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MANAGEMENT OF DEFECT CLAIMS IN INFRASTRUCTURE PROJECTS IN SRI LANKA

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Abstract: Infrastructure projects lead to more claims due to their complexity, high cost, and time consumption compared to building projects. Defect claims are considered to be inevitable in infrastructure projects. Thus, this study aims to investigate how to manage defect claims in infrastructure projects in Sri Lanka. The study adopted a mixed research approach Semi-structured interviews with experts was used to identify and validate causes, consequences and management strategies of defect claims in infrastructure projects in Sri Lanka. The Questionnaire survey was conducted to evaluate their significance. Manual content analysis and relative important index was used to analyse the data. The research findings reveal subcontractor failures are the most significant cause of defect claims. Further, the most critical consequence of defect claims is cost overrun, and clear and frequent communication is the most effective strategy for managing defect claims. This study contributes to the theory by exposing significant causes, consequences, and strategies to manage defect claims in infrastructure projects. Findings of the study will help the industry to manage defect claims in infrastructure projects and enable the successful completion of projects by achieving their targets.

Keywords. *Causes, Consequences, Defect claims, Infrastructure projects, Management strategies.*

1. Introduction

Infrastructure projects play a significant role in community development and significantly contribute to a country's economic growth (Martinsuo et al., 2019). However, infrastructure projects are complex, time-consuming, incorporate high risk and externalities, and require more irreversible investments than building projects (Babatunde et al., 2020). At the pre-contract stage, infrastructure projects face difficulties due to some complex tasks that deal with significant community influence, such as land acquisitions, utility relocations, and environmental, forest, and other clearances (Babatunde & Perera, 2017). Furthermore, even in the construction stage, infrastructure projects face environmental issues, public constraints, and requirements for approvals from different authorities (Ferrer et al., 2018). Eventually, this highly stressful and complicated process of infrastructure projects initiates critical issues such as delays, disruptions, disputes, poor performance, and even suspension or termination of the project (Jalal et al., 2021). These issues build a strong background for the evolvement of numerous claims in infrastructure projects (Beiki-Ashkezari et al., 2022).

Le-Hoai et al. (2018) define claims as seeking consideration or change by one of the parties to a contract based on an implied or expressed contract provision. There are different classifications for construction claims based on related parties and their responsibilities, legal basis, rights claimed, and characteristics of claims. Considering parties and their responsibilities, construction claims can be divided into three categories: against the contractor, against the owner, and other contract parties (Khekale & Futane, 2015). Further claims against the contractor are divided into defect, delay, termination, and tort claims (Parikh et al., 2019).

Defect claims are inevitable in any project regardless of its nature or size (Lin et al., 2016). Defect claims may arise due to a breach of express or implied terms (Zaneldin, 2020). If a party breaches express or implied terms such as negligent work, carelessness of workers, poor quality of work, fraud, and breach of products, liability may cause defect claims (Paton-Cole, and Aibinu, 2021). Additionally, heavy rain, flooding, improper approvals, violation of government regulations, and less productivity of plant and labour also may cause defect claims (Fawzy et al., 2018).

Effective claims management is essential for completing the project within the time, cost, and quality framework (Schonbeck et al., 2021). A comprehensive understanding of claims must be managed competently in any construction project, especially in infrastructure(Shahhosseini and Hajarolasvadi, 2021

There are a number of research studies which identify causes (Mishmish & El-Sayegh, 2018; Parikh et al., 2019), consequences (Mills et al., 2009; Paton-Cole & Aibinu, 2021; Hopkin et al., 2017), and management strategies (Jalal et

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al., 2021; Stamatiou et al., 2019) related to claims in typical construction projects. However, defect claims are unescapable and cause severe effects on construction projects. Furthermore, only a few research studies exist related to defect claims in the international context discussing the causes for defects claims (Paton-Cole, and Aibinu, 2021; Sandanayake et al., 2021; Ni-Fhloinn, 2017). In recent years, Sri Lankan government investment in infrastructure has been more than 4% of the GDP annually (Central Bank of Sri Lanka, 2019), meaning there is a significant weightage for infrastructure projects in the national economy. Although defect claims are continuously remaining prevalent as a harmful effect on the success of infrastructure projects, minimum attention was paid by the industry to manage them effectively. Therefore, there is still a critical necessity for identifying and prioritising causes, consequences, and management strategies related to the Sri Lankan context. Thus, the study aims to investigate how to manage defect claims in infrastructure projects in Sri Lanka. The objectives of this study are to identify the significant causes and consequences of defect claims in infrastructure projects in Sri Lanka and propose suitable strategies to manage defect claims in infrastructure projects in Sri Lanka. This research paper covers a comprehensive literature review, a thorough description of the research methodology, an elaboration of research findings in accordance with the specified objectives, and a comprehensive analysis comparing the findings to the existing literature through pattern matching. Lastly, the paper concludes by summarising the key outcomes of the study and providing insightful recommendations derived from the research.

2. Literature Review

2.1. DEFECT CLAIMS

Claims are requests for compensation for losses sustained by a party to the contract over the terms of the contract (Alqershy & Kishore, 2021). Several reasons may cause claims, such as insufficient information, changes, unforeseen circumstances, shortages, acts of God, and mainly conflicts (Matseke & Khatleli, 2021). Construction contracts have different types of claims, such as defect claims, delay claims, duty claims, and disruption claims (Fawzy & El-Adaway, 2015). Defect claims are frequently found in any construction project and often create constraints in achieving project targets (Sandanayake et al., 2021). Construction defects are defined as faults in design, materials, workmanship, or systems used in a construction project which create failure of a component or part of a structure that may cause damage to the property or person (Brogan et al., 2018). Those defects can cause severe issues since defect remedying results in 4-5% of the project's total cost (Sandanayake et al., 2021). In extreme cases, defects can cause critical project failures, resulting in physical injury or damage to people or property, becoming the basis for defect claims (Milion et al., 2017). This latter type of defect is often called passive defect and may lead to serious debate in insurance circles and courts, which highly stresses all the involved parties (Paton-Cole, and Aibinu, 2021).

When the parties enter into a contract, contracting parties accept higher uncertainty when the contract is signed, such as the degree of error contained within the contract documentation and changes in scope (Oppong et al., 2021). Most probably, it may highly contribute to arisen of defect claims (Sandanayake et al., 2021). Also, Jingmond and Agren (2015) explained that carelessness of workers, fraud, and breach of product liability might cause defect claims. Thus Jonsson and Gunnelin (2019) revealed that heavy rain, flooding, improper approvals, violation of government regulations, and negligent work also cause defect claims. Further unrealistic expectations of project participants, poor project management by the main contractor, inadequate specification, late giving possession, and project acceleration are also identified as some of the causes of defect claims (Lin et al., 2016).

When a claim arises during the execution of the project, its consequences can affect the project's success (Parikh et al., 2019). Also, if the construction claims are not adequately managed, it can result in project delays, increase project costs, undermine team spirit, and damage business relationships (Lin et al., 2016). Additionally, deterioration of the quality of the product to be delivered (Nguyen, 2022), loss of productivity, and reduction in investment profits also happen (Kikwasi, 2021). In the worst-case scenario, poor claims management may lead one party to bear the loss unfairly and eventually face insolence (Fazliani & Charoenngam, 2015). Therefore, the best solution is to use management strategies early in the projects to avoid defect claims (Kikwasi, 2021).

2.2 STRATEGIES TO MANAGE DEFECT CLAIMS

Contract administrators and project participants must identify claim avoidance and management strategies to complete the project (Zaneldin, 2020) successfully. The literature proposes different strategies to manage claims in general. Literature suggests maintaining a formalise risk register which can help decision-making if a problem arises, as a popular claim management strategy (Oppong et al., 2021; Kikwasi, 2021; Le-Hoai et al., 2018). Also, Sandanayake et al. (2021) stated that the risk avoidance checklist could be used to eliminate or minimise causes of claims and avoid the risk of claims and wasted effort at the beginning of the projects. In addition, proper construction management (Ameyaw & Chan, 2015), regular communication, and progress monitoring (Kikwasi, 2021) can help administrate the construction process and avoid claims. Due to their unique characteristics, infrastructure projects are usually distinct from general building construction projects (Xiao & Hao, 2021). Therefore, discussing how to identify and manage defect claims in infrastructure projects is essential.

2.3 WHY MANAGING DEFECT CLAIMS IN INFRASTRUCTURE PROJECTS IN SRI LANKA IS CRUCIAL?

Infrastructure projects deal with massive social and economic constraints (Matar et al., 2017). Therefore, there is a high potential for different types of claims occurrence in infrastructure projects. Further, compared to a typical

construction project, the possibility of defects and the consequence of defect claims are also enormous (Parikh et al., 2019). Therefore, defect claims lead to significant damages to these projects, such as cost overruns and delays in completion, damage contractor's reputation, waste time of contract parties and decreased contractor morale (Milion et al., 2017). Further, authors has stated that several defect claims have continued and increased in infrastructure projects in recent years. Therefore, it is evident that defect claim management in infrastructure projects is a crucial topic that eagerly requires industry attention.

Research has been carried out on claims management methods internationally (Zaneldin, 2020; Fawsy et al., 2018; Fawzy & El-Adaway, 2015; Khekale & Futane, 2015; Assaf et al., 2019) as well as in the Sri Lankan context (Sendanayake, 2014; Alwis, 2017). Also, some research studies are carried out related to claim management in infrastructure projects in the international context (Parikh et al., 2019; Hayati et al., 2018) and few in the Sri Lankan context (Nimalasena et al., 2021; Liyanage, 2014). On the other hand, when considering the defect claims, there are limited research studies carried out by past researchers in the international context especially revealing its causes (Paton-Cole, and Aibinu, 2021; Sandanayake et al., 2021; Ni-Fhloinn, 2017) but none of them is related to Sri Lankan context. Therefore, it is still a research gap for defect claim management in Sri Lanka (Sendanayake, 2014). Especially there is a shortage of literature on the causes, consequences and management strategies investigated sufficiently for defect claims in infrastructure projects, both in international and Sri Lankan contexts. Thus, it is vital to rank the causes and consequences of defect claims according to their significance and to propose appropriate strategies to manage defect claims in infrastructure projects, especially in Sri Lanka.

3. Research Methodology

A mixed approach is more effective for research on vulnerable groups than quantitative or qualitative methods in isolation (Morse, 2016). Therefore, this study adopted a mixed approach incorporating semi-structured interviews and a questionnaire survey. The study commenced with a comprehensive literature review. Then semi-structured interviews were conducted to enable the researcher to understand the subject deeply with the flexible questioning pattern (Creswell, 2014). The interview respondents were selected using purposive sampling, according to the criteria given in Table 1.

Table1: Details of semi-structured interview respondents

Interviewee	Designation	Compulsory criteria		Optional criteria	
		Total experience in the construction industry (Yrs)	Experience in claims management in infrastructure (Yrs)	Construction-related MSc/BSc degree	Construction-related professional qualifications
R1	Contract Administrator	20	9	√	√
R2	Contract Administrator	18	7	√	√
R3	Contract Administrator	19	10	√	√
R4	Contract Administrator	17	11	√	√
R5	Project Manager	15	13		√
R6	Project Manager	15	11	√	√
R7	Project Manager	25	16	√	√
R8	Quantity Surveyor	15	5		√
R9	Senior Project Manager	17	7	√	√
R10	Project Quantity Surveyor	20	10	√	√
R11	Project Quantity Surveyor	16	8	√	√
R12	Quantity Surveyor	15	5	√	
R13	Contracts Manager	19	9	√	√

The interviewees were limited to thirteen because data saturation was reached after that point, and no new data were obtained (Saunders et al., 2018). All the information gathered was analysed using manual content analysis in a well-structured manner to improve the quality of the research (Hsieh & Shannon, 2005). Finally, identified specific causes, consequences and management strategies of defect claims were sorted out, amalgamated, and carried further to the questionnaire survey.

Questionnaire surveys help collect data from many respondents and quantify a sample's opinion (Rowley, 2014). Therefore, a questionnaire survey was used to rank and determine the most significant causes, consequences and management strategies of defect claims in infrastructure projects in Sri Lanka. Hundred and fifty questionnaires were distributed among professionals in the construction industry with more than three years of experience in claims management, more than three years of experience in infrastructure projects and more than five years of total experience in the construction industry. Eighty-two responses were received, with a 54.7% response rate. Details of respondents for the questionnaire survey are summarised in Table 2.

Table 2: Details of questionnaire respondents

Profession	Working experience in the Claims Management					Working Experience in infrastructure Projects					Total Working Experience			
	3- 5	5-10	10-15	15<	Total	3-5	5-10	10-15	15 <	Total	5-10	10-15	15 <	Total
Contract Administrators	10	7	4	3	**24**	10	7	5	2	**24**	2	8	14	**24**
Project Managers	5	9	4	2	**20**	5	10	3	2	**20**	2	6	12	**20**
Quantity Surveyors	7	8	5	3	**23**	10	7	6		**23**	3	9	11	**23**
Construction Managers	5	5	2	3	**15**	8	4	1	2	**15**	2	3	10	**15**
Total	**27**	**29**	**15**	**11**	**82**	**33**	**28**	**15**	**6**	**82**	9	26	47	**82**

The data collated from the questionnaire survey were analysed using Relative Important Index (RII). Relative importance index analysis permits prioritising indicators rated on Likert scales (Rooshdi et al., 2018) which is required for the study. Therefore, the point scale was adopted and transformed into relative important indices (RII), as shown below equation.

$$RII = \{ (\sum Wxn)/(AxN) \} \ X100\%$$

where W: Constant expressing the weighting given to each response, A: The highest weighting, n: The frequency of responses, N: Total number of the responses.

Further, the mean weighted rating for each attribute is computed using Standard Deviation (SD) to identify the attributes' behaviour within every type of defect claim, causes of defect claims, consequences of defect claims and strategies to manage defect claims using the following equation.

$$SD=\sqrt{(\sum_{i=1}^{n}(x_i - \bar{x})^2 /n)}$$

where x_i: Response for the attributes, $\bar{x}$: Mean of the data set, Xi: Each value of the population, n: The number of respondents.

Studies discussed factors with an RII value of 0.600 are moderately important factors in a study conducted with a five-point Likert scale (Ujene & Akpanamasi, 2017; Rayan et al., 2022). Therefore, as Holt (2014) suggested, factors with 0.700 or more RII values are considered highly significant in this study. In addition, causes with the lowest SD value are considered as most precise causes. Cronbach's alpha is used to evaluate the internal consistency of a set of test items or scales (Cronbach,1951). According to Nunnally (1978), a data set will become reliable when Cronbach's alpha value is closer to 1 and generally considered more than 0.7 to be reliable. For the current data sets, it was more than 0.8. Therefore, the study can be regarded as reliable.

4. Research Findings

4.1 SIGNIFICANT CAUSES OF DEFECT CLAIMS

The literature review identified fifty causes of defect claims for construction projects. However, from the expert interviews, eighteen causes from the literature have been narrowed down to seven causes, two causes have been removed, and seven new causes have been identified. Therefore, ultimately forty-four causes were carried forward to the questionnaire survey. Out of those, twenty-six causes were identified as significant causes. Bold italic texts in Table 3 refer to the causes modified during the expert interviews. Conversely, causes newly identified by the expert interviewees are in bold text in Table 3.

Table 3: Causes of Defect Claims

Causes of Defect Claims	RII	Std. Dev.	Rank	Causes of Defect Claims	RII	Std. Dev.	Rank
Subcontractor failures	0.894	0.761	1	The productivity of plant and labour	0.756	0.717	14
Inadequate and inexperienced professionals employed	0.856	0.681	2	Contract acceleration	0.75	0.862	15
Site conditions	0.85	0.842	3	Buildability issues	0.744	0.981	16
Improper approvals	0.838	0.821	4	***Arise variations due to the scope change***	0.744	1.021	16
Bad quality of work	0.831	0.654	5	Labour disputes/Union strikes	0.738	0.681	18
Inaccurate topological date	0.825	0.811	6	Impact from the surrounding environment	0.731	1.025	19
Lack of resources	0.819	0.723	7	**Deviations from pre-determined work plans**	0.731	0.631	19
Improper project management	0.813	0.678	8	Unrealised time targets	0.731	0.761	19
Inexperienced contractors	0.805	0.806	9	**Bankruptcy**	0.725	0.864	22
Inadequate specifications	0.8	0.874	10	***Unfair risk allocation***	0.719	0.791	23
Design issues	0.788	0.791	11	Contractors' financial failure	0.713	0.763	24
Unavailability of information	0.769	0.754	12	Delays in work progress	0.706	1.12	25
Import/export restrictions	0.763	0.793	13	Breach of product liability	0.7	1.048	26

As shown in Table 3, out of the forty-four causes of defect claims carried out in the questionnaire survey, twenty-six causes were identified as significant causes for defect claims in Sri Lankan infrastructure projects. Of the significant causes, the subcontractor's failure ranked as the most important cause for defect claims. Regarding this cause, R10 mentioned, "*Some sub-contractors selected by the contractor or even the nominated ones do not have adequate specialisation and experience. Therefore, there is nothing to be surprised by their work which contains tons of defects".* Further, R7 also agreed to this point by stating, "*Even though the contractor may try to remedy those defects by deducting their payments, the overall impact on the quality of the output cannot be denied. This issue is crucial since a considerable portion of these mega projects involves subcontracting*".

Out of the seven new causes identified through the interviews, six were established as significant causes for defect claims other than 'political interface' related to local infrastructure projects. Further, out of seven modified causes derived by the amalgamation of eighteen causes from the literature, five were verified as significant causes. Two non-significant amalgamated causes are 'adverse weather' and 'improper contract document preparation'.

4.2 SIGNIFICANT CONSEQUENCES OF DEFECT CLAIMS

Fourteen consequences of defect claims were identified through the literature review as applicable to general construction projects. However, at the end of the expert interviews, five consequences from the literature were narrowed down to two and three new consequences were also identified. Ultimately fourteen consequences were ranked using the questionnaire survey. Bold italic texts in Table 4 refer to the consequences which were modified during the expert interview. Conversely, consequences which the expert interviewees newly identified are in bold text in Table 4.

Table 5: Consequences of Defect Claims

Consequences of Defect Claims	RII	Std. Dev.	Rank
Cost overrun	0.894	0.983	01
Deterioration of the quality of the product to be delivered	0.819	0.756	02
Produce law quality projects	0.800	0.841	03
Damage Business relationships	0.750	0.823	04
Share information with project parries	0.744	0.759	05
Loss of profit	0.731	0.783	06
Loss of client confidence in project participants	0.725	0.980	07
Delay the Project completion date	0.719	1.016	08
Added investment risks	0.700	0.785	09

As shown in Table 4, nine out of fourteen identified consequences are recognised as significant consequences of defect claims in Sri Lankan infrastructure projects. Three new consequences were revealed through the semi-structured interviews: loss of clients' confidence in consultants, added investment risks and producing low-quality projects. All these three consequences were considered significant for defect claims in Sri Lankan infrastructure projects. When considering the significant causes, R7 revealed that the "*required huge cost for defect rectifications, defect investigations, and other legal expenses due to defect claims is how the defect claims contribute to the cost overrun*" in the interview process. Confirming that the study declares the most significant consequence of defect claims is cost overrun in Sri Lankan infrastructure projects. Furthermore, deterioration of the quality of the product to be delivered and produce low-quality products were identified in the following two rankings in terms of the consequences of the defect claims. Therefore, it confirms R11's response in the interview that "*defects are one of the major causes for quality concerns in infrastructure projects, and it enhances the other negative effects such as time and cost overrun*". Five consequences were recognised as non-significant consequences of defect claims in Sri Lankan infrastructure projects through the fourteen consequences brought forward to the questionnaire from literature and semi-structured interviews. Out of that one consequence, abandonment of the project was amalgamated in the interview from two consequences: abandonment of the project and non-completion.

4.3 SUITABLE STRATEGIES TO MANAGE DEFECT CLAIMS

The literature review identified twenty-eight strategies to manage claims as applicable to general construction projects. However, four literature strategies were narrowed down to two at the end of the expert interviews, and five new strategies were also identified. Ultimately thirty-one strategies were listed and carried forward to the questionnaire survey. Bold italic texts in Table 5 refer to the management strategies which were modified during the expert interview. Conversely, management strategies which the expert interviewees newly identified are in bold text in Table 5.

Table 5: Strategies to manage Defect Claims

Strategies to manage Defect Claims	RII	Std. Dev.	Rank	Strategies to manage Defect Claims	RII	Std. Dev.	Rank
Clear and frequent communication	0.919	0.499	1	Negotiation	0.794	0.325	13
Proper distribution of required information	0.913	0.619	2	Support from top management to the project team	0.781	0.673	14
Establishing quality control measures	0.906	0.671	3	Insurances	0.775	0.718	15
Keep Records	0.9	0.718	4	Third-party review of project design at the tender stage	0.769	0.499	16
Early Notification	0.894	0.761	5	Prequalification of the main contractor	0.763	0.896	17
Use of named subcontractors instead of nominated subcontractors	0.888	0.914	6	Maintain Risk Register	0.756	0.478	18
Create, implement, and utilise a logical and user-friendly schedule	0.881	0.875	7	Risk avoidance checklist	0.756	0.753	18
Monitoring system set up by the main contractor	0.875	0.907	8	Equitable Sharing of Risks	0.75	0.463	20
Scope Assessment	0.856	0.924	9	**Enough resources should be provided**	0.738	0.721	21
Conduct regular Site Meetings	0.85	0.88	10	Setting contingency plans	0.731	1.086	22
Built good team spirit	0.831	0.847	11	**Functional site layout must be assessed and provided**	0.719	0.541	23
Adequate use of professionals should be employed	0.8	0.845	12	Proper identification of roles and responsibilities	0.713	0.634	24

As shown in Table 5, out of the thirty-one strategies to manage defect claims carried to the questionnaire survey, twenty-four were identified as significant strategies to manage defect claims in Sri Lankan infrastructure projects. According to the ranking of the consequences, clear and frequent communication between the parties and the distribution of required information was considered the most significant strategies for managing defect claims in Sri Lankan infrastructure projects. These findings emphasise the importance of regular communication and proper information distribution, which help to reduce defect claims in infrastructure projects in Sri Lanka. R12 highlighted, "*Communication should clarify objectives, expectations, progress, achievements, recognition, and, of course, all the information regularly. Also, the distribution of information achieves a few different purposes, including getting the right information to the right person at the right time. Then overcome most of the incidents before it appears as a defect*." Establishing quality control measures is an amalgamation of two other strategies identified in the literature was ranked next in the present study. It proves the fact discussed by the experts in the interviews that proper quality controlling procedure is significant in infrastructure projects to minimise defects. Out of the five new strategies identified through the interviews, the client's good financial capability was ranked as a non-significant strategy for managing defect claims.

5. Discussion

Defect Claims cause huge damage to projects, and when it originates in infrastructure projects, it affects not only the project but also the entire county's socio-economical aspects at large (Parikh et al., 2019). Therefore, proper knowledge of its causes, consequences and different management strategies are vital to effectively managing these defect claims.

Some causes derived from the literature were removed during the semi-structured interviews. For example, experts rejected claim validity in the presence of notice requirements (Do et al., 2022) in the interview process as it was not a commonly applicable significant cause for defect claims in Sri Lankan infrastructure projects. Further, some causes identified through literature were amalgamated during expert interviews. Three causes as variations initiated by the owner (Jonsson & Gunnelin, 2019; Lin et al., 2016), confusing requirements of the owner and change of scope/ scope definition (Do et al., 2022; Shahhosseini & Hajarolasvadi, 2021) were amalgamated into one cause as "arisen of variations due to scope changes". As identified by Mishmish and El-Sayegh (2018) for road construction projects, Subcontractor failures are confirmed by the study as the most significant cause of defect claims in Sri Lankan infrastructure projects. The study discloses that since subcontractors carry out a large portion of work from the infrastructure projects, there is a considerable effect for defects arising from their faults. Two new causes discovered through the semi-structured interviews were not found in the literature as inadequate and inexperienced professionals employed, and site conditions were established as second and third in the ranking as significant causes for defect claims in Sri Lankan infrastructure projects.

Agreeing with Milion et al. (2017) discussion about defect claims for regular construction projects, this study declares that the most significant consequence of defect claims is cost overrun in Sri Lankan infrastructure projects. Further, the study elaborates that cost overrun may result in many other negative consequences, such as labour and wage issues, material supply issues, time extensions etc. In addition to that, Aibinu et al. (2011) declare that prevention cost is lower than remedies to the claims. Therefore, as Kikwasi (2021) suggested, the ultimate solution is to correctly identify the causes and use suitable management strategies at the early stage of the projects to avoid defect claims and unnecessary costs resulting from the defect claims.

Quality is an essential aspect of any construction project. Babatunde and Perera (2017) discussed that it is a critical requirement because infrastructure projects deal with huge assets and, most of the time, with many people's lives. In most cases, defects can weaken the quality of the project, so the study identifies it as a critical consequence in Sri Lankan infrastructure projects.

In addition to that, damaging business relationships identified by quite authors - (Milion et al., 2017; Lin et al., 2016; Shahhosseini & Hajarolasvadi, 2021; Kikwasi, 2021; Fazliani & Charoenngam, 2015) as a typical consequence which is more likely to occur in infrastructure projects due to the defect claims. However, Fazliani and Charoenngam (2015) have revealed some cases where the claims will not be out due to the fear of damaging business relationships among involved contract parties. Still, in that case, one party has to bear the loss unfairly and may finally end up in bankruptcy even. This statement describes the severity of the 'damage to the business relationship' consequence. The present study also confirmed it as a significant consequence of defect claims in infrastructure projects in Sri Lanka. Moreover, preliminary interview respondents of the study revealed that defect claims definitely cause damage to business relationships, and parties will not work together in the future. Hence, clients fear involving contractors with a history of defect claims in earlier projects, and contractors will not be involved with these clients.

Le-Hoai et al. (2018) and Shen et al. (2017) discussed clear and frequent communication between the parties and proper information flow to all stakeholders selected as the most significant strategy to manage defect claims in the present study. It emphasises that communication is one of the most potent management strategies to avoid/minimise defect claims in a project. Also, this process should clarify objectives, expectations, progress, achievements, recognition, and all the information regularly. Further, experts highlight that this strategy will help to notify issues early and allow negotiating between parties before they turn into claims, so most of the claims can avoid in the unmatured stage.

However, maintaining a risk register was the most frequently discussed strategy in the literature by different authors (Sandanayake et al., 2021; Lin et al., 2016; Mishmish & El-Sayegh, 2018; Ni-Fhloinn, 2017; Le-Hoai et al., 2018). Introducing risk registers, Le-Haoi et al. (2018) describe that risk registers identify the risks associated with the project, then set out how those risks might be managed and identify the time and cost associated with managing those risks. Also, Kikwasi (2021) enlightened that the risk register includes identified risks from previous projects, but the risk register is designed to develop as the project proceeds. This study also confirmed that maintaining a risk register is a significant strategy for managing defect claims in Sri Lankan infrastructure projects.

6. Conclusions and Recommendations

Claim-related studies are executed for different construction projects, but infrastructure projects receive relatively less attention. Therefore, this study aimed to identify the significant causes and consequences of defect claims and strategies that would help to manage defect claims in Sri Lankan infrastructure projects.

The causes, consequences and management strategies of defect claims were validated and ranked according to their significance for the Sri Lankan infrastructure projects using interviews and questionnaire surveys. Twenty-six significant causes were identified in the study. 'Subcontractor failures' was selected as the most significant cause of defect claims. Further, the study substantiated nine significant consequences of defect claims, and 'cost overrun' ranked as the most significant consequence of defect claims in Sri Lankan infrastructure projects. Moreover, thirty-one strategies to manage defect claims were identified, and twenty-four were established as important strategies to manage defect claims in Sri Lankan infrastructure projects. According to the study, the most significant management strategy highly recommended to avoid defect claims is improving clear and frequent communication between all the project stakeholders.

The study contributes to both industry and theory. In past literature, few research identified causes of defect claims internationally, but none tried identifying the consequences and strategies to manage them. Therefore, going beyond the causes, this study deliberated about significant causes, consequences and management strategies for defect claims related to infrastructure projects which is beneficial for the international context as a case study that can use for different contexts such as for developed countries. Also, the present study contributes to the theory by filling the research gap related to defect claim management in infrastructure projects, especially in Sri Lankan context. Effective defect claim management and avoidance can be implemented by identifying their causes and consequences and suitable management strategies to be implemented in the early stage of the construction industry. With the aid of this study, stakeholders can identify potential defect claims and select suitable management strategies to control or minimise their critical consequences. Therefore, it is beneficial for the successful completion of infrastructure projects by achieving its time, cost and quality targets which carry a huge social and economic effect on the industry. Notably, it will protect the relationship with the funding agents because, as discussed, most of these mega infrastructure projects are funded by donors in most developing countries, especially in Sri Lanka.

This study has some limitations. First, this study referred to infrastructure projects in the Sri Lankan context, so the results can differ for building construction projects. Further, this research was done with a generic view of all types of infrastructure projects, and if a study referred to a single type of infrastructure project, the output might be different. Hence, the authors propose to repeat the study for building construction projects or a specific type of infrastructure project.

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