors report a turnover of Rs. 16–250 million.

Globally, SMEs constitute the majority of businesses and contribute significantly to economic development. They are responsible for approximately 90% of all businesses and more than 50% of jobs worldwide, with formal SMEs in emerging economies contributing up to 40% of GDP (Ardic et al., 2011; McCourtie, 2013). Within the construction sector, SMEs play a critical role in sustaining the economy by creating employment opportunities, supporting larger enterprises, and driving infrastructural development (Agwu, 2014; Kamal & Flanagan, 2014). Furthermore, as larger firms increasingly subcontract SMEs to maintain operational efficiency, the SMEs role in the supply chain becomes indispensable (Fulford & Standing, 2014; Tezel et al., 2020).

SMEs play a pivotal role in maintaining the economic fabric of Sri Lanka, contributing significantly to employment, GDP and social stability (Rathnasinghe, 2024). SMEs are actively involved in building, repairing, renovating, and maintaining infrastructure, serving as a critical component in meeting the construction industry's labour and resource needs (Madhavika et al., 2024). Construction SMEs facilitate the execution of national infrastructure projects, thereby driving economic progress and creating employment opportunities. Their contributions are essential for improving accessibility and sustaining growth in high-demand categories such as residential and highway projects (Dasanayaka, 2010; Ranadewa et al., 2018; Rathnasinghe, 2024). They comprise over 75% of all businesses, provide employment for 45% of the workforce, and contribute 52% of the national GDP (Ministry of Industry and Commerce, 2016).

Several studies have investigated various aspects of SMEs in the Sri Lankan construction sector. Dasanayaka (2010) investigated the concentration of small industries in Western districts, such as Colombo, and identified regional disparities in SME distribution. Ranadewa et al. (2018) examined the financial challenges faced by construction SMEs and Lebunu Hewage et al. (2024) and Rathnasinghe (2024) examined the risk management in Sri Lankan SME construction sector. Additionally, Ranadewa et al. (2018) conducted a SWOT analysis for construction SMEs in Sri Lanka.

While SMEs are integral to the construction sector, existing literature and studies often provide fragmented insights into their definition, contributions, and the difficulties they encounter. Furthermore, there is a lack of detailed investigation regarding the adequacy of legal provisions and governance structures in supporting SME contractors. This gap highlights the need for a focused investigation into how these factors collectively influence the performance of SMEs in the Sri Lankan construction industry. The research gap is further accentuated by the lack of a thorough review of the legal provisions specifically governing small and medium-sized enterprise (SME) contractors in Sri Lanka's construction industry. Although legal frameworks exist, there is limited analysis of how well these provisions address the unique challenges faced by construction SMEs. The absence of detailed research on the effectiveness and adequacy of these legal structures leaves a gap in understanding how current regulations impact SME contractors'

operations, growth, and sustainability. Therefore, this study aims to fill this gap by investigating the current status of SME contractors in Sri Lanka's construction industry. Specifically, the research seeks to: (1) to identify the definition of SMEs in Sri Lanka (2) to investigate the contribution of SME contractors to Sri Lankan construction industry (3) to identify the problems associated with the SME contractors (4) to review the legal provisions in Sri Lanka and to investigate the shortcomings of current governance and legal provisions related to SME contractors.

2. Research Methodology

This study adopts a qualitative research approach, which is particularly well-suited for exploring the complex and multifaceted nature of the challenges and contributions of SME contractors in Sri Lankan construction industry. Qualitative research is recognised for its capacity to provide rich, contextualised insights, especially when addressing intricate socio-economic and institutional dynamics (Creswell, 2009). The study follows a systematic research process, as illustrated in Figure 1.

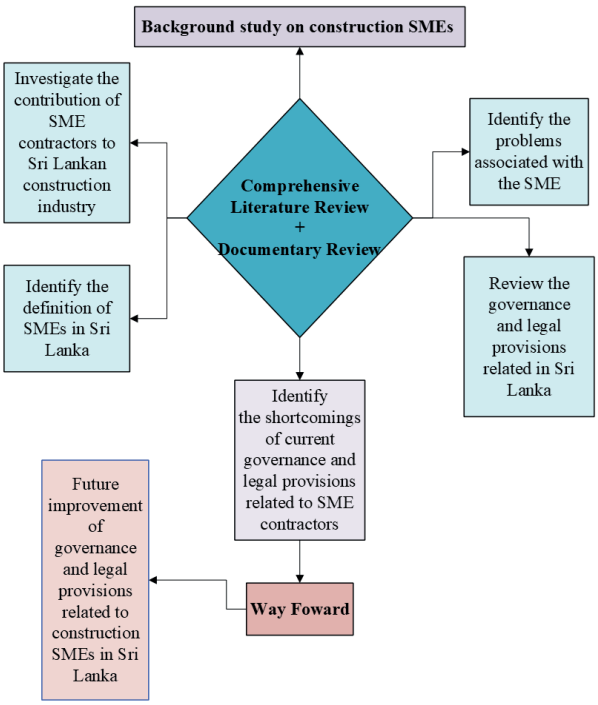


Figure 2 0 1: Research Process

This study begins with a background study to establish the context of SME contractors in Sri Lanka's construction industry. The process continues with a comprehensive literature review and documentary review to investigate critical aspects such as SME contributions, challenges, definitions, and governance frameworks. The findings are then analysed to identify shortcomings in current governance and legal provisions, leading to the development of recommendations for improvement.

2.1 Data Collection

To achieve the objectives of the study, two data collection methods were employed: a literature review and a documentary review as detailed below.

2.1.1 Literature review

The literature review was conducted to systematically identify and evaluate existing academic knowledge on SMEs in the construction sector. Peer-reviewed journal articles, conference proceedings, and relevant grey literature were retrieved using structured search queries in reputable academic databases. This method is particularly effective for synthesising diverse sources of information and uncovering theoretical frameworks, contradictions, and trends (Sileyew, 2020). The review focused on topics such as SME definitions, classifications, economic roles, challenges, and policy landscapes.

2.1.2 Documentary review

The documentary review complemented the literature review by focusing on non-academic sources such as policy documents, legal provisions, and governance frameworks. This approach provided practical insights into the institutional and regulatory environment within which SMEs operate, enabling a deeper understanding of their challenges and contributions. Documentary reviews are particularly useful for qualitative research as they bridge theoretical perspectives with empirical realities (Williams, 2007).

2.2 Data Analysis

The selected literature was analysed using content analysis, a method that allows for the systematic identification of patterns, themes, and insights within textual data (Ullah & Ameen, 2018; Williams, 2007). This approach enables the categorization and coding of information to uncover relationships and trends relevant to SME contractors in the construction sector. Content analysis is particularly effective for qualitative studies as it facilitates the extraction of meaningful insights while maintaining methodological rigour (Ullah & Ameen, 2018). The insights generated through content analysis not only illuminated the governance and legal challenges faced by SMEs but also highlighted opportunities for improvement within the Sri Lankan construction industry. By integrating a literature review, documentary review, and content analysis, this research methodology provides a comprehensive and methodologically robust framework for addressing the objectives of the study.

3. Research Findings

3.1 Definition for SMEs in Sri Lanka

In Sri Lanka, various organizations use different definitions to classify SMEs for distinct purposes. Primarily, the SME policy framework defines SMEs based on the number of employees and annual turnover (Amaradiwakara & Gunatilake, 2017). Table 1 presents the SMEs as micro, small, and medium enterprises in the manufacturing and services sectors in Sri Lanka.

Table 3 0 1: Definitions of Medium, Small and Micro-Sized Enterprises in Sri Lanka

Sector	Criteria	Medium	Small	Micro	Reference
Manufacturing Sector	Annual Turnover	Rs. 251 – 750 million	Rs.16 - 250 million	Less than Rs.15 million	National Policy Framework for SME Development (2014)
	No. of Employees	51 - 300	11 - 50	Less than 10	
Services Sector	Annual Turnover	Rs. 251 – 750 million	Rs.16 - 250 million	Less than Rs.15 million	
	No. of Employees	51 - 200	11 - 50	Less than 10	
All Sectors	Annual gross turnover	less than Rs. 500,000,000.			Inland Revenue Act, No. 24 of 2017
Construction Sector	Annual Turnover	Rs. 250 - 750 million	Rs. 16 - 250 million		Ranadewa et al. (2018)
	Grade as per CIDA	Grade C3 to C2	Grade C6 to C4		

Table 1 presents the classification of SMEs in the manufacturing and services sectors, with specific limits for annual turnover and number of employees for micro, small, and medium enterprises. For example, in the manufacturing sector, medium enterprises are those with an annual turnover between Rs. 251 and 750 million and between 51 and 300 employees, while micro enterprises have an annual turnover of less than Rs. 15 million and fewer than 10 employees. This classification is consistent across both manufacturing and services sectors.

Additionally, the Inland Revenue Act, No. 24 of 2017 also provides a definition to the SMEs; "Small and Medium Enterprise" means a person who satisfies the following conditions:

a) the person who conducts business solely in Sri Lanka other than an individual who is engaged in providing professional services individually or in partnership being an individual who is professionally qualified.
b) the person does not have an associate that is an entity, and
c) the person's annual gross turnover is less than Rs. 500,000,000.

It may be noted that there are different terms used in different documents to identify this sector as Small and Medium Enterprises (SME), Micro, Small and Medium Enterprises (MSME), Rural Enterprises, Small and Medium Activities, Cottage and Small-Scale Industries, and so on (Gamage, 2003).

In the construction sector, despite their significant contribution to the country's economic development, there is no formal or universally recognized definition of SMEs (Perera et al., 2014; Ranadewa et al., 2015). Ranadewa et al. (2018) proposed a definition for construction

SMEs, categorizing medium-sized contractors as those with an annual turnover between Rs. 250 million and Rs. 750 million (Grade C3 to C2) and small-sized contractors with a turnover between Rs. 16 million and Rs. 250 million (Grade C6 to C4), based on the classification by CIDA. This turnover-based categorization helps to provide a clearer definition for the construction SME sector in Sri Lanka, recognizing its critical role in the nation's economic progress.

3.2 Contribution of SME contractors to Sri Lankan construction industry

The statistics of CIDA highlight the pivotal role of SMEs in Sri Lanka's construction sector. Mainly, the contractors are classified into two main areas: main contractors and specialist contractors. Main contractors encompass sectors such as Building Construction, Highway Construction, Bridge Construction, Water Supply and Sewerage, Irrigation and Drainage Canals, Dredging and Reclamation, Storm Water Disposal and Land Drainage, Maritime Construction, and Heavy Construction, categorized under grades CS2 – C9.

Specialist contractors are divided into Electrical & Mechanical Services (EM), Specialized Construction Contractors (SP-C) and Piling Contractors (GP-P). under the specialized construction contractors, there are several types of contractors included as Aluminium and Finishes (A&F), Floor, Wall and Ceiling Finishes (FW&C), Carpentry and Joinery, Light Metal Work (ME), Landscaping (LA), Furniture, Fittings & Equipment (FF&E), Water Proofing (WP), Swimming Pools (SP) and so on. Therefore, the following tables show the total number of main contractors and specialist contractors in Sri Lanka from 2020 to 2023. Further, the contractors are classified as SMEs based on the Inland Revenue Act No. 24 of 2017, which defines SMEs as entities with an annual gross turnover of less than Rs. 500,000,00. According to these criteria, CS2, CS1 and C1 contractors can be identified as large-scale contractors and C2-C9 and all other specialist contractors are identified as SMEs. Table 2 presents the main contractors registered from 2020 to 2023 in Sri Lanka.

Table 3 0 2:Main Contractors Registered In 2020-2023

Year	Category	Financial Limit (Rs. Million)	Building	Highway	Bridge	Water Supply and Sewerage	Irrigation and Drainage Canals	Dredging and Reclamation	Storm Water Disposal and Land Drainage	Maritime Construction	Heavy Construction
	Grade	Number of Small and Medium Contractors Registered in Each Field and Category									
2020	C2	600 - 300	47	21	4	10	4	-	1	-	-
	C3	300 - 150	49	31	1	8	6	-	1	-	-
	C4	150 - 50	287	145	18	44	41	2	4	2	-
	C5	50 - 25	310	129	17	30	32	1	3	1	-
	C6	25 - 10	451	223	12	45	41	2	9	1	-
	C7	10 - 05	1017	608	462	433	575	353	280	81	-
	C8	05 - 02	392	195	-	137	168	81	99	15	-
	C9	02 ≥ X	87	41	-	37	32	16	18	5	-
	Total		2640	1393	514	744	899	455	415	105	-
2021	C2	600 - 300	47	19	3	9	5	1	1	-	-
	C3	300 - 150	49	26	-	7	5	-	1	-	-
	C4	150 - 50	251	138	22	43	39	2	3	1	-
	C5	50 - 25	262	119	18	27	47	3	5	1	-
	C6	25 - 10	387	200	15	46	51	1	8	1	-
	C7	10 - 05	832	499	388	383	458	230	245	67	2
	C8	05 - 02	317	158	-	117	126	57	68	12	-
	C9	02 ≥ X	63	25	-	29	21	10	19	5	-
	Total		2208	1184	446	661	752	304	350	87	2
2022	C2	600 - 300	40	19	-	9	3	1	1	-	-
	C3	300 - 150	38	21	2	9	8	1	-	-	1
	C4	150 - 50	223	109	12	37	40	2	5	-	-
	C5	50 - 25	226	103	12	27	42	1	3	1	-
	C6	25 - 10	332	175	12	41	36	1	6		-
	C7	10 - 05	629	326	228	250	332	163	162	45	-
	C8	05 - 02	243	110	1	76	93	60	42	13	-
	C9	02 ≥ X	49	19	-	19	12	7	11	-	-
	Total		1780	882	267	468	566	236	231	59	1
2023	C2	600 - 300	36	15	1	8	1	-	1	-	-
	C3	300 - 150	38	16	2	7	9	-	1	-	-
	C4	150 - 50	193	109	12	41	27	-	2	-	-
	C5	50 - 25	212	103	14	25	38	-	3	1	-
	C6	25 - 10	308	135	18	35	38	1	5	-	-
	C7	10 - 05	499	285	202	230	253	137	111	43	-
	C8	05 - 02	214	91	1	69	88	49	41	2	-
	C9	02 ≥ X	30	11	-	18	11	7	9	-	-
	Total		1530	765	250	433	465	194	173	46	-

The data from CIDA illustrates significant trends in the participation of SME contractors in Sri Lanka's construction industry from 2020 to 2023, as shown in Table 2. A notable decline in the total number of registered contractors is evident, dropping from 2,640 in 2020 to 1,530 in 2023. This reduction is most pronounced in lower grades (C7–C9), which consistently account for the largest portion of SME contractors but have seen a sharp decline, particularly in C7, which fell from 1,017 to 499 during this period. In contrast, higher grades (C2–C4), representing contractors with larger financial capacities, have remained relatively stable but account for fewer participants overall. Figure 1 presents the trends in SME contractor registrations over the years.

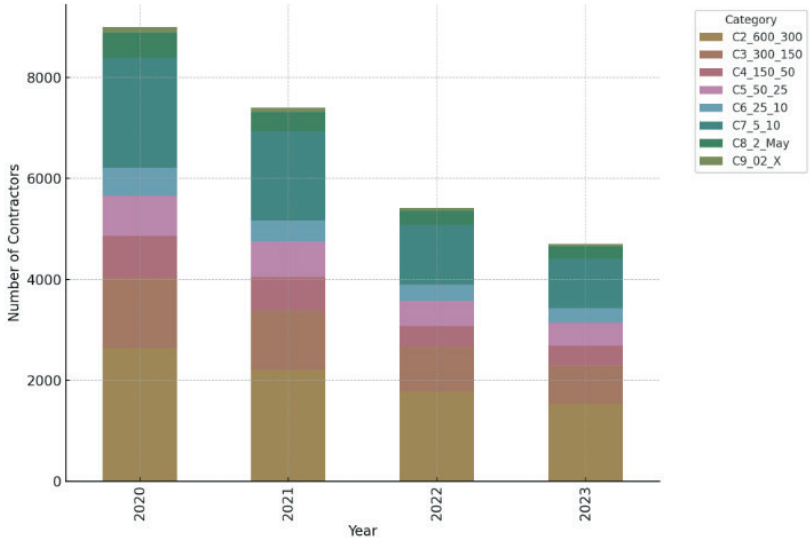


Table 3 0 3:Tends in SME contractor registrations over the years

According to Figure 1, there has been a noticeable decline in SME contractor registrations during the years 2020–2023, primarily due to the impacts of the COVID-19 pandemic and the subsequent economic crisis, as reported by the Department of Census and Statistics. Accordingly, field-specific analysis reveals that building construction dominates SME activity, particularly in grades C7 and C8, highlighting its accessibility and demand. In 2023, 765 contractors were engaged in building projects, compared to smaller numbers in specialised fields such as highway construction and irrigation. Maritime construction and dredging remain niche areas, with minimal representation. These trends highlight disparities in SME participation across fields and grades, highlighting the challenges lower-grade contractors face in sustaining operations and competing in more specialised sectors. Table 3 presents the specialised contractors registered from 2020 to 2023 in Sri Lanka

Table 3 0 4: Specialised Contractors Registered In 2020-2023

Year	Category	Financial Limit (Million)	No. of Contractor	Category	Financial Limit (Million)	No. of Contractor	Category	Financial Limit (Million)	No. of Contractor
2020	EM1	X ≥ 50	131	SP1	X ≥ 50	46	GP B1	X ≥ 150	11
	EM2	50 ≥ X > 25	78	SP2	50 ≥ X > 25	39	GP B2	150 ≥ X > 50	1
	EM3	25 ≥ X > 10	34	SP3	25 ≥ X > 10	20	GP B3	50 ≥ X > 10	2
	EM4	10 ≥ X > 02	168	SP4	10 ≥ X > 02	52	GP B4	10 ≥ X	1
	EM5	02 ≥ X	69	SP5	02 ≥ X	23			
	Total		480			180			15
2021	EM1	X ≥ 50	125	SP1	X ≥ 50	44	GP B1	X ≥ 150	11
	EM2	50 ≥ X > 25	71	SP2	50 ≥ X > 25	37	GP B2	150 ≥ X > 50	1
	EM3	25 ≥ X > 10	30	SP3	25 ≥ X > 10	19	GP B3	50 ≥ X > 10	2
	EM4	10 ≥ X > 02	147	SP4	10 ≥ X > 02	43	GP B4	10 ≥ X	1
	EM5	02 ≥ X	55	SP5	02 ≥ X	18			
	Total		428			161			15
2022	EM1	X ≥ 50	119	SP1	X ≥ 50	41	GP B1	X ≥ 150	9
	EM2	50 ≥ X > 25	63	SP2	50 ≥ X > 25	35	GP B2	150 ≥ X > 50	1
	EM3	25 ≥ X > 10	26	SP3	25 ≥ X > 10	16	GP B3	50 ≥ X > 10	2
	EM4	10 ≥ X > 02	120	SP4	10 ≥ X > 02	39	GP B4	10 ≥ X	1
	EM5	02 ≥ X	39	SP5	02 ≥ X	15			
	Total		367			146			13
2023	EM1	X ≥ 50	107	SP1	X ≥ 50	38	GP B1	X ≥ 150	8
	EM2	50 ≥ X > 25	55	SP2	50 ≥ X > 25	31	GP B2	150 ≥ X > 50	2
	EM3	25 ≥ X > 10	20	SP3	25 ≥ X > 10	12	GP B3	50 ≥ X > 10	-
	EM4	10 ≥ X > 02	98	SP4	10 ≥ X > 02	36	GP B4	10 ≥ X	-
	EM5	02 ≥ X	33	SP5	02 ≥ X	14			
	Total		313			131			10

Table 3 indicates the specialised contractors registered from 2020 to 2023 according to CIDA. A consistent decline is observed in the total number of contractors across all categories. For instance, EM contractors decreased from 480 in 2020 to 313 in 2023, while SP contractors dropped from 180 to 131, and GP B contractors fell from 15 to 10. The data indicates that higher-grade contractors (EM1, SP1, GP B1) with greater financial capacities have fewer participants, reflecting barriers to entry in high-value projects. Conversely, lower grades (EM4, EM5, SP4, SP5) dominate in numbers but exhibit a sharper decline over the years, possibly due to financial and operational challenges. GP B contractors remain the smallest category throughout, with a minimal presence in all financial ranges, indicating limited activity in general-purpose

building construction. These trends emphasize the need for targeted support to sustain SME participation, particularly in lower grades and specialised sectors.

The data from 2020 to 2023 highlight the dominant position of SMEs in Sri Lanka's construction sector, consistently accounting for over 97% of registered contractors annually. However, the overall number of registered contractors declined significantly during this period, dropping from 7,954 in 2020 to 4,413 in 2023. This reduction is mirrored in the SME sector, which saw a decrease from 7,840 in 2020 to 4,310 in 2023, illustrating the challenges faced by smaller contractors. These declines highlight the pressing need for targeted policies and support mechanisms to sustain SMEs, as they play a critical role in the sector's resilience and growth.

When comparing the performance of SMEs to main contractors, it is evident that SMEs experience more significant reductions year over year. Between 2020 and 2023, SME registrations fell by 45%, while the total number of contractors declined by 44.5%, with SMEs bearing the brunt of the decrease. Specialist SME contractors, critical to high-value and export-oriented projects, also saw a marked decline, with reductions of 10.96% in 2020–2021, 12.91% in 2021–2022, and 13.69% in 2022–2023. These trends suggest that SMEs, especially those in specialised fields, are particularly vulnerable to economic and structural challenges, jeopardising the broader industry's ability to maintain innovation and meet international standards.

3.3 Problems Associated with Construction SMEs in Sri Lanka

SMEs are considered the backbone of the economy not just in developing nations but also in industrialized nations such as the United States of America (Fernando & Samarakoon, 2021). Since SMEs directly contribute to the country's economy, there are several issues and challenges related to them that can be understood in developing countries such as Sri Lanka than the developed countries. Sometimes, this leads to SMEs in low productivity compared to large firms (Central Bank of Sri Lanka, 2023). Therefore, it is significant to identify the issues related to SMEs in order to take the proper mitigation strategies for those issues. Table 4 summarises the problems associated with construction SMEs in Sri Lanka.

Table 3 0 5: Problems Associated with SMEs In Sri Lanka

Challenges	Source
Limited access to finance	[1], [5], [6], [7], [9], [10]
Limited business skills and inability to retain human Resources	[1], [2], [5], [6], [7]
Low market share and limited access to markets	[1], [5], [6], [7], [9], [10]
Regulatory restrictions	[1], [5], [7]
Impact of the pandemic and economic crisis	[1], [6], [7], [8], [9]
Inadequate institutional support	[2], [5], [6], [7], [8], [9], [10]
Low tendency towards adopting E-Commerce / E-Marketing	[3], [5], [8], [9]
The suspension of Parate Executions	[4]
Technical problems (design failures, estimation errors)	[5], [6], [7], [8], [9], [10]
Quality issues (poor workmanship, waste, low productivity)	[5], [6], [7], [8], [9]
Lack of skilled workers and staff capacity	[1], [2], [5], [6], [7], [10]
Slow adoption of new technologies	[5], [6], [7]
Increasing competition and pressure from larger enterprises	[5], [6], [7], [9], [10]
Negative attitudes towards SME stability and professionalism	[1], [2], [5], [6], [7], [8], [9]
Lack of access to international markets	[5], [6], [7], [8], [10]
[1] (Central Bank of Sri Lanka, 2021) [2] (Fernando & Samarakoon, 2021) [3] (Bandara et al., 2024) [4] (Jayamanne, 2024) [5] (Lukson et al., 2024) [6] (Bandaranaike et al., 2024) [7] (Madhavika et al., 2024) [8] (Hewage et al., 2024) [9] (S. W. S. B. Dasanayaka, 2011)[10] (Ranadewa et al., 2018)	

Despite their significant presence, SMEs face numerous challenges that hinder their growth and competitiveness. Limited access to finance, inadequate business skills, and restricted market access are among the primary barriers, alongside regulatory hurdles and incoherent policies. The COVID-19 pandemic and the ongoing economic crisis have exacerbated these issues, with inflation, currency devaluation, and rising production costs placing additional pressure on SMEs. The lack of government initiatives to support internationalization and the minimal adoption of e-commerce further impede their contribution to exports, which stands at a mere 5% compared to 30-50% in other countries. Additionally, policies like the Parate Executions Act have strained SME financing and viability. Nevertheless, many governments have made efforts to include legal provisions in legislation to help SMEs overcome these challenges. Figure 2 summarizes the research findings, highlighting the relationship between the challenges faced by SMEs, legal provisions for SME contractors, their shortcomings, and potential solutions to address these shortcomings.

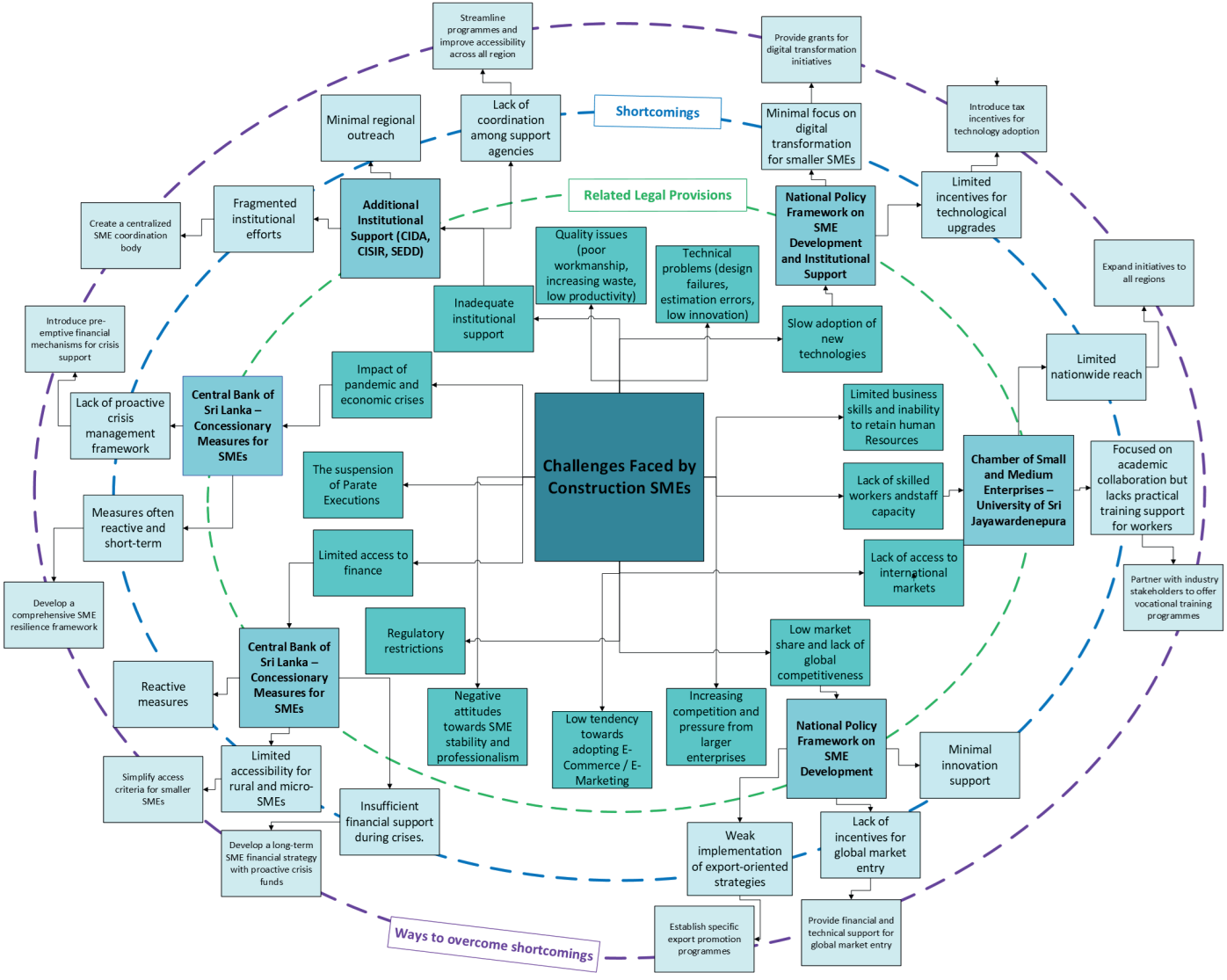


Figure 3 1: Summary of research findings

3.4 Governance and legal provisions related to SME contractors

To address the challenges facing the SME sector in Sri Lanka, it is vital to have proper legal provisions. That said, the protective mechanism provided to all contractors by the Construction Industry Development (CID) Act serves as a legally binding framework applicable to all parties, offering some level of support and regulation for contractors, including SMEs. However, Sri Lanka currently lacks specific legislative procedures or Acts dedicated to governing SMEs (Gamage, 2003). This absence of a formal legal framework makes it difficult to effectively manage and support SMEs within the economy. Without clear legislation, SMEs in Sri Lanka face numerous challenges, including inconsistent regulatory requirements, limited access to finance, and inadequate support for innovation and growth. The lack of standardized guidelines and protections leaves SMEs vulnerable to market fluctuations and unfair practices (Ranadewa et al., 2018; Gamage, 2003).

Although Sri Lanka lacks a comprehensive legislative framework to govern SMEs, the following are several policy frameworks and concessionary measures that the Sri Lankan government has implemented to support the existence and growth of SMEs within the country. These initiatives aim to enhance the operational environment for SMEs, providing them with the necessary resources and opportunities to thrive. Table 5 indicates a summary of governance in the Sri Lankan SME sector.

Table 3 6:Policies and Regulations Govern Sri Lanka's SME Sector

Regulations/ Policies	Established Entity	Introduction	Objective
Chamber of Small and Medium Enterprise – University of Sri Jayawarde-napura	Department of Entrepreneur-ship at the University of Sri Jayewardenepu-ra in 2009	Serves as a bridge between academia and industry to promote SME development in Sri Lanka.	To foster a conducive environment for small and medium enterprises in Sri Lanka by acting as a comprehensive network, policy planner, and facilitator of business development, entrepreneurship culture, and foreign project coordination.
National Policy Framework on SME Develop-ment	Ministry of Industry and Science	Outlines strategic interventions to empower SMEs to compete locally and globally through innovation, skills, and technology.	To drive holistic economic growth in Sri Lanka through targeted support for SME sectors, value addition promotion, export-oriented industry encouragement, job creation, innovation advancement, and technology adoption, all while prioritizing environmental sustainability and regional inclusivity.

Regulations/ Policies	Established Entity	Introduction	Objective
Central Bank of Sri Lanka – Concessionary Measures for SMEs	Central Bank of Sri Lanka	Address financial challenges caused by COVID-19 and economic downturns, the Central Bank provides SMEs with financial relief and recovery plans to ensure sectoral sustainability.	To ensure sustainable recovery and growth, to provide comprehensive financial relief and support to businesses affected by COVID-19 and economic challenges, including debt moratoria, concessional measures, targeted assistance, and revival initiatives.
Additional Institutional Support (e.g., CIDA, CISIR, SEDD)	Various institutions, including CIDA and CISIR,	Provide technical, financial, and entrepreneurial support, addressing SME development needs across different sectors.	To develop SME-related sectors by launching various programs and institutions aimed at financial support, innovation, entrepreneurship development, and resilience in crises such as COVID-19 and economic downturns.

Table 5 summarises the key policies and regulations governing the SME sector in Sri Lanka. It highlights several initiatives aimed at supporting SME growth and development. The Chamber of Small and Medium Enterprise of University of Sri Jayewardenepura acts as a network and policy planner, fostering business development and entrepreneurship. The National Policy Framework on SME Development provides a strategic direction to enhance the competitiveness of SMEs by promoting innovation, value addition, and sustainability. The Central Bank of Sri Lanka has implemented concessionary measures to offer financial relief to SMEs affected by economic challenges, particularly the COVID-19 pandemic. Additionally, various institutions such as CIDA, CISIR, and SEDD provide technical and financial support to SMEs, helping them grow and innovate. Together, these frameworks aim to strengthen the SME sector, although the lack of a comprehensive legal framework remains a challenge for consistent governance and regulation.

3.5 Shortcomings of current governance and legal provisions related to SME contractors

The governance and legal provisions for SME contractors in Sri Lanka exhibit significant limitations that impede their development and contribution to the national economy. Notably, Sri Lanka lacks a dedicated legislative framework specifically tailored to SMEs. This absence results in fragmented and inconsistent regulatory requirements, which complicate the management and growth of these enterprises. Without comprehensive legislation, SMEs are exposed to challenges such as market volatility, unfair practices, and inadequate support during economic

downturns. These issues underline the urgent need for a cohesive legal framework to guide and support SMEs effectively. Another critical shortcoming is the absence of a centralized coordinating body for SME governance. In contrast to countries like Malaysia, which has established SME Corporations as a central agency, the lack of such an institution in Sri Lanka results in inefficiencies and bureaucratic delays. This deficiency hinders the implementation of streamlined policies and programmes that could otherwise enhance SME operations. A centralized body could serve as a focal point for resource allocation, policy planning, and stakeholder engagement, thus addressing the current fragmented approach to SME governance.

The financial and incentive mechanisms available to SMEs in Sri Lanka are also inadequately structured. The provision of concessional loans, tax reliefs, and other financial support measures remains limited and does not comprehensively address the diverse needs of SMEs. This financial inadequacy is particularly detrimental during economic crises, such as the COVID-19 pandemic, when SMEs require tailored interventions to ensure their survival. Moreover, the regulatory framework governing SMEs is disjointed, resulting in high compliance costs and discouraging formalization, which is essential for accessing institutional support. Furthermore, the promotion of innovation and technological advancement among SMEs in Sri Lanka is insufficiently prioritized. Unlike other nations with specific legal provisions encouraging technological adoption and research collaborations, SMEs in Sri Lanka lack the necessary support to embrace digital transformation. This neglect restricts their global competitiveness and stifles opportunities for growth in a rapidly digitizing world. The absence of structured incentives for technological innovation is a critical gap that must be addressed to enable SMEs to leverage modern advancements effectively.

Lastly, the country's governance framework fails to provide adequate support mechanisms during crises. In comparison, nations such as South Korea and Japan have established legal provisions to assist SMEs during economic disruptions, offering tailored financial relief and recovery programmes. Sri Lanka, however, lacks similar proactive measures, leaving SMEs vulnerable to systemic shocks. Developing a crisis response framework within the SME governance structure is therefore essential to ensure resilience and sustainability during adverse conditions.

3.6 Ways to minimise shortcomings of SME legal provisions and governance

Addressing the shortcomings of the existing legal provisions governing SMEs in Sri Lanka necessitates a comprehensive and structured approach to enhance their effectiveness and inclusivity. A primary challenge lies in the fragmented nature of institutional support, which can be mitigated by establishing a centralized governance body to coordinate efforts among institutions such as the CIDA, the Industrial Technology Institute (CISIR), and the Small Enterprise Development Division (SEDD). Such a centralized entity would streamline programmes, eliminate duplication, and ensure equitable access to resources and support across diverse regions, thus addressing inconsistencies in the provision of institutional support.

Improving access to finance remains a critical requirement for SME growth and resilience. To this end, simplifying eligibility criteria for concessionary financial assistance offered by the Central Bank of Sri Lanka is essential. Proactive strategies, including the creation of pre-emptive crisis funds

and the formulation of long-term financial policies for SMEs, are necessary to build resilience against economic shocks. Moreover, region-specific financial schemes must be introduced to support rural and micro-SMEs, which often face unique challenges compared to their urban counterparts. The slow adoption of technology by SMEs can be overcome by introducing targeted incentives such as tax benefits for technological upgrades and grants for digital transformation initiatives. Partnerships with technology providers and embedding digital skills training within national policy frameworks can further facilitate the integration of innovative practices and promote adaptability among smaller enterprises. Addressing the shortage of skilled workers and high rates of employee turnover requires an expansion of vocational training programmes and the development of industry-academia partnerships. By extending initiatives like those led by the University of Sri Jayawardenepura, with a focus on practical and industry-specific training, SMEs can be better equipped to retain and upskill their workforce.

In light of these shortcomings, it is imperative for Sri Lanka to adopt a more structured and supportive approach to SME governance. Establishing a dedicated SME Act would provide the legal foundation required to address these challenges comprehensively. Additionally, the creation of a centralized agency could facilitate policy implementation and stakeholder coordination. Enhancing financial support mechanisms, incentivizing innovation, and developing robust crisis response measures would further strengthen the SME sector. By adopting best practices from countries with successful SME governance frameworks, Sri Lanka can create an enabling environment that not only mitigates current challenges but also unlocks the full potential of its SME sector.

4. Conclusions

The findings of this study emphasize the vitality of SME contractors in Sri Lankan construction industry, particularly in addressing high-demand sectors such as building and highways. SME contractors contribute significantly to economic development, job creation, and the delivery of essential infrastructure. However, their potential is hindered by persistent challenges, including financial constraints, regulatory inefficiencies, and limited technological advancement. These difficulties are exacerbated by the ongoing economic crisis and the lack of robust institutional support. Furthermore, the fragmented nature of legal and policy frameworks governing SMEs impedes their ability to achieve sustainable growth and remain competitive in a rapidly evolving market.

This research provides valuable insights for academia, industry stakeholders, and policymakers. For the academic community, it presents a comprehensive analysis of the current status and operating environment of SME contractors in Sri Lanka, shedding light on their systemic challenges. For industry practitioners, the study highlights actionable areas for improvement, such as enhancing access to finance and fostering digital transformation to improve operational efficiency and market competitiveness. For policymakers, the research emphasizes the urgent need for coherent and supportive governance structures and regulatory frameworks to enable SME growth and resilience.

By identifying key shortcomings in the existing governance and legal provisions, this study offers a foundation for future improvement efforts. The findings serve as a call to action for policymakers to implement strategic reforms, including the development of an integrated SME policy framework and the promotion of innovation through targeted initiatives. Future research should focus on benchmarking the performance of Sri Lankan SMEs against their global counterparts to derive best practices and globally aligned strategies. By addressing these gaps, Sri Lanka can strengthen the SME sector's governance and legal landscape, ensuring it remains a vital driver of economic development and sustainability.

5. References

1. Acar, E., Kocak, I., Sey, Y., & Arditi, D. (2005). Use of Information and Communication Technologies by Small and Medium-Sized Enterprises (SMEs) in Building Construction. Construction Management & Economics, 23, 713–722. https://doi.org/10.1080/01446190500127112

2. Agwu, M. (2014). Issues, Challengesand Prospectsof Small and Medium Scale Enterprises (SMEs) in Port-Harcourt City. European Journal of Sustainable Development, 3, 101–114. https://doi.org/10.14207/ejsd.2014.v3n1p101
3. Amaradiwakara, A., & Gunatilake., M. M. (2017). Factors affecting growth of small and medium enterprises in Sri Lanka. International Journal of Advanced Research, 5(2), 1805–1814. https://doi.org/10.21474/IJAR01/3345

4. Ardic, O. P., Mylenko, N., & Saltane, V. (2011). Small and medium enterprises: A cross-country analysis with a new data set. The World Bank. https://doi.org/10.1596/1813-9450-5538

5. Bandara, K. B. T. U. K., Prasanna, R. P. I. R., Gamage, S. K. N., Rajapakshe, P. S. K., Ekanayake, E. M. S., Jayasundara, J. M. S. B., & Abeyrathne, G. A. K. N. J. (2024). Agribusiness Small and Medium Entrepreneurs’ Overall Perceptions of Institutional Support Towards Facing Technology Challenges: A Case of Sri Lanka. Journal of Agricultural Sciences – Sri Lanka, 19(1), 31–48. https://doi.org/10.4038/jas.v19i1.9265

6. Bandaranaike, B. B., Gallage, S. D., & Sivanraj, S. (2024). Risk management in Sri Lankan SME construction sector: identifying barriers and enablers. 12th World Construction Symposium - 2024, 891–903. https://doi.org/10.31705/WCS.2024.71

7. Central Bank of Sri Lanka. (2021). Catalysing Micro, Small and Medium Sized Enterprises (MSMEs) as a Growth Driver and Challenges. https://www.cbsl.gov.lk/sites/default/files/cbslweb_documents/publications/annual_report/2021/en/13_Box_04.pdf

8. Creswell, J. (2009). Research design: Qualitative, quantitative and mixed methods approaches (3rd ed.). SAGE Publications.

9.. Dasanayaka, S. (2010). Implications of Organizational Culture on Innovation: An Ex ploratory Micro Study of Sri Lankan Gift and Decorative-ware Sector Firms.

10. Dasanayaka, S. W. S. B. (2011). Global challenges for SMEs in Sri Lanka and Pakistan in comparative perspectives. Business Review, 6(1), 61–80. https://doi.org/10.54784/1990-6587.1182

11. Department Of Census and statistics (DCS). (2019). Annual survey of trade services. http://www.statistics.gov.lk/Resource/en/Industry/Annual_Surveys/T&S_FinalReport_2019.pdf

12. Fulford, R., & Standing, C. (2014). Construction industry productivity and the potential for collaborative practice. International Journal of Project Management, 32(2), 315–326. https://doi.org/https://doi.org/10.1016/ j.ijproman.2013.05.007

13. Gamage, A. (2003). Small and medium enterprise development in Sri Lanka: A review. Meijo Review, 22, 133–150. https://wwwbiz.meijo-u.ac.jp/SEBM/ronso/no3_4/aruna.pdf

14. Jilcha Sileyew, K. (2020). Research Design and Methodology. In Cyberspace. IntechOpen. https://doi.org/10.5772/intechopen.85731

15. Lebunu Hewage, U. W. A., Wadu Mesthrige, J., & Too, E. G. (2024). Barriers to risk management in small construction projects in Sri Lanka. Built Environment Project and Asset Management, 14(2), 296–311. https://doi.org/10.1108/BEPAM-06-2023-0104

16. Lukson, E. E., Ranadewa, K. A. T. O., Parameswaran, A., Wijerathna, M. R. D. P., & Kodituwakku, D. (2024). Integrated project delivery implementation among construction SMEs in Sri Lanka: barriers and strategies. 12th World Construction Symposium - 2024, 619–633. https://doi.org/ 10.31705/WCS.2024.49

17. Madhavika, N., Bandara, M., Manchanayake, M., Perera, C., Bandara, W., Jayasinghe, P., & Ehalapitiya, S. (2024). Navigating economic crisis: Factors shaping resilience in Sri Lankan construction SME supply chains. International Journal of Construction Management, 1–13. https://doi.org/10.1080/15623599.2024.2415158

18. Makabate, C. T., Musonda, I., Okoro, C. S., & Chileshe, N. (2022). Scientometric analysis of BIM adoption by SMEs in the architecture, construction and engineering sector. Engineering, Construction and Architectural Management, 29(1), 179–203. https://doi.org/10.1108/ECAM-02-2020-0139

19. McCourtie, S. (2013, April 5). Micro, Small, and Medium Enterprise (MSME) Finance. The World Bank Group. https://www.worldbank.org/en/results/2013/04/05/msme-finance-expanding-opportunities -and-creating-jobs

20. Ministry of Industry and Commerce. (2016). National Policy Framework for of small and medium-sized enterprise (SME) Development. http://www.sed.gov.lk/sedweb/en/wp-content/uploads/2017/03/SME-fram-work_eng.pdf

21. Mustafa Kamal, E., & Flanagan, R. (2014). Key characteristics of rural construction SMEs. Journal of Construction in Developing Countries, 19, 1–13.

22. Nowotarski, P., & Paslawski, J. (2017). Industry 4.0 Concept Introduction into Construction SMEs. IOP Conference Series: Materials Science and Engineering, 245, 052043. https://doi.org/10.1088/1757-899X/245/5/ 052043

23. Perera, K., Ranadewa, T., & Nagaratnam, K. (2014). Project risk management by small-scale contractors in Sri Lankan building construction published in the proceedings.

24. Ranadewa, K., Sandanayake, Y., & Siriwardena, M. (2015). Capacity Building in Construction SMES: A proposal through enabling lean. "Making Built Environments Responsive": Proceedings of the 8 ThInternational Conference of Faculty of Architecture Research Unit (FARU), 519–531
.Ranadewa, T., Sandanayake, Y., & Siriwardena, M. (2018). A SWOT ANALYSIS FOR SRI LANKAN CONSTRUCTION SMES. The 7th World Construction Symposium 2018: Built Asset Sustainability: Rethinking Design, Construction and Operations, 1–12. http://dl.lib.uom.lk/handle/123/20171

25. Rathnasinghe, N. (2024, May 15). Small and Medium-sized Enterprises (SMEs) of Sri Lanka. Friedrich Naumann Foundation for Freedom. https://www.freiheit.org/south-asia/small-and-medium-sized-enterprises-smes-sri-lanka

26. Tewari, P. S., Skilling, D., Kumar, P., & Wu, Z. (2013). Competitive Small and Medium Enterprises: A Diagnostic to Help Design Smart SME Policy (Issue 16636). https://EconPapers.repec.org/RePEc:wbk:wboper:16636

27. Tezel, A., Taggart, M., Koskela, L., Tzortzopoulos, P., Hanahoe, J., & Kelly, M. (2020). Lean construction and BIM in small and medium-sized enterprises (SMEs) in construction: a systematic literature review. Canadian Journal of Civil Engineering, 47(2), 186–201. https://doi.org/10.1139/cjce-2018-0408

28. Ullah, A., & Ameen, K. (2018). Account of methodologies and methods applied in LIS research: A systematic review. Library & Information Science Research, 40(1), 53–60. https://doi.org/10.1016/j.lisr.2018.03.002

29. Williams, C. (2007). Research Methods. Journal of Business & Economics Research, 5(3). https://doi.org/https://doi.org/10.19030/jber.v5i3.2532

NAVIGATING PARADOXES: EXPLORING MOTIVATIONS AND GOVERNANCE IN UNSOLICITED PROPOSALS FOR PPPS IN SRI LANKA

Piyumi Nisansala Thennakoon[a], Himal Suranga Jayasena[b],
and Umesha Sasanthi Weerapperuma[c]
Department of Building Economics, University of Moratuwa, Moratuwa, Sri Lanka[ab]
School of Architecture and Civil Engineering, Faculty of Science, Engineering, and Technology, University of Adelaide, Australia[c]

Abstract

Although there is an expanding body of literature on unsolicited proposals and its motivations and success factors, limited knowledge exists regarding the motivations for their implementation in contexts such as Sri Lanka. This study addresses the contradiction in the motivations for implementing Unsolicited Proposals (USPs) in the Sri Lankan context despite their perceived drawbacks. The study aims to identify the motivations for USPs and assess the status of these motivational factors in the Sri Lankan context. The research design integrates a structured Systematic Literature Review (SLR), twelve expert interviews, and manual content analysis for a comprehensive approach. The SLR identifies motivations for USPs within the existing knowledge. Data from semi-structured interviews on practitioners' experiences, observations, and opinions were qualitatively analysed to derive the study findings. The findings of the study indicate diverse and context-specific motivations for implementing unsolicited proposals in the Sri Lankan construction industry. These motivations encompass potential innovation, addressing infrastructure gaps, and realising cost savings. However, there also exist paradoxical motivations associated with USPs, including the potential for corruption and lack of transparency in procurement. The study acknowledges the potential distortions caused by manipulative networks. The findings emphasise the vital need for increased transparency and accountability in the procurement process to mitigate the risks associated with USPs.

Keywords: Procurement, Infrastructure Development, Private Public Partnership (PPP), Unsolicited Proposal (USP), Government Motivation.

Introduction

Unsolicited Proposals in procurement, particularly in the context of Public-Private Partnerships (PPPs), have gained attention in recent years. An Unsolicited Proposal (USP) is a proposition or offer submitted by private sector entities to government or public sector agencies without a formal request or solicitation from the procuring entity (Casady & Baxter, 2022). Unlike typical procurement processes, which usually involve Requests for Proposals (RFPs) or Invitations to Bid (ITBs) and a competitive bidding process, USPs are initiated by the private sector and present a unique solution or opportunity for the government with innovative ideas, products, or services (Mallisetti et al., 2022).

USPs can be beneficial in expediting procurement timelines and reducing transaction costs compared to traditional public procurement (Casady & Baxter, 2022). They can also change the roles and duties of both the private and public sector agencies involved in the procurement

process (Mallisetti et al., 2022). Major international procurement frameworks, including the European Bank for Reconstruction and Development, the Asian Development Bank, and the World Bank, have acknowledged this concept (Zawawi et al., 2016).

However, unsolicited proposals also present challenges and risks (Aziz & Nabavi, 2014). These challenges often raise concerns regarding the fundamental principles of fairness, transparency, and competition in the procurement process. Unsolicited proposals have been associated with a spectrum of adverse factors, including issues such as corruption, limited social and economic benefits, suboptimal value for money, opacity, misallocation of risk, absence of competitive tendering processes, nepotism, and an overall dearth of equitable treatment (Hodges & Dellacha, 2007; Osei-kyei et al., 2018; PPIAF, 2014; World Bank Group/PPIAF, 2018). Moreover, initiatives involving unsolicited proposals are known to elicit unfavourable public perceptions due to perceived favouritism and the absence of competitive elements (Aziz & Nabavi, 2014; Zawawi et al., 2016).

Despite the significant drawbacks associated with USPs, there is a global inclination and impetus to pursue PPP projects through the avenue of USPs, particularly within developing nations (Nyagormey et al., 2020; World Bank Group/PPIAF, 2018). Gibson et al. (2023) trace the origin of unsolicited proposals to 1980s and 1990s when state governments sought entrepreneurial engagement with the private sector over major projects. This historical context suggests that the use of USPs may have been driven primarily by specific circumstances rather than a generally favoured approach. Therefore, it is evident that the motivation for employing USPs is context specific. Context-specific knowledge is important for formulating policies and strategies.

The Infrascope Index of 2020 categorises Sri Lanka as a nation with an emerging PPP-enabling environment, showing its emerging status concerning regulations, institutions, maturity, and financing. However, in the context of investment and business climate, it has been designated as a developed region (The Economist Intelligence Unit, 2020). According to the World Bank Group (2017), a substantial number of public sector projects in Sri Lanka have been procured through USPs, emphasising their significant role in advancing infrastructure development in the country (Verite, 2021). This suggests that there may be motivation within the Sri Lankan government to utilise USPs as a vehicle for infrastructure implementation. This motivation, despite perceived drawbacks, prompts an examination of the factors driving the selection of USPs as a strategy for developing infrastructure projects in the Sri Lankan construction industry.

Presenting findings derived from an examination of pertinent legislation, regulations, and guidelines, Fernando et al. (2023) reported that, initially, the line ministries and state agencies, through guidelines in 1998, were directed to handle USPs in a manner consistent with solicited proposals, permitting the consideration of USPs directly with cabinet approval only under urgent and exceptional circumstances. Subsequently, in 2011, the guidelines introduced direct negotiation methods for processing USPs, thereby bypassing the normal procurement procedure. However, the guidelines later replaced this, advocating the use of the Swiss Challenge procurement option to launch USPs. In September 2019, the Ministry of Finance declared the abolition of the Swiss Challenge procurement method, stating that it had

inherent deficiencies, reverting to the methodology recommended in the guidelines of 1998. Consequently, while Sri Lanka has employed various strategies, including full competition, direct negotiation, and the Swiss Challenge option, to accommodate USPs over time, all USPs for public procurement are currently processed on the basis of full competition. Accordingly, Sri Lanka presents an ideal context for studying the diverse experiences and perceptions of those involved in public sector procurement. This article presents a study that addresses the gap in knowledge on the contradictory nature of motivation behind implementing USPs, while there exist perceived drawbacks in Sri Lankan context. The study adopts a comprehensive approach consisting of a structured systematic literature review, twelve experts' interviews, and manual content analysis to address the current gap in knowledge. Therefore, the objectives of this study can be summarised as follows: (1) identifying the motivations for implementing PPP projects through USPs, and (2) assessing the status of these motivational factors in the Sri Lankan context.

Research Methodology

Systematic Literature Review

A Systematic Literature Review (SLR) was adopted to identify the motivations for USPs in the existing body of knowledge. SLR provides a methodical approach for researchers to gather, evaluate, and synthesise scholarly work on a particular topic, ensuring reproducibility and transparency (von Danwitz, 2018). Scholars have identified the best practices for SLR that involve several steps (Cronin et al., 2008; Raouf & Al-Ghamdi, 2019; Uman, 2011; Yigitcanlar et al., 2019). The process is illustrated in Figure 1, considering the scope of the current research and the parameters selected for this particular situation.

Identifying key research questions is vital to establish the study's aim and scope and to select appropriate keywords for the SLR. According to Tawfik et al. (2019) and Verweij & Trell (2019), the first step in carrying out a systematic review process is defining the review questions. The initial research question was formulated as follows. The systematic literature review aims to answer this question to fulfil the first objective of the study.

1) What motivates the implementation of PPPs as USPs?

The second step involved searching for relevant articles. Research articles were searched using the search keywords in a common scholarly database. The quality of the results is influenced by the choice of scholarly database for the literature review (Omrany et al., 2022). For the retrieval of data, multiple databases have been developed such as Scopus, Web of Science (WoS), Google Scholar, Medline or ScienceDirect. Scopus is one of the most widely used sources for similar topics, and it covers the most reputable publications in different research areas, such as engineering, business, management, and accounting (Hong & Chan, 2014). The search string "Unsolicited" AND "Procurement" OR "PPP" was used to find articles. These keywords were selected as terms appropriate for the scope and objectives of this study. All scientific journal articles published in English were selected for review. The literature on this subject is limited. A total of 30 articles were retrieved from the search.

Next, all articles were subjected to title and abstract screening. Three (3) articles were removed because of inaccessibility, and Two (2) articles were excluded because they were not specific to the study. Furthermore, full-text screening was performed, and eight (8) articles were removed due to the absence of information on motivation factors for implementing USPs. Finally, 16 publications were selected for this study. A content review of the selected research publications yielded findings that addressed the review question. These findings are discussed in the following sections, followed by the derivation of the conclusions.

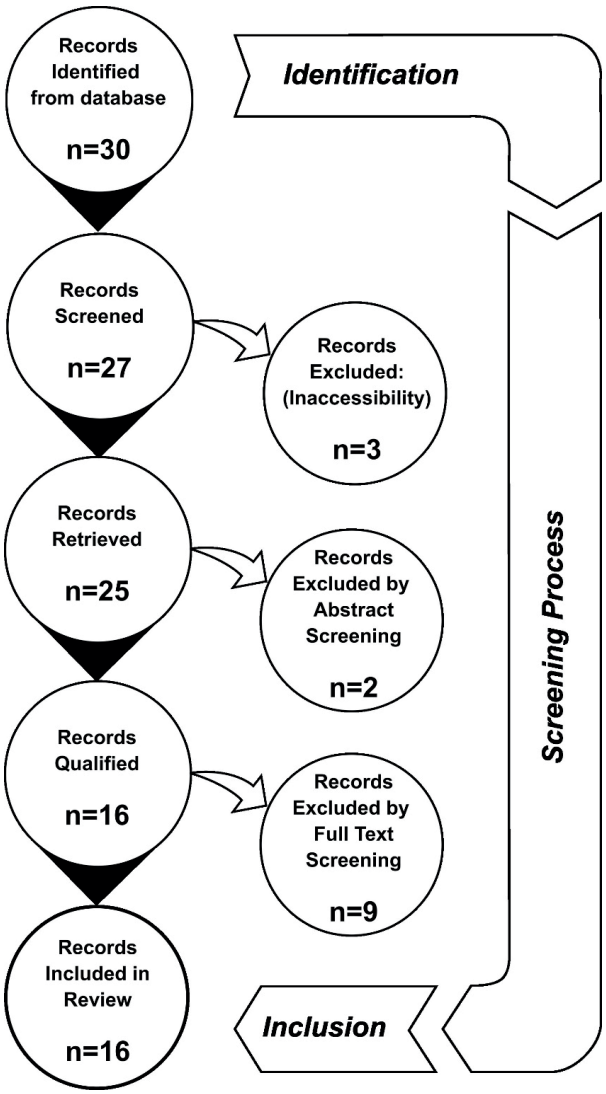


Figure 1: Systematic Literature Review Document Selection Process

Qualitative Analysis

This study utilised a qualitative research approach because of its ability to comprehensively analyse theoretical concepts, models, and frameworks (Creswell, 2014). To gather qualitative data, semi-structured interviews were conducted with practitioners, with a focus on their experiences, opinions, and observations regarding the context of USPs. This qualitative study aimed to answer the research question and fulfil the second objective of the study.

2) What is the status of each motivational factor in the implementation of PPPs as USPs in the Sri Lankan context?

The key objective of this study is to uncover the motivating factors behind USPs in PPPs within the construction industry in Sri Lanka. This was achieved through manual content analysis while considering the motivating factors identified in the systematic literature review. Content analysis, as identified by White and Marsh (2006), serves as a data analysis technique for generating reliable and valid inferences from textual or meaningful material within the context of its application. A notable advantage of content analysis lies in its capacity for data reduction, offering a systematic, repeatable approach for condensing extensive text into a limited set of topic categories, guided by defined coding principles (Graue, 2015). The choice of coding method represents a critical stage in data analysis, contingent upon factors like the research scope, available time, and budget (Cope, 2014). Manual coding, in particular, is preferred for research studies that necessitate a heightened level of focus on the dataset (Saldana, 2014). Cope (2014) stated that manual coding not only minimises potential distractions but also ensures a comprehensive engagement with the data. Consequently, manual content analysis with manual coding was used for the analysis of the collected qualitative data.

Further, there are no rigid guidelines for determining the appropriate sample size in qualitative research (Creswell, 2014; Patton, 2002). However, qualitative research generally involves studying small numbers in depth and detail (Huberman and Miles, 1994). In this study, a non-probability snowball sampling method was employed because of the limited number of practitioners exposed to USPs and related contexts. The initial selections were purposeful and based on prior awareness of the participants' engagement in USPs. Data were continuously analysed, and additional interviews were conducted with new participants introduced by the initial participants. Theoretical saturation was reached after the ninth interview, and three additional interviews were conducted to validate this. Accordingly, twelve (12) experts with sound knowledge and experience in USP PPP in the Sri Lankan construction industry were interviewed for this study. Table I summarises the participants' profiles.

Table I: Profiles of Interviewees

Interviewee code	Profession	Designation	Years of experiences
R1	PPP Specialist	Chief operating officer	15 years
R2	Quantity Surveyor / Research Scholar	Senior Quantity Surveyor/Ph.D. Candidate	08 years
R3	PPP Specialist	Chairman	30 years
R4	Procurement Specialist	Resident Engineer	20 years
R5	PPP Specialist	Deputy Director	12 years
R6	PPP Specialist	Deputy Director	06 years
R7	Procurement Specialist	Director	15 years
R8	Resident Engineer	Director	15 years
R9	Engineer	Deputy Director	14 years
R10	Engineer	Project Engineer	13 years
R11	Procurement Specialist	Director	09 years
R12	Engineer	Senior Engineer	10 years

Findings of the Systematic Literature Review

SLR assisted in synthesising and summarising the existing body of knowledge on USPs relevant to this study. It presented the knowledge related to the use of USPs related to construction projects and the motivations of the governments to choose USPs as an option for PPP projects. The synthesis pointed to relevant knowledge that could be found outside the SLR, mostly from non-scientific publications that would help contextualise the understanding of USPs in the context of Sri Lanka.

USP in the Construction Industry

USPs involve a private firm initiating an infrastructure or service project proposal without receiving a direct request or invitation from the government (Mallisetti et al., 2022). This differs from the typical practice of public sector organisations launching infrastructure projects. Financial capability is crucial for private sector proponents and strong financial strength is a necessary requirement (Aziz & Nabavi, 2011). Controversy surrounds USPs (Chew, 2015), and understanding the motivations behind them is important despite the associated drawbacks, such as corruption, limited social and economic benefits, suboptimal value for money, transparency issues, risk misallocation, absence of competitive tendering process, nepotism, and fairness concerns (Aziz & Nabavi, 2014; Moon et al., 2023).

Motivation of Governments for Implementing PPPs as USPs

The growing use of USPs indicates that many countries find implementing PPP projects using USPs advantageous and can significantly contribute to public infrastructure development (Osei-Kyei & Chan, 2017). Governments' motivations for using USPs are primarily based on their perceptions (Moon et al., 2023). One key motivation is the lack of financial and technical capabilities in the public sector to procure, prioritise, and identify projects (Geddes & Wagner, 2013). Conducting a comprehensive preliminary study is crucial for ensuring the social and economic viability of a project (Ng et al., 2013). To conduct a proper and accurate preliminary study, an experienced technical team and substantial financial resource allocation are required (Li et al., 2007). However, many public departments in developing countries lack financial resources and expertise. Consequently, governments often rely on private developers to procure PPP projects (Osei-Kyei et al., 2020).

Governments often prefer USPs for PPP projects because of the expediency of implementation compared to a solicited approach (Hodges & Dellacha, 2007). Formal planning procedures and competition in solicited projects can lead to prolonged procurement timelines, prompting public departments to opt for direct negotiations instead of lengthy tendering processes (Marques, 2018). USPs, with only one project proponent, allow for swift negotiations (Osei-kyei et al., 2018), reducing the costs associated with competitive tendering processes and diminishing recurring expenses associated with competitive bidding (Castelblanco & Guevara, 2020). Another motivating factor is the ability of USPs to generate innovative and creative ideas from the private sector to address the infrastructure challenges that public departments may struggle with, as emphasised by Boyer and Scheller (2018). Additionally, many nations, especially developing countries, lack comprehensive policy guidelines for executing PPP projects (Osei-Kyei et al., 2020), making USPs a suitable alternative when a detailed regulatory framework is lacking (Geddes and Wagner, 2013).

Hodges and Dellacha (2007) emphasise that safeguarding the intellectual property rights of private investors is a prominent motivating factor. Private proponents own intellectual property rights to their proposals under their property rights as investors. Therefore, to avoid violating the proprietary rights of proposers, many governments tend to accept these offers as unsolicited (Zawawi et al., 2016). Violations of proprietary rights can cost the public sector significantly in compensation and discourage future private-sector initiatives. Consequently, many governments believe that they have no option but to accept initiatives submitted by private investors as unsolicited or engage in direct negotiations.

One motivation that drives the adoption of USPs in infrastructure projects is the government's desire to access private financing more swiftly than traditional methods (Moon et al., 2023). In contrast to the conventional approach, which may take longer, the unsolicited method enables private entities to propose projects using readily available resources and capital (Mallisetti et al., 2022). However, there are concerns about corruption in developing countries because the absence of competitive bidding in USPs can lead to fraudulent activities by government officials (David-Barret and Fazekas, 2020). Table II summarises the motivations for implementing USPs in construction projects, as identified through a systematic literature review.

Table II: Motivations of Implementing USPs

Motivation	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Lack of financial and technical capabilities of public sectors to procure, prioritize, and identify projects	✓	×	✓	✓	×	✓	×	✓	✓	×	×	✓	×	✓	×	✓
Lack of financial resources and expert knowledge in the public sector to carry out a proper and accurate preliminary	×	×	✓	×	✓	×	×	✓	✓	✓	×	✓	✓	×	✓	✓
Project procured unsolicited is considered the quickest approach to implementing PPP projects compared with a solicited approach	×	✓	✓	×	✓	✓	✓	✓	×	×	✓	✓	×	×	×	✓
Obtaining the private sector's innovative and creative ideas from unsolicited proposals rather than solicited proposals	✓	✓	✓	×	×	×	✓	✓	✓	×	✓	✓	×	✓	✓	✓
Government's interest in accessing private entity finance facilities more quickly than solicited approaches	×	✓	✓	×	×	×	✓	✓	×	✓	✓	✓	×	×	×	×
Concerns about entrusting the proposed project to a less qualified firm through competitive bidding	×	×	×	×	×	×	×	✓	×	×	×	×	✓	✓	✓	×
Aim to reduce the costs associated with the competitive bidding process	×	×	×	×	×	✓	✓	✓	×	✓	×	✓	×	×	×	✓
Prioritize the protection of intellectual property rights for investors	✓	×	✓	×	×	×	✓	✓	✓	×	×	×	×	×	×	×
Address the lack of interest from private investors or developers in projects located in remote areas	×	×	×	×	✓	✓	✓	✓	✓	×	×	×	×	×	✓	✓

Sources:[1] Moon et al., 2023; [2] Mallisetti et al., 2022; [3] Mallisetti & Dolla, 2021; [4] Castelblanco & Guevara, 2020; [5] David-Barret & Fazekas, 2020; [6] Osei-Kyei et al., 2020; [7] Osei-kyei et al., 2018; [8] Boyer & Scheller, 2018; [9] Marques, 2018; [10] Osei-Kyei & Chan, 2017; [11] Takano, 2017; [12] Zawawi et al., 2016; [13] Aziz & Nabavi, 2014; [14] Geddes & Wagner, 2013; [15] Verma, 2010; [16] Li et al., 2007

USP Practices in the Sri Lankan Context

Recent reports show that the Sri Lankan government frequently procures public sector projects through unsolicited proposals (World Bank Group, 2017). Between 2010 and 2016, the government invested 6%-7% of the GDP in public investments. Due to the country's critical economic situation, sourcing finances through foreign funding has become popular (World Bank Group, 2017). USPs play a significant role in infrastructure development in the Sri Lankan construction industry (Verite, 2021). Verite (2022) noted that a lack of necessary finance to fund infrastructure projects is a key motivation for implementing PPPs through USPs in Sri Lanka. It is important to identify other motivating factors prevalent in the Sri Lankan context that make USPs a suitable method for PPPs.

Findings of the Qualitative Analysis

The data collected through the interviews consisted of the opinions of experts regarding the generic motivation factors identified in relation to USPs. Subsequently, the collected data were analysed using manual content analysis. The findings of the expert interviews are discussed below:

Motivation for the Sri Lankan Government to Implement PPP Projects as USPs

All motivation factors identified in the SLR were cross-checked with the respondents' opinions. Each respondent was asked to validate whether the motivational factors identified in the SLR were applicable to the Sri Lankan context. Respondents were invited to share any additional motivation factors that they had experienced or were aware of. Consequently, two additional motivation factors were identified by the respondents: the absence of a proper framework to manage USPs, and corrupt practices due to a lack of competitiveness. Furthermore, their experiences with each motivational factor were analysed. Table III summarises the findings of the expert interviews. Additional motivation factors identified through data collection are indicated in bold.

Table III: Identified Motivation Factors for USPs

Motivation Factors	Respondents											
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R 10	R 11	R 12
Lack of financial and technical capabilities of public sectors to procure, prioritize, and identify projects	✓	✓	×	✓	×	✓	✓	✓	✓	✓	✓	✓
Lack of financial resources and expert knowledge in the public sector to carry out a proper and accurate preliminary	✓	✓	×	×	×	✓	×	×	×	✓	✓	✓
Project procured unsolicited is considered the quickest approach to implementing PPP projects compared with a solicited approach	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓
Obtaining the private sector's innovative and creative ideas from unsolicited proposals rather than solicited proposals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Government's interest in accessing private entity finance facilities more quickly than solicited approaches	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓
Concerns about entrusting the proposed project to a less qualified firm through competitive bidding	✓	×	✓	×	×	✓	✓	×	✓	×	×	✓
Aim to reduce the costs associated with the competitive bidding process	✓	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓
Prioritize the protection of intellectual property rights for investors	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Address the lack of interest from private investors or developers in projects located in remote areas	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Absence of a proper and comprehensive regulatory framework to manage PPPs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Potential corrupt practices due to absence of a competitive bidding process in USPs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Lack of financial and technical capabilities in the public sector to procure, prioritise, and identify projects.

According to the respondents' opinions, the motivation factor concerning the lack of financial and technical capabilities in the public sector to procure, prioritise, and identify projects was highlighted. R1 stated that "lack of financial capabilities is an obvious factor. When it comes to technical capabilities, they are also low in the country, and most of the time, the public sector follows very traditional methods." R1, R2, R4, R10, R11, and R12 further elaborated this idea. However, R1, R7, and R8 mentioned that, although the lack of financial capability is a motivation factor to allow USPs for PPPs, the lack of technical capability is not a motivation. They argue that experts with technical capabilities are available within the country. R8 expressed, "Even though there is technical capability, due to the absence of a proper national policy, the output of that technical capability is zero. We are always engaging with politically biased projects rather than projects that meet national requirements." In addition, R3 stated, "This should not be considered a motivation factor because the government can locate USPs, learn from them, and then call for a tendering process. Furthermore, the government can use its funds to hire technical experts if necessary." R5 also expressed that technical incapability is not a motivating factor, as the government has the required technical capability to handle almost all projects. Overall, all the respondents highlighted financial incapability within the country as a motivation to allow USPs. However, in terms of technical incapability, more than half of the respondents disagreed, emphasising the need for policy directives rather than a lack of technical expertise.

Lack of financial resources and expert knowledge in the public sector to carry out a proper and accurate preliminary study.

R2 emphasised that the "ability to take risks concerning preliminary investigations, market surveys, or feasibility studies is lacking in the public sector. However, the private sector takes such risks and submits proposals." This sentiment is further elaborated by R1, R6, R10, R11, and R12. Conversely, R8 expressed that "financial incapabilities of the government sector to carry out proper preliminary studies are an obvious factor, but when it comes to expert knowledge, the government has enough expertise to conduct proper preliminary studies." R2, R3, R4, R5, R7, and R9 also shared this perspective. R5 further asserted that capacity built-in should not be essential for a government organization because if they lack the capacity to conduct a preliminary study, transparent consultants can be hired." Therefore, while all respondents agreed on the lack of financial resources for preliminary studies, most asserted that the required expert knowledge is available within the country.

Projects procured unsolicited are considered the quickest approach to implementing PPP projects compared with a solicited approach.

According to the opinions of the respondents, most of them identified the expedited procurement process as a motivation factor for the government to implement USPs for PPP projects. R1 explained, "A lengthy procedure is avoided, and there's no need for the public sector to conduct a feasibility study, pre-feasibility study, and market survey because the project proponent has already completed them and presents the proposal. This allows for quick project procurement." R2 highlighted, "In solicited proposals, employer's requirements need to be

finalised, followed by a tendering procedure. However, for USPs, these steps are shortened, motivating the government to start the project within a shorter period." Similarly, R8 stated that USPs become the quickest approach compared to solicited proposals (SPs), especially considering the time consumption of the procurement process. The other respondents also elaborated on the same idea. However, R5 provided a nuanced view, stating, "Although there is timesaving for USPs compared to SPs during the procurement process, considerable time is spent on the negotiation process in the later stages." Furthermore, R5 emphasised that while the procurement stage is quicker in USPs than in SPs, project implementation becomes more time-consuming than in SPs at later stages.

Obtaining the private sector's innovative and creative ideas from unsolicited proposals rather than solicited proposals.

All respondents agreed on the motivation factor that USPs allow the government to obtain creative and innovative ideas from the private sector. R7 expressed, "under solicited proposals, projects should adhere to donors' frameworks, limiting flexibility. In contrast, in unsolicited proposals, flexibility is higher, allowing for creative and innovative ideas." R11 noted a challenge in the Sri Lankan context regarding the identification of projects as innovative or otherwise. Additionally, R11 highlighted the importance of having a proper identification or definition of "innovative project proposals" within the regulatory framework at the government or ministry level to prevent the implementation of less innovative, politically biased projects. R12 shared insights from their ministry level experiences, stating, "Proposals integrated with unique technologies, processes, or products are considered innovative proposals." Consequently, all respondents emphasised that USPs provide a platform for assessing the creative and innovative ideas of the private sector.

Government's interest in accessing private entity finance facilities more quickly than in solicited approaches.

Most respondents also identified this motivation factor. R1 explained that "in the case of emergency infrastructure requirements, such as power-generated infrastructures, the quickest and easiest approach to secure financial facilitation for such projects is by implementing them as USPs." Similarly, R8 shared, "When a project is implemented as a USPs and financial facilities are obtained from a bank, a foreign bank is often involved. Settling interim payments is much easier in USPs compared to government-funded projects, providing a smoother cash flow." R7 expressed concern that relying on this motivation factor led the government to prioritise less economically beneficial projects, resulting in reduced national outcomes. Most of the respondents had similar sentiments. However, R6 presented a different perspective, suggesting that "if a proper competitive bidding process is implemented, the government can quickly access finance facilities at a lower cost, making it less of a motivation factor for the government to allow USPs." Despite the ease of accessing private sector finance facilities through USPs, R6 argued that the Sri Lankan government may not have a genuine intention to quickly access finance facilities and may accept less-prioritised projects, undermining the effectiveness of this motivation factor.

Concerns about entrusting the proposed project with a less qualified firm through competitive bidding.

R10 emphasized that "unsolicited proposals are often submitted by firms with a deep understanding of the client's needs and a proven track record of success in similar projects, increasing the likelihood of a successful outcome." Additionally, R10 emphasised that the government is motivated to choose a successful outcome rather than opting for a high-risk competitive bidding process. Furthermore, R8 highlighted the risk of involving a less-qualified firm in project implementation, expressing the government's motivation to avoid such risks. R5 pointed out that competitive bidding can result in the selection of a firm with a different vision for the project, leading to disagreements over project scope, timelines, and budgets. R2 added that unsolicited proposals allow the client to choose a firm that is aligned with their goals and objectives, fostering collaboration. Other respondents also maintained these perspectives.

Aim to reduce the costs associated with the competitive bidding process.

The majority of respondents agreed with this motivation factor. R1 pointed out that "executing a competitive bidding process requires a considerable amount of time, money, and other resources." Additionally, R11 highlighted that, in a competitive bidding process, excessive competition can result in the wastage of significant amounts of money, time, and resources. R11 further noted that the lack of public sector resources is a prominent issue faced during competitive bidding processes. Furthermore, R6 emphasised that as a developing country, "Sri Lanka is concerned about its financial capabilities and lacks the expert knowledge required for an extensive competitive bidding process". Therefore, to avoid substantial costs, Sri Lanka is motivated to opt for USPs, which involve "little to no competition".

Prioritise protection of investors' intellectual property rights

R5 noted that USPs often place a high prioritise protecting proprietary information, encompassing intellectual property rights related to unique technologies and concepts, along with sensitive business information. Additionally, R9 emphasized that "to provide appropriate protection to the unique and innovative ideas of project proponents, governments are motivated to implement PPP projects as USPs." This perspective was shared by all the other respondents.

Address the lack of interest from private investors or developers in projects located in remote areas.

R1 emphasized that "projects located in highly populated areas are most economically viable and financially attractive, leading developers to prefer such areas for project execution." Furthermore, R12 stated that due to poor financial returns, projects in remote areas fail to attract private developers, resulting in a severe infrastructure shortage in those areas. R12 further expressed concern about infrastructure shortages in remote areas in the Sri Lankan context. Moreover, R10 highlighted that infrastructure shortages in remote areas are a major issue in Sri Lanka, with the government facing challenges in funding projects for such regions. Additionally, R9 highlighted that "the Sri Lankan government is motivated to implement USPs to address the infrastructure requirements in remote areas of the country." However, R3 pointed out the risk of private investors imposing significant tariffs to cover their investments in economically less-benefited projects.

Potential corrupt practices due to absence of a competitive bidding process in USPs.

All respondents strongly agreed with this motivation factor. R7 expressed that "most developing countries, like Sri Lanka, use these Unsolicited Proposals as means of corrupt practice due to the lack of competitive bidding." Additionally, R2 highlighted that prolonged practice of this motivation factor would eventually lead to the abolishment of the USP mechanism. The respondent stated, "After 2010, most development projects were undertaken as USPs, and corrupt practices occurred frequently. Government assets were utilized in a corrupt manner, leading the country to now be distrustful of adopting USPs due to corruption, and the use of USPs has become limited." All the other respondents shared similar sentiments. Their expressions conveyed a factual rather than potential context, reflecting a deep-rooted perception. Consequently, without a thorough assessment of the true value of USPs, government decision makers are likely to rely on this motivation factor.

Absence of a proper and comprehensive regulatory framework for managing PPPs.

In addition to the findings of the literature review, R3 identified the absence of a proper and comprehensive regulatory framework to manage USPs as another motivation factor. Subsequent respondents interviewed after R3 agreed with this factor. R3 expressed that "any government should have a comprehensive policy framework for PPPs, and due to the absence of such a policy framework, USPs are used to implement PPP projects." Furthermore, R8 explained that "despite the existence of the PPP concept within Sri Lanka for the last few decades, we still lack a proper and matured policy guideline for PPP projects." R12 emphasised that a mature PPP policy framework should outline the proper path and timeline for dealing with PPP projects implemented as USPs. Additionally, R6 stated that "as a country, there is an absence of a strategic approach, policy, vision, or proper process to use our resources under the PPP modality, and the government becomes market-driven, responding to proposals not initiated by the government." All other respondents echoed similar sentiments. Consequently, this motivation factor often prevails in developing countries, such as Sri Lanka, emphasising the need for well-structured PPP policy guidelines that specifically address USPs.

Discussion

The motivation behind implementing unsolicited PPPs in the Sri Lankan construction industry is influenced by factors such as the desire to expedite project delivery, reduce costs, and enhance infrastructure quality, as revealed in this research. Significant associated risks, including corruption and lack of transparency, also serve as motivating factors. These findings are consistent with existing knowledge, although with nuanced variation. Although technical incapability in the public sector is a general motivator, it is not an agreed-upon motivator in the Sri Lankan context. Respondents emphasised the need for policy directives to properly utilise expertise, rather than a lack of technical expertise. According to Mallisetti et al. (2021), policy directives are crucial in the context of USPs, suggesting that their absence could be a reliable motivator for USPs in the Sri Lankan context.

Casady & Baxter (2022) identified the need for streamlined USP solicitation, which potentially impacts the negotiation timeline. This point is highlighted in the study's findings, where it was indicated that while USPs are thought to offer rapid procurement, it may not be to the expected level. Consequently, this reduces the government's motivation to select USPs because of the fast procurement. Governments relying on this motivation factor must carefully evaluate whether the overall delays associated with USPs outweigh the benefits compared to solicited projects (Brocklebank, 2014).

While obtaining the private sector's innovative ideas is identified as a motivator (Gibson et al., 2022), this study finds an issue with it. There seems to be an inconsistency in identifying an innovative idea. In the Sri Lankan context, this appears to be a nominal motivator intertwined with other unethical motivators such as the potential for corruption (Verite, 2022). Consequently, the significance of private sector innovative ideas is less than what should be expected. This study further identifies the potential for the government to prioritise less economically beneficial projects through USPs, driven by the motivation to swiftly access private entity finance for public sector projects (Osei-kyei et al., 2018). It is also questionable whether private investors' lack of interest in developing remote areas is a genuine motivator for selecting USPs. It was pointed out that, if this were the case, investors might impose significant tariffs, making projects in such regions unviable for the communities.

Concerns about entrusting the proposed project to a less qualified firm through competitive bidding are also a motivator for the preference of USPs in Sri Lanka. This highlights the limitations of current public procurement practices (Mallisetti & Dolla, 2021). However, the information gaps between public agencies and USP proponents can make it difficult for the public sector to actively shape and structure the project, affecting its value for money (Casady & Baxter, 2021; Gibson et al., 2022) and reducing the real impact of this motivator. It is also questionable whether the protection of intellectual property rights could become a real motivator because such protection is required only if there is a USP in place. The potential for corrupt practices through the use of USPs is deeply ingrained in the Sri Lankan context. The protection of such practices by a network engaged in corrupt activities makes their detection challenging. This factor becomes a critical motivator, because it may manipulate other motivating factors for its own benefit.

Institutional motivations, formally acknowledged by governments or incorporated into USP frameworks, along with the personal motivations of decision-makers, both politicians and public officials, play crucial roles. Consistency of this was observed between the literature and data. It becomes clear that, when managing USPs, governments must identify motivation factors specific to their country and regulations (World Bank Group, 2017).

Conclusions

In conclusion, the motivators for adopting Unsolicited Proposals (USPs) in the Sri Lankan context reflect a multifaceted landscape. While technical incapability within the public sector lacks unanimous agreement as a motivator, this study highlights the pivotal role of policy directives in shaping the utilisation of expertise. The absence of a comprehensive regulatory framework has

emerged as a significant motivator for USPs, emphasising the need for well-structured policy guidelines specific to this approach. Private sector innovation, while recognised in the literature, is portrayed as a nominal motivator intricately linked with potentially unethical practices. The government's potential prioritisation of less economically beneficial projects through USPs, driven by the motivation to access private entity finance rapidly, raises questions about genuine investor interest in remote areas. Crucially, the deeply rooted perception of the potential for corrupt practices presents a complex motivator, influencing and potentially manipulating other drivers. Navigating this nuanced landscape requires tailored strategies and policy frameworks to ensure transparency, efficiency, and ethical practices for USP implementation.

The potential for corrupt practices also brings a key limitation to this study, because it could significantly manipulate other motivators that appear differently from reality. Deeper interventions, such as ethnographic studies, are required to investigate this type of context. Researchers must take necessary precautions to minimise the risks involved in conducting such studies. Another limitation lies in the study's focus on broad justifications for using USPs rather than a thorough examination of inherent characteristics, such as push and pull theories. Future research could build on these generic motivations. Additionally, investigating the drivers of the private sector's interest in USP agreements remains a topic for future studies.

CONTRIBUTION OF THE STUDY

Theoretical Contribution

The theoretical contribution of this research is particularly significant as there are no studies that have explored the motivations to implementing USPs in the Sri Lankan context. Implementing a PPP project as a USP consisting with numerous challenges such as corruption, restricted social and economic advantages, inadequate value for money, lack of transparency, misallocation of risks, absence of competitive bidding, favoritism, and unfair practices. These challenges resonate within the Sri Lankan context as well. However, understanding the motivations driving the Sri Lankan government's interest in implementing USP projects is pivotal. Therefore, this study is bridging the knowledge gap on identifying the motivations and success factors behind the implementing of USPs in Sri Lankan context. By delving into this unexplored territory, the research contributes to the theoretical understanding of PPP dynamics, shedding light on the intricacies of decision-making processes and policy frameworks within the context of infrastructure development and public-private collaborations.

Practical Contribution

In terms of practical implications of this study which is the motivations for implementing USPs in Sri Lankan context, offer valuable insights for government officials, policymakers, industry, and academic professionals in the country. This study also provides guidance to ensure the effective implementation of a USP project while understanding the motivations factors of the country.

References

1. Aziz, A.A., & Nabavi, H. (2014). Unsolicited proposals for PPP projects: Private sector perceptions in the USA. Construction Research Congress 2014: Construction in a Global Network - Proceedings of the 2014 Construction Research Congress, 1349–1358. https://doi.org/10.1061/9780784413517.138

2. Boyer, E. J., & Scheller, D. S. (2018). An Examination of State-Level Public–Private Partnership Adoption: Analyzing Economic, Political, and Demand-Related Determinants of PPPs. Public Works Management and Policy, 23(1), 5–33. https://doi.org/10.1177/1087724X17729097

3. Casady, C. B., & Baxter, D. (2022). Procuring healthcare public-private partnerships (PPPs) through unsolicited proposals during the COVID-19 pandemic. Journal of Public Procurement, 22(1), 6–16.

4. Castelblanco, G., & Guevara, J. (2020). Risk Allocation in PPP Unsolicited and Solicited Proposals in Latin America: Pilot Study in Colombia. Construction Research Congress 2020, 1321–1329.

5. Chew, A. (2015). Use of unsolicited proposals for new projects-the approaches in Australia. Eur. Procurement & Pub. Private Partnership L. Rev., 10, 29.

6. Creswell, J. W. (2014). Research Design: Qualitative, Quantitative and Mixed Methods Approaches. In Notes and Queries (Vols. s4-I, Issue 25). https://doi.org/10.1093/nq/s4-I.25.577-c

7. Cronin, P., Ryan, F., & Coughlan, M. (2008). Undertaking a literature review: a step-by-step approach. British Journal of Nursing, 17(1), 38–43.

8. David-Barret, E., & Fazekas, M. (2020). Grand corruption and government change: an analysis of partisan favoritism in public procurement Content courtesy of Springer Nature , terms of use apply . Rights reserved . Content courtesy of Springer Nature , terms of use apply . Rights reserved . 411–430.

9. Fernando, G., Kulathunga, U., Thayaparan, M., & Hadiwattege, C. (2023). Legal And Regulatory Framework Related To Unsolicited Proposals In Various Countries: A Systematic Review For Procurement Stage. The 11th World Construction Symposium, July, 712–726.

10. Geddes, R. R., & Wagner, B. L. (2013). Why do U.S. states adopt public-private partnership enabling legislation? Journal of Urban Economics, 78, 30–41. https://doi.org/10.1016/j.jue.2013.05.003

11. Gibson, C., Legacy, C., & Rogers, D. (2023). Deal-making, elite networks and public–private hybridisation: More-than-neoliberal urban governance. Urban Studies, 60(1), 183–199.

12. Hodges, J. T., & Dellacha, G. (2007). Unsolicited infrastructure proposals: How some countries introduce competition and transparency, GRIDLINES, March, Note No 19.

13. Hong, Y., & Chan, D. W. M. (2014). Research trend of joint ventures in construction: a two-decade taxonomic review. Journal of Facilities Management, 12(2), 118–141.

14. Huberman, A. M., & Miles, M. B. (1994). An Expanded Source Book: Qualitative Data Analysis. In SAGE publications London: Vol. 2nd ed.

15. Li, B., Akintoye, A., Corresponding, P. J. E., Hardcastle, C., Li, B., Akintoye, A., Corresponding, P. J. E., Hardcastle, C., Li, B., Akintoye, A., Edwards, P. J., & Hardcastle, C. (2007). Critical success factors for PPP / PFI projects in the UK construction industry Critical success factors for PPP / PFI projects in the UK construction industry. 6193. https://doi.org/10.1080/01446190500041537

16. Mallisetti, V., & Dolla, T. (2021). Motivations and Critical Success Factors of Indian Public – Private Partnership Unsolicited Proposals. Journal of The Institution of Engineers (India): Series A, 102(1), 225–236. https://doi.org/10.1007/s40030-020-00494-w

17. Mallisetti, V., Dolla, T., & Laishram, B. (2022). Unpacking the framework of unsolicited proposal for public private partnership projects – the Indian case. Journal of Financial Management of Property and Construction, 27(2), 179–198. https://doi.org/10.1108/JFMPC-04-2020-0021

18. Marques, R. C. (2018). Empirical Evidence of Unsolicited Proposals in PPP Arrangements: A Comparison of Brazil, Korea and the USA. Journal of Comparative Policy Analysis: Research and Practice, 20(5), 435–450. https://doi.org/10.1080/13876988.2017.1390866

19. Moon, W. S., Ku, S., Jo, H., & Sim, J. (2023). The institutional effects of public–private partnerships on competition: unsolicited proposal projects. Journal of Public Procurement, 23(1), 56–77. https://doi.org/10.1108/JOPP-10-2021-0066

20. Ng, S. T., Wong, J. M. W., & Wong, K. K. W. (2013). A public private people partnerships (P4) process framework for infrastructure development in Hong Kong. Cities, 31, 370–381. https://doi.org/10.1016/j.cities.2012.12.002

21. Nyagormey, J. J., Baiden, B. K., Nani, G., & Adinyira, E. (2020). Review on criteria for evaluating unsolicited public – private partnership PPP proposals from 2004 to 2018 proposals from 2004 to 2018. International Journal of Construction Management, 0(0), 1–15. https://doi.org/10.1080/15623599.2020. 1783596

22. Omrany, H., Chang, R., Soebarto, V., Zhang, Y., Ghaffarianhoseini, A., & Zuo, J. (2022). A bibliometric review of net zero energy building research 1995–2022. Energy and Buildings, 262, 111996.

23. Osei-Kyei, R., & Chan, A. P. C. (2017). Implementation constraints in public-private partnership. Journal of Facilities Management, 15(1), 90–106. https://doi.org/10.1108/jfm-07-2016-0032

24. Osei-Kyei, R., Chan, A. P. C., & Dansoh, A. (2020). Project selection index for unsolicited public–private partnership proposals. International Journal of Construction Management, 20(6), 555–566. https://doi.org/10.1080/15623599. 2019.1573480

25. Osei-kyei, R., Chan, A. P. C., Dansoh, A., Ofori-kuragu, J. K., & Oppong, G. D. (2018). Strategies for Effective Management of Unsolicited Public – Private Partnership Proposals. 34(3), 1–12. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000598.

26. Patton, M. Q. (2002). Qualitative research & evaluation methods. sage.

27. PPIAF (2014). Unsolicited Proposals – An Exception to Public Initiation of Infrastructure PPPs An Analysis of Global Trends and Lessons Learned. August. World Bank, Washington DC. Available at: www.ppiaf.org.

28. Raouf, A. M., & Al-Ghamdi, S. G. (2019). Effectiveness of project delivery systems in executing green buildings. Journal of Construction Engineering and Management, 145(10), 3119005.

29. Takano, G. (2017). Public-Private Partnerships as rent-seeking opportunities : A case study on an unsolicited proposal in Lima , Peru. Utilities Policy, 1–11. https://doi.org/10.1016/j.jup.2017.08.005

30. Tawfik, G. M., Dila, K. A. S., Mohamed, M. Y. F., Tam, D. N. H., Kien, N. D., Ahmed, A. M., & Huy, N. T. (2019). A step by step guide for conducting a systematic review and meta-analysis with simulation data. Tropical Medicine and Health, 47(1), 1–9.

31. The Economist Intelligence Unit. (2020). Infrascope: The Enabling Environment for Public-Private Partnerships. In Millennium Challenge Corporation (MCC) (Vol. 64, Issue 2).

32. Uman, L. S. (2011). Systematic reviews and meta-analyses. Journal of the Canadian Academy of Child and Adolescent Psychiatry, 20(1), 57.

33. Verite. (2021). Opportunities to Protect Public Interest in Public Infrastructure: Review of Regulatory Frameworks in Sri Lanka Opportunities to Protect Public Interest in Public Infrastructure : Review of Regulatory Frameworks in Sri Lanka, February. Available at: https://www.veriteresearch.org/publication/opportunities-to-protect-public-interest-in-public-infrastructure-feb-2021. (Accessed 12 December 2023)

34. Verite. (2022). The Lure of Chinese Loans: Sri Lanka's Experiment with a Special Framework to Finance Its Infrastructure Investments, August. Available at: https://www.veriteresearch.org/publication/the-lure-of-chinese-loans. (Accessed 12 December 2023)

35. Verma, S. (2010). Government Obligations In Public-Private Partnership Contracts. Journal Of Public Procurement, VOLUME 10, 10(1), 565–590.

36. Verweij, S., & Trell, E.-M. (2019). Qualitative comparative analysis (QCA) in spatial planning research and related disciplines: A systematic literature review of applications. Journal of Planning Literature, 34(3), 300–317.

37. von Danwitz, S. (2018). Managing inter-firm projects: A systematic review and directions for future research. International Journal of Project Management, 36(3), 525–541.

38. World Bank Group/PPIAF (2018). Policy Guidelines for Managing Unsolicited Proposals in Infrastructure Projects. Available at: https://ppp.worldbank.org/public-private-partnership/library/policy-guidelines-managing-unsolicited -proposals-infrastructure-projects-volume-i-volume-ii-and-volume-iii. (Accessed 12 December 2023)

39. World Bank Group (2017). Sri Lanka PPP Diagnostic Note: Accelerating Infrastructure Investment through PPPs. World Bank, Washington, DC. https://doi.org/10.1596/28462

40. Yigitcanlar, T., Kamruzzaman, M., Foth, M., Sabatini-Marques, J., Da Costa, E., & Ioppolo, G. (2019). Can cities become smart without being sustainable? A systematic review of the literature. Sustainable Cities and Society, 45, 348–365.

41. Zawawi, Z., Imran, M., Kulatunga, U., & Thayaparan, M. (2016). Malaysian experience with public-private partnership (PPP) Managing unsolicited proposal. Built Environment Project and Asset Management, 6(5), 508–520. https://doi.org/10.1108/BEPAM-10-2015-0059

EXPLORING ALTERNATIVE FOUNDATION SYSTEMS FOR LOW TO MIDDLE INCOME RESIDENTIAL AND COMMERCIAL BUILDINGS UNDER EXTREME SOIL CONDITIONS: A CASE STUDY OF GAMPAHA DISTRICT

Dilantha Premadasa[1], Kamal L Meedeniya[1]
National Engineering Research and Development Centre of Sri Lanka [1]

Abstract:

This research explores alternative foundation systems for Low to Middle Income Residential and Commercial Buildings in areas with extreme soil conditions, specifically in the Gampaha District of Sri Lanka. With rapid urbanization and land scarcity, many low- to middle-income homeowners are forced to construct on marshy or unstable soils, resulting in structural instability and frequent foundation failures. The study aims to propose cost-effective, sustainable foundation solutions to address these challenges.

A comprehensive methodology, including a detailed literature review, site investigations, field testing, and data analysis, was employed. The research focused on analyzing soil conditions such as low bearing capacity and high water tables, common in the region. Traditional deep foundations, though effective, are often too costly for low-income residents. Therefore, the study tested alternative solutions using precast concrete cylinders and quarry dust to create affordable, durable foundations.

Field tests were conducted at two construction sites, validating the proposed system's effectiveness in improving structural stability. The research findings offer valuable insights into the design and implementation of foundation systems for challenging soil conditions. The study provides a replicable model for Low to Middle Income Residential and Commercial Buildings residential construction in similar environments, contributing to safer and more cost-efficient building practices. This research holds significant implications for both local and regional construction practices, particularly in areas facing extreme soil challenges.

Keywords: Alternative foundation systems, extreme soil conditions, soil bearing capacity, precast concrete cylinders, sustainable construction.

1. Introduction

Land scarcity and rapid population growth have compelled people to inhabit increasingly challenging areas. In Sri Lanka, many residential plots are situated on difficult terrain with problematic soil conditions, and the majority of Sri Lankans, being middle-income earners, often cannot afford premium land with solid ground, which is ideal for building residential structures.

Since 1950, Sri Lanka's urban population has been gradually increasing, though at a slower pace compared to other developing nations. By 1995, approximately 4.5 million people resided near urban centers, with urban population growth at 2.5%, outpacing the overall population growth of 1.4%. The rising demand for housing has driven up land prices, leading to the construction of homes on less suitable plots, such as those with soft clay soils (Jayasinghe, 2004).

When affordable, stable land is unavailable, people often turn to developing marshy areas or other lands with extreme soil conditions. These areas present significant challenges, particularly in foundation design, as the soil tends to have a low bearing capacity and high water table levels. Common solutions include pile foundations and soil improvement techniques, though pile foundations are typically cost-prohibitive for middle- and low-income groups. As a result, many opt for traditional pad foundations combined with soil improvement measures. Unfortunately, improper construction techniques often lead to foundation failures.

This research seeks to address the need for an alternative, cost-effective foundation system for constructing Low to Middle Income Residential and Commercial Buildings on extreme soil conditions. The key objectives are:

1. To propose an alternative foundation system that enhances current practices and is affordable.
2. To identify the most suitable foundation types for extreme soil conditions.
3. To disseminate findings through publication.
4. To bridge the gap in research on foundation systems in marshy or extreme soil environments.

2. Literature Review

A comprehensive literature database was developed as part of this research, focusing on alternative foundation types for Low to Middle Income Residential and Commercial Buildings in extreme soil conditions in the Gampaha District of Sri Lanka. The reviewed studies spanned the period from 1970 to 2021, including original research published in English. The literature primarily focused on foundation design criteria for Low to Middle Income Residential and Commercial Buildings in areas with problematic soil conditions. The strategy and exclusion criteria used for the literature review are outlined in the flow diagram below, titled "Flow Diagram of the Strategy and Exclusion Criteria."

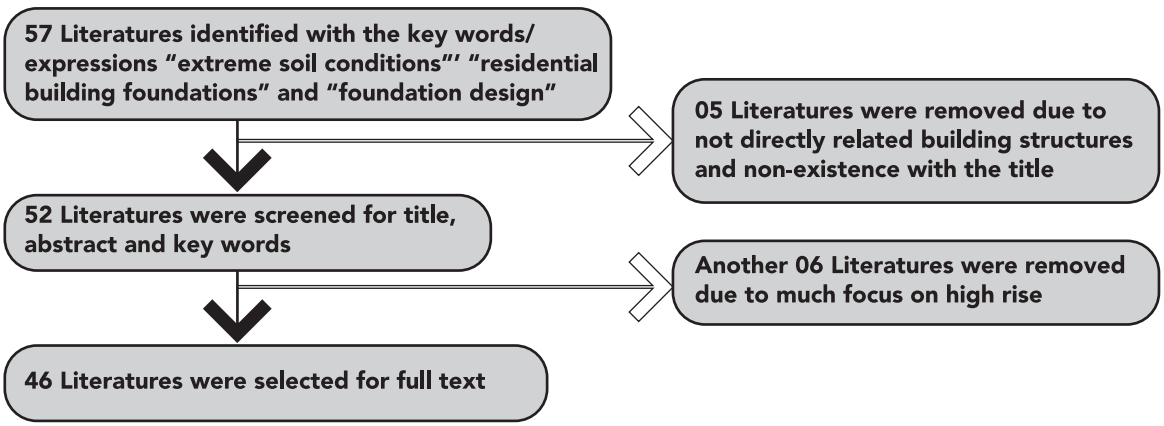
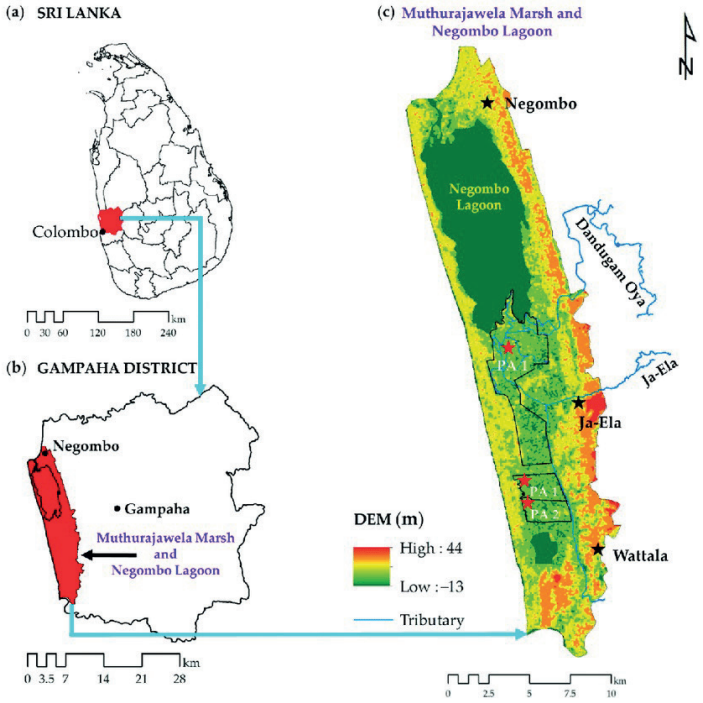


Figure 2-1 : Flow diagram of the used strategy and exclusion criteria

2.1. Geographic and Environmental Overview of Gampaha District

The Gampaha District, located in the Western Province of Sri Lanka, is the second-largest industrialized area in the country, home to numerous industries that contribute to its economic importance. However, the district also presents a range of soil-related challenges due to its geographical features. The district is bordered by the Kelani River to the south and the Ma Oya River to the north, and the Indian Ocean forms its western boundary. It has a humid climate with annual rainfall ranging between 2,000 and 3,500 mm, primarily from the Southwest and Northeast monsoons, contributing to intense rock weathering and the formation of thick lateritic soil layers.

The soil profile in Gampaha District varies widely, with certain areas, such as the Muthurajawela Marsh, consisting primarily of peat and other poorly drained organic soils. Muthurajawela is one of the largest coastal peat bogs in Sri Lanka, and its unique soil properties make foundation construction particularly challenging. Peat soils are known for their low bearing capacity and high water retention, which contribute to excessive settlement and instability in building foundations (Bambaradeniya, 2008).



Source: https://www.researchgate.net/figure/Location-of-the-study-area-a-map-of-Sri-Lanka-26-b-Gampaha-District-and-c_fig1_355374004/download

Figure 2.2: Muthurajawela MArsh and Negombo Lagoon

2.2. Challenges of Building on Wetlands and Poor Soil Conditions

Constructing foundations in wetlands or areas with extreme soil conditions, such as marshlands, requires special considerations. Wetlands are saturated environments where water is present near or above the surface for much of the year, and these conditions lead to soil properties that are unfavorable for construction (Erika, 2022). Problems such as low bearing capacity, high settlement potential, and susceptibility to differential movement make it difficult to build stable structures without significant soil improvement efforts (Korff, 2009).

Previous studies highlight the challenges of constructing on weak soils, emphasizing the importance of foundation design in achieving structural stability. The foundation is responsible for bearing the loads from the superstructure and transferring them to the ground. If the soil beneath the foundation is weak or unstable, issues like foundation movement, distortion, and damage to the superstructure can occur (Salena, 2016). This is particularly relevant in areas like Gampaha, where the high water table and soft clay soils create difficult building conditions (Fernando, 2018).

2.3. Design Criteria for Foundations in Problematic Soils

The literature also reveals that the design of foundations in weak soil conditions often involves either deep foundations, such as piles, or soil improvement techniques. Shallow foundations are more cost-effective but require careful evaluation of the soil's bearing capacity and settlement characteristics. In the case of extreme soil conditions, alternative foundation solutions are necessary to prevent structural failure.

One critical consideration is the soil's bearing capacity, which refers to the maximum load the soil can support without experiencing shear failure. This parameter is essential in the design of shallow foundations and must be thoroughly evaluated for residential buildings in marshy areas. Settlement calculations, including immediate and long-term settlements, are also important factors in foundation design (Ajai Kumar Rai, 2017).

2.4. Soil-Structure Interaction and Foundation Failure

Several studies highlight the role of soil-structure interaction in determining the stability of buildings constructed on weak soils. The deformation of soil under load, particularly in soft or expansive soils, can cause large settlements or foundation movement, leading to cracking and other structural damage (Yail J. Kim, 2011). Differential settlement, caused by uneven soil conditions, can be especially harmful, resulting in misalignments and overstressing of structural components.

Understanding the behavior of problematic soils, such as those found in the Muthurajawela Marsh, is crucial for preventing foundation failures. Peat soils, in particular, are prone to excessive settlement due to their high organic content and water retention capabilities (A. Rhett Whitlock, 1996). Therefore, effective soil improvement and foundation stabilization techniques must be employed when building in such areas.

2.5. Alternative Foundation Solutions

Various alternative foundation systems have been proposed for construction on extreme soil conditions. One of the common methods includes using deep foundations, such as driven piles or bored piles, to bypass the weak upper soil layers and transfer the building load to a more stable stratum (Bengt H. Fellenius, 2006). However, these solutions can be expensive, especially for low-income housing.

Shallow foundations, when combined with soil improvement techniques, are often preferred due to their lower cost and simpler construction. Techniques such as preloading, drainage, and the use of geotextiles can enhance the load-bearing capacity of weak soils, making shallow foundations a feasible option in some cases (Michael Majchrzak, 2004). Nevertheless, the effectiveness of these methods depends on the specific soil conditions, and further research is needed to optimize foundation designs for areas like the Gampaha District.

The literature review provides valuable insights into the challenges of building in areas with extreme soil conditions, such as those found in the Gampaha District. While traditional foundation solutions, such as pile foundations, are effective in overcoming weak soil conditions, they are often cost-prohibitive for low-income residential projects. The review also highlights the importance of proper soil investigation, foundation design, and soil improvement techniques to ensure structural stability. This research aims to develop an alternative foundation system that is both cost-effective and suitable for residential construction in challenging soil environments

3. Methodology

The research integrated a structured and systematic approach to explore alternative foundation systems for residential buildings in areas with extreme soil conditions in the Gampaha District. The methodology is outlined as follows:

1. **Literature Review:** A thorough review of existing literature on soil conditions, foundation design, and construction practices was conducted. This provides the theoretical framework and context for identifying alternative foundation types suitable for extreme soil conditions.
2. **Site Identification:** Twenty locations within the Gampaha District, known for problematic soil conditions such as low bearing capacity, high water tables, and marshy soils, were selected for investigation and testing.
3. **Data Collection:** Relevant data on soil characteristics, water table levels, and bearing capacities were collected from existing reports, surveys, and studies specific to the Gampaha District. This data was used for understanding the environmental and geotechnical context.
4. **Visual Site Investigation:** Field visits to the selected locations were conducted to visually inspect soil conditions, topography, and environmental factors, ensuring that practical insights supplement the collected data.
5. **Field Testing:** Empirical tests, such as soil boring, Standard Penetration Tests (SPT), and Plate Load Tests, were conducted on-site to gather real-time data on soil strength, settlement characteristics, and the performance of proposed foundation systems.

6. **Data Modeling and Analysis:** The collected field data model using software tools GEOSTAB for quantitative analysis. This step included evaluating soil-structure interaction and predicting the long-term performance of the proposed foundation systems under real-world conditions.
7. **Pile Observation:** Test piles drive through the extreme soil at selected sites to assess their performance under the extreme soil conditions identified. Parameters such as load-bearing capacity, settlement behavior, and durability were documented and analyzed.
8. **Validation:** The field data and analysis results were validated through cross-comparison with existing standards and practices to ensure accuracy and reliability. If necessary, adjustments were made to refined the foundation system designs.
9. **Reporting and Dissemination:** The findings from the study was compiled into a comprehensive report. A research article was published, and an e-document was distributed to technical officers in the Western Province, sharing the insights and recommendations from the research.

This methodology ensured a systematic progression from theoretical research to field testing and data analysis, led to validated findings on alternative foundation systems were implemented in areas with extreme soil conditions.

4. Data Analysis, Results and Discussion

Based on preliminary data obtained from Technical Officers in Katana Pradeshiya Sabha, Ja Ela Pradeshiya Sabha, Wattala, and Negombo, the research team visited 21 locations. Interviews with building owners and data collection through structured questionnaires provided key insights.

1. Occupant Information and Building Characteristics:
   - The number of occupants in the selected houses ranges from 2 to 7.
   - All buildings studied are single-story structures with floor areas ranging from 800 ft^2 to 1800 ft^2.

2. Age of the Houses:
   - The distribution of house ages is illustrated in the accompanying graph.

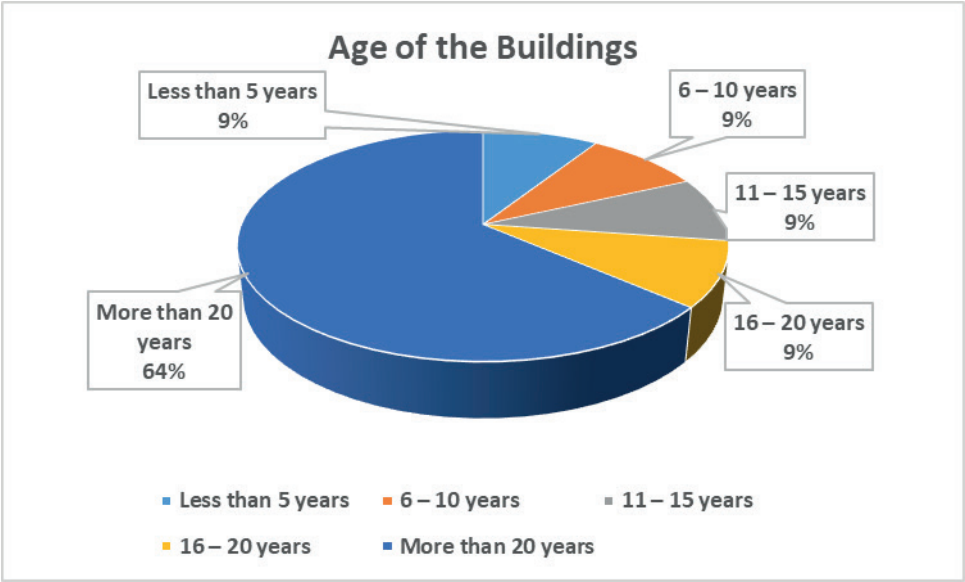


Figure 4 1: Age of the Buildings

The survey revealed that all but one building owner had not tested soil conditions, measured the water table, or sought expert advice for foundation design. The types of foundations used in the sample buildings are detailed in the accompanying chart.

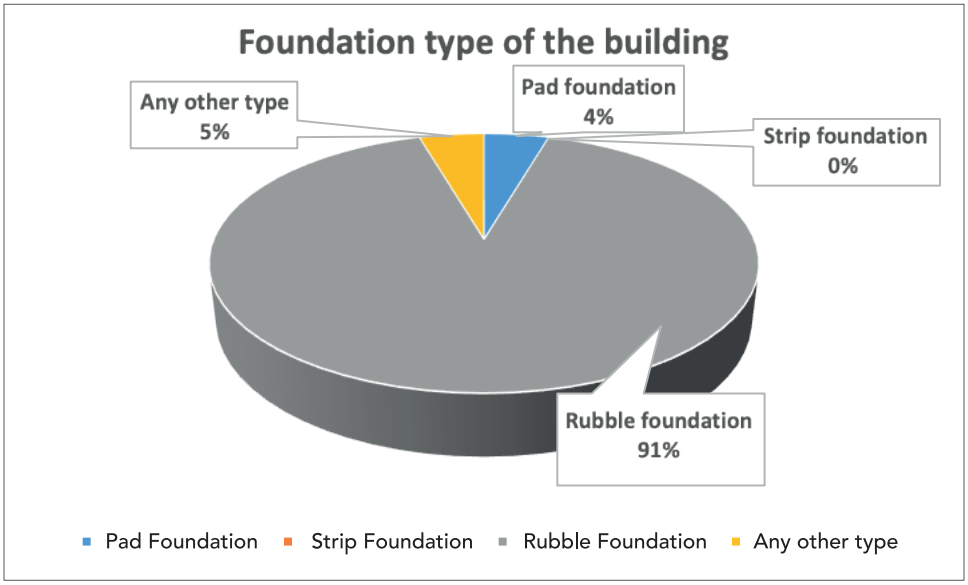


Figure 4 2: Foundation type of the building

- Water Table Depth: The water table in the study areas was found to be less than one foot deep.

- Observed Physical Damages:
  - Significant physical damages were observed in nearly all the buildings, primarily due to foundation settlements.
  - Cracks:
    - Floor Settlements: Cracks in the floors were observed.
    - Wall Cracks: Visible cracks in the walls were present.
    - Hairline Cracks: Hairline cracks (<1.5 mm wide) were noticed on slabs, beams, and/or columns.

Foundations serve as the base level of a building, performing two critical functions: keeping moisture and groundwater out of the structure, and evenly distributing the building's weight among load-bearing walls to the ground beneath. Selecting the correct foundation is crucial, as an inappropriate choice can lead to instability, making the structure unreliable or even dangerous. When choosing the most appropriate foundation for a building, several factors must be considered, including the size of the structure, the type of construction, and the geology, topology, and pedology of the site. Additional factors include accessibility, the presence of water, and space availability on the construction site. Foundations are generally categorized into shallow and deep types:

- Shallow Foundations: Suitable when the structure's load is relatively low compared to the surface soil's bearing capacity.
- Deep Foundations: Necessary when the surface soil's bearing capacity is insufficient to support the structure's load, requiring the load to be transferred to deeper, more stable soil layers.

Due to urbanization and the scarcity of urban land, many people are forced to build on extreme or marshy soils. Most of these are residential buildings, requiring deep foundations or soil improvement methods, which are often costly and require expert supervision. Many residents, being from middle or lower-income backgrounds, opt for unprofessional methods like using PVC pipes or barrel sheets as micro-piles, which do not reach hard soil layers. Consequently, many structures have suffered damage, leading to financial losses and negative impacts on the economy.

This research aims to develop a sustainable foundation system for residents in the Gampaha District who build on extreme soil conditions. The proposed foundation will initially be implemented at two sites: a three-story building in Walisara and a two-story house in Gampaha. After constructing the foundations and loading the columns, slabs, and beams, settlement of each load will be checked.

Calculations:

1. Design Standards: Following design standards were used for the research study.

• Structural Concrete: BS 8110	• Retaining Wall Analysis: BS 8002
• Structural Steel: BS 4449	• Building Materials Weight: BS 648
• Masonry Work: BS 5628	• Building Loading: BS 6399 (1996)

2. Wind Load:
   a) Zone 3 (Sri Lanka Wind Loading): Design of Buildings for High Winds-Sri Lanka, July 1980, Ministry of Local Government, Housing and Construction.
   b) Wind Load References: BSI CP 3: Chapter V: Part 2: September 1972

3. Concrete Covers:
   a) Base Cover: 50 mm
   b) Column Cover: 25 mm
   c) Beam Cover: 25 mm

5. Implementation of Project Outcome

5.1 Construction Sites Selected for implementation

Construction Site A:

Borehole Report

Layer 1 - Sand and Building Debris
Layer 1c/1d - Medium dense to dense

Layer 2 - Sandy Clay
Layer 2c - Sand and gravel / Clay Sand
Layer 2a - Peat Soil

Layer 3 - Sandy Clay
Layer 3c/3d - Firm to Stiff
Layer3d - Stiff
Layer3e - Very Stiff

Layer 4 - Sandy to Complete Weather Rock

Table 1 - Thickness of the different layers at the borehole locations and the observed SPT

BH 1			BH 2		
Layer	Thickness (m)	SPT	Layer	Thickness (m)	SPT
Layer 1	1.00	-	Layer 1	1.00	-
Layer 2c	1.00	06	Layer 2a	4.50	00 - 01
Layer 2a	1.00	00	Layer 3d	3.00	12 - 17
Layer 1c/1d	3.00	34-46	Layer 4d	1.00	12
Layer 3c/3d	1.50	10			
Layer 3d	1.50	15			
Layer 3e	1.50	25			
Layer 3d	1.50	14			
Layer 4d/4e	1.00	20			

Table 2 – Estimated strength parameters and compressibility properties of Layers

Layer	ϕ'	c' (kPa)	c_u (kPa)	$\frac{C_c}{1+e_o}$	OCR	Elastic modulus, E (kPa)	Poisson's ratio, v
Layer 1	-						
Layer 1c/1d	35-36	3				24000-30000	0.27
Layer 2a			5 - 10			500	0.40
Layer 2c			35	0.25	5.8	2000	0.36
Layer 3c/3d			55	0.15	4.5	7000	0.34
Layer 3d			80-100	0.15	5.7-14.2	6000-12000	0.32-0.34
Layer 3e			130	0.15	8.8	17000	0.30
Layer 4d			65	0.075	5.3	8000	0.33
Layer 4d/4e			100	0.075	4.3	14000	0.32

M/s. Kavindu Furniture, No 01, Wellahena, 2nd Lane Welisara Ragama construction site was selected for implementation of project outcome.

The client required three storied furniture showroom building for commercial purposes. After done soil investigation up to 10 feet level soil consist of Peat with degraded vegetable soil, it does not have bearing capacity. Ground water table also near to the ground level. Soil experts recommend to do deep foundation (Bored and Cast in-situ Piles) design for commercial building. The foundation type also costly, client does not have money to implement such foundation system.

Implement 5'0" diameter precast concrete cylinders with filling of Quarry Dust built new foundation type for this building in 2022.

Step 01: The proposed building is Three Storied Building and 5 Feet diameter Precast Concrete Cylinders were selected for the Installation.

Step 02: Insert Five Number Precast Concrete Cylinders (2'0" height) Excavate up to 10 feet level

Figure 5.1: Implementation of Precast Cylindrical Rings with Filling Quarry Dust, Foundation Designed by the Researchers (Construction Site A)

Construction Site B:

Two Storied Building at Gampaha, Indigolla. Insert 3'6" Precast Concrete Cylinders

Water Table	1m lev y Sand(Soft)		0-25
Layer 2	3-5m	Stiff Clay	100-200

Figure 5.2: Implementation of Precast Cylindrical Rings with RCC Cages & Column Reinforcements, Foundation Designed by the Researchers (Construction Site B)

Excavate up to 6 feet level insert 3 Number 3'6" Precast Concrete Cylinders

5.2 Loading Calculation for Three Storied Building & Material Properties

- Maximum Height of Building 30 Feet(10m)
- Expected Loading for Domestic Structures

Design Loads for Domestic Houses	Design Loads for Factories, Work Shop or Similar Building	Considering Three Loading Patterns, without wind Load.
Dead Load - 1.5 kN/m^2	Dead Load - 5.3 kN/m^2	Loading Factor Dead Load - 1.4
Live Load - 1.0 kN/m^2	Live Load - 3.0 kN/m^2	Live Load - 1.6

Ultimate load bearing at 10 feet level approximately 50kN/m^2

Geotechnical Analysis & Validation of Foundation

Maximum Serviceability Load From Columns 200kN

Calculating Elastic Settlement of Foundation

S_c = Elastic Settlement

E_s = Modulus of Elasticity of Soil

H = Thickness of the Soil Layer

μ_s = Poisson ratio of the soil

$\Delta\sigma_x$, $\Delta\sigma_y$, $\Delta\sigma_z$ = Stress increase due to the net applied foundation load in the x,y,z direction

I_z = Strain influence factor

Modulus of Elasticity of Dense Sand 34.50 to 55.20

Poisson's Ratio 0.30 to 0.45

Depth(m)	Δz	Es(kN/m^2)	Average Iz	Iz/Es(m^3/kN)
0 - 1.0	1.0	10,000	0.2333	$0.291x10^{-4}$
1.0 - 1.5	0.5	12,000	0.433	$0.217x10^{-4}$
1.5 - 4.0	2.5	14,000	0.361	$0.903x10^{-4}$
4.0 - 6.0	2.0	16,000	0.111	$0.139x10^{-4}$

C1 = 1-0.5(q/¯q-q) =1-0.5[17.8x1.5/250-(17.8x1.5] = 0.94

C2 = 1 + 0.2 log(5/0.1) =1.34

Hence

S_c = C1,C2/¯q-q)

= 0.94x1.34[200-(17.8x1.5)](1.55x10-4)

= 338.34x10-4m

S_c = **34mm**

Hence, 200kN service load create 34 mm settlement for building

S_T =Total Settlement of a given point

ΔS_T =Difference in total settlement between any two points

In 1950s, Skempton and McDonald Proposed Limiting Values for Maximum settlement angular distortion,

In Clay Soil Maximum Settlement, S_T = 45mm

Maximum differential settlement, ΔST = 76mm

Finding Data Validation Observation Using Visual Observation After Marking Levels in Ground Columns.

Marking Datum on Ground Beam Level and Measuring Ground Settlement using Dumpy Level.

Observation Results .

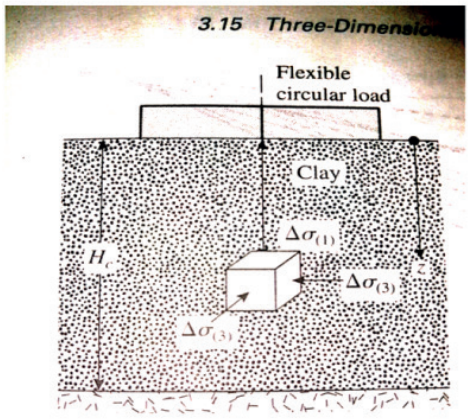


Figure 5.3: Three dimensional Effect on primary consolidation settlement

5.3 Ultimate Bearing Capacity for Circular Foundation

Ultimate Bearing Capacity: Load per unit area of the foundation at which shear failure in soil occurs.

$Qu = 1.3c'Nc + qNq + 0.3\gamma BN\gamma$

Quarry Dust Physical Properties,

Compressive Strength Check for Quarry Dust adding Ordinary Portland Cement with (1:6 portion)

Figure 5.4: Compressive Strength Test Performed at the Materials Testing Laboratory

5.4 Proposed Design of Foundation

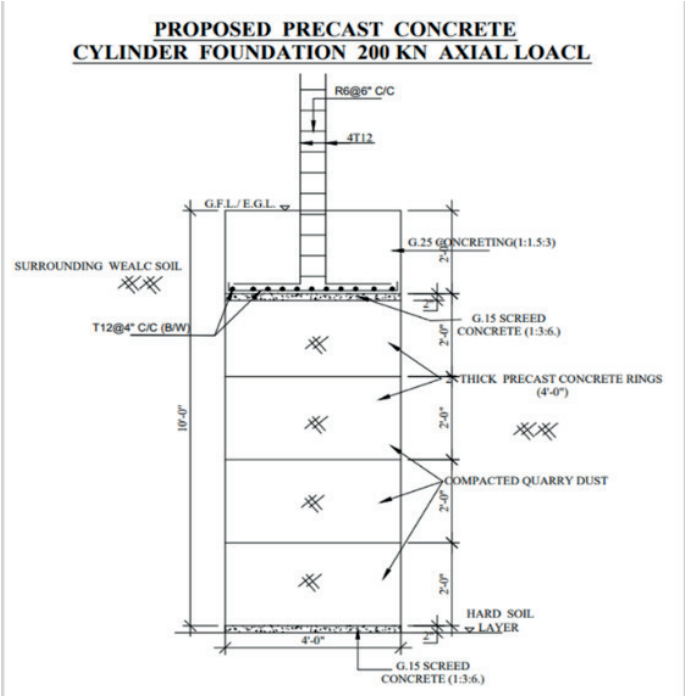


Figure 5.5: Proposed Design Foundation

Figure 5.6: Building Completed with the Proposed Foundation Design

6. Conclusion

The structured methodology employed in this research provided a comprehensive approach to addressing the challenges associated with constructing foundations in extreme soil conditions in the Gampaha District. Through a combination of literature review, site identification, and thorough data collection—including empirical field testing and visual site inspections—the study established a robust foundation for understanding the implications of soil conditions on foundation performance.

The analysis of preliminary data highlighted critical issues such as inadequate soil testing, shallow water tables, and the prevalence of physical damages in buildings due to improper foundation choices. These findings underscore the importance of selecting appropriate foundation systems tailored to specific site conditions to ensure the structural integrity and longevity of buildings.

The proposed sustainable foundation system, tested in two distinct construction sites, demonstrates a viable solution for low- to middle-income residents who are often forced to build on challenging terrains. By utilizing innovative methods such as precast concrete cylinders and quarry dust, this research offers a cost-effective alternative to conventional deep foundations, which are often prohibitively expensive.

The successful implementation of this foundation system in real-world scenarios not only validates the research outcomes but also provides a replicable model for similar projects in regions with comparable soil conditions. The findings, supported by rigorous analysis and field testing, will be disseminated to relevant stakeholders to promote the adoption of these sustainable practices, ultimately contributing to safer and more durable construction in the Gampaha District and beyond.

7. References

1. 1Sruthi Obulreddy, 2. T. (2019, February). A Critical Review on Foundations in Expansive Soils. International Journal of Scientific Development and Research (IJSDR), 4 (2), 13-18.

2. A R Lawal, M. O. (2017). Assessment of types and significant causes of building defects in University of Ilorin, Ilorin, Nigeria. Journal of Research Information in Civil Engineering, 1824-1839.

3. A. Rhett Whitlock, M. A. (1996, February). Foundation Design Considerations for Construction on Marshlands. Technical papers.

4. Ajai Kumar Rai, B. M. (2017, August). A Prospective Study of Design and Development Issues of Various Shallow/Hybrid Foundation as Flood and Earthquake proof Foundation. International Journal of Engineering and Advanced Technology (IJEAT), 06(06).

5. Allen P. Nangan II, 2. U. (n.d.). Concrete Foundation Systems and Footings. World Scientific News.

6. Al-Taie, E. (2016). Analysis of Shallow Foundations in Three Different Regions in Iraq. Doctoral Thesis, Lulea University of Technology.

7. Authority, U. D. (2006). Guidelines for Western Province Wetlands Zoning & Relevant Regulations for Application in Urban Development Plan Preparation. Environment & Landscape Division.

8. Bambaradeniya, C. (2008). Western Province Biodiversity Profile and Conservation Plan. Biodiversity Secretariat .

9. Barthur, R. (197). Design of Residential Footings Built on Expansive Soil using Prbabalistic Method. The University of Adelaide Department of Civil and Environmental Engineering.

10. Bengt H. Fellenius Dr. Tech., P. E. (2006). Basics of Foundation Design. www.Fellenious.net.

11. Bill Coulbourne, D. K. (2009). Recommended Residential Construction for Coastal Areas. FEMA.

12. Building, P. i. (2017, May 25). Four Tips For Building on Wet, Marshy Land. Retrieved from https://www.partnersinbuilding.com/news/four-tips-building-on-wet%2C-marshy-land

13. Chan, R. K. (2006). Foundation Design and Construction. Hong Kong: Geo Publications.

14. CHENG, K. S. (n.d.). Study of Defects in Residential Buildings. Systems and Process Engineering Centre United Kingdom.

15. Commission, G. C. (1991). Master Plan of Muthurajawela Lagoon and Negombo Lagoon.

16. Darshana Athukorala 1, *. R. (2021). Impacts of Urbanization on the Muthurajawela Marsh and Negombo Lagoon, Sri Lanka: Implications for Landscape Planning towards a Sustainable Urban Wetland Ecosystem. MDPI Remote sensing, 2.

17. Department, B. (2017). Code of Practice for Foundations 2017. Colombo: Building Department.

18. Elsamee, W. N. (2013). An Experimental Study on the Effect of Foundation Depth, Size and Shape on Subgrade Reaction of Cohessionless Soil. Engineering, 05.

19. Emerton, L. A. (2003, June). COUNTING THE COSTS OF URBAN WETLAND Proceedings of the National Symposium on Wetland Conservation and Management. Wetland Conservation, 67-73.

20. Erika. (2022). Can you build on wet lands? 11 Things you should know. Retrieved from https://gokcecapital.com/build-on-wetlands/

21. Fernando, S. (2018). Island wide Construction Raw Material Survey Report on Gampaha District. Colombo: Geological Survey and Mines Bureau.

22. Hamakareem, M. I. (2021). Foundation Selection Criteria For the Building. Retrieved from The Constructor Building Ideas: https://theconstructor.org/geotechnical/foundation-selection-criteria/6971/

23. https://lisbdnet.com/how-to-build-a-house-on-swampy-ground/. (n.d.). Retrieved 2022, from Can you build a house in wet land?: https://lisbdnet.com/how-to-build-a-house-on-swampy-ground/

24. Jayasinghe1, M. T. (2004). Foundation Improvements for Blockwork Houses on Weak Soils. Annual Transaction of IESL, 2004 (pp. 162-168). Colombo: Institute of Engineers, Sri Lanka.

25. Jayesh Magar1, A. K. (2020). Study and Analysis of Types of Foundation and Design Construction. International Research Journal of Engineering and Technology (IRJET), 3301-3307.

26. John A. Wickhm, J. (n.d.). Foundations in Expansive Soils. Office of the Chief.

27. Korff, M. (2009). Deformations and damage to buildings adjacent to deep excavations in soft soils literature survey F531. Deltares.

28. Kotinkaduwa, T. (2022, September 05). The Big Land Grab. www.dailymirror.lk. Daily Mirror.

29. Liam WOTHERSPOON1, M. P. (2004). Combined Modelling of Structural and Foundation Systems. 13th World Conference on Earthquake Engineering. Vancouver, B.C., Canada.

30. Limited, S. A. (2011, January). Australian Standard Residential slabs and footings AS 2870—2011. Australian Standard. Standards Australia Limited.

31. Mahmoud Nazarzadeh, S. S.-e. (2017). Probabilistic Analysis of Shallow Foundation Settlement considering Soil Parameters Uncertainty Effects. Open Journal of Geology, 07.

32. Malhotra, S. (September 2008). Installation Behavior of Concrete Cylinder Piles.

33. Michael Majchrzak, M. L. (2004). Settlement of Shallow Foundations Constructed Over Reinforced Soil: Design Estimates vs. Measurements. Fifth International Conference of Case Histories in Geotechnical Engineering. New York.

34. Nippon Koei Co., L. (n.d.). The study on storm water drainage plan for the Colombo metropolitan region in the democratic socialist republic of Sri Lank.

35. O A Arab1, A. J. (2021). Numerical Modelling Observations of Settlement for Pad Footings Supported on Soft Clay Soil. IOP Conf. Series: Materials Science and Engineering 1.

36. Prof. Priyan Dias, P. A. (2015). Hazard Resilient Housing Construction Manual Hazard Resilient Construction Series No. 1. National Building Research Organisation.

37. Ratnayake, S. (2017). Ground Water Pollution Due to Industrial Discharges in Gampaha District. WEPA Action Programme 2017. Colombo: Central Environmental Authority.

38. Salena, I. Y. (2016 , April). A Case Study of Foundation Failure in The Existing Residential Building. Jurnal Teknik Sipil Fakultas Teknik, 02, 91-103.

39. Schmidt, N. O. (1970). Foundations For Low-Cost Housing. International Symposium for Low Cost Housing Problems (pp. 154-155). Missouri: Missouri University of Science and Technology.

40. Tahar Ayadat1, A. H. (2013). Design of Foundations Built on a Shallow Depth (Less than 4 m) of Egyptian Macro-Porous Collapsible Soils. Open Journal of Geology, 03(03).

41. Tubbergh, C. v. (November 2012). The effect of soil conditions on the cost of construction projects. . In D. Booyens.

42. Yago Ryan Pinheiro dos Santos1#, M. I. (2021). Soil-structure interaction analysis in reinforced concrete structures on footing foundation. An International Journal of Geotechnical and Geoenvironmental Engineering, 1-11.

43. Yail J. Kim1, S. G. (November 2011). Settlement Rehabilitation of a 35-Year-Old Building:Case Study Integrated with Analysis and Implementation. PRACTICE PERIODICAL ON STRUCTURAL DESIGN AND CONSTRUCTION , 215-222.

44. Zeevaert, L. (1987). Foundation Engineering for Difficult Subsoil Conditions. (02, Ed.) New York: Van Nostrand Reinhold Company .

Zone 3 (Sri Lanka Wind Loading): Design of Buildings for High Winds-Sri Lanka, July 1980, Ministry of Local Government, Housing and Construction.Wind Load References: BSI CP 3: Chapter V: Part 2: September 1972

9 772012 850003

ISSN 2012 – 8509

CIDA

MINISTRY OF HOUSING, CONSTRUCTION, AND WATER SUPPLY

CONSTRUCTION INDUSTRY DEVELOPMENT AUTHORITY