MANAGEMENT OF DEFECT CLAIMS IN INFRASTRUCTURE PROJECTS IN SRI LANKA

Akmeemana Peduruge Jayarangi Nandun Thusharika

(189573 D)

Master of Science in Construction Law and Dispute Resolution

Department of Building Economics

University of Moratuwa

Sri Lanka

November 2022

MANAGEMENT OF DEFECT CLAIMS IN INFRASTRUCTURE PROJECTS IN SRI LANKA

Akmeemana Peduruge Jayarangi Nandun Thusharika
(189573 D)

Dissertation submitted in partial fulfilment of the requirements for
the Master of Science in Construction Law and Dispute Resolution

Department of Building Economics

University of Moratuwa
Sri Lanka

November 2022

DECLARATION

"I declare that this is my own work, and this dissertation does not incorporate, without acknowledgement, any material previously submitted for a Degree or Diploma in any other University or institute of higher learning, and to the best of my knowledge and belief, it does not contain any material previously published or written by another person, except where the acknowledgement is made in the text.

Further, I acknowledge the intellectual contribution of my research supervisor Charted Quantity Surveyor Professor (Mrs.) B.A.K.S. Perera for the successful completion of this research dissertation. I affirm that I will not make any publication from this research without the names of my research supervisor as contributing authors unless otherwise I have obtained written consent from my research supervisors.

Also, I hereby grant to the University of Moratuwa the non-exclusive right to reproduce and distribute my dissertation, in whole or in part, in print, electronic or other mediums. I retain the right to use this content in whole or part in future works (such as articles or books).

…….. 09th November 2022

Thusharika A.P.J.N. Date

The above candidate has carried out research for the Dissertation under my supervision.

……. 09th November 2022

Ch. QS Prof. (Mrs.) B.A.K.S Perera Date

Thesis Supervisor

ABSTRACT

Defect claims are inevitable in construction projects. The complexity, high cost, and time consumption for the completion of infrastructure projects lead to more defect claims. Thus, this study aimed at how to manage defect claims in infrastructure projects in Sri Lanka. Firstly, the types, causes, consequences, and strategies to manage claims were identified through a literature review. This was followed by a detailed study of defect claims in infrastructure projects to identify the types, causes, consequences, and management strategies of defect claims in Sri Lanka. This was accomplished via semi-structured interviews. Next, a questionnaire survey was carried out to identify the most significant types, causes, consequences, and management strategies of defect claims in infrastructure projects in Sri Lanka. Manual content analysis and relative importance index helped analyse the collected empirical data through interviews and questionnaires, respectively.

The research findings revealed seven types of defect claims and identified the most significant defect claim types as construction defects, workmanship defects, design defects, and material defects. The most significant causes of defect claims were indented as subcontractor failures, inadequate and inexperienced professionals employed, site conditions, improper approvals, bad quality of work, inaccurate topological data, lack of resources, improper project management, selected inexperienced contractors, and inadequate specifications. The research findings further disclosed the most significant consequences of defect claims as cost overrun, deterioration of the quality of the product to be delivered, producing low-quality projects, damage to Business relationships, and sharing information with project parties. Furthermore, the most suitable strategies to manage defects claims were disclosed as clear and frequent communication, distribution of the required information, establishing quality control measures, keeping records, early notification, use of named subcontractors rather than nominated subcontractors, creating, implementing, and utilising a logical and user-friendly schedule, monitoring the system set up by the main contractor, scope assessment, and conducting regular site meetings.

Keywords: *Defect Claims, Infrastructure projects, Management, Sri Lanka*

I dedicate this dissertation to my beloved parents for their immense love, care, support, and encouragement.

ACKNOWLEDGEMENT

At this moment of my thesis submission, I would like to express my sincere gratitude to all individuals who supported me throughout my journey, inspiring and encouraging me.

First and foremost, I express my deepest gratitude to my supervisor, Chartered Quantity Surveyor Ch. QS. Prof. (Mrs.) B.A.K.S. Perera for her utmost guidance, assistance, and confidence towards me in succeeding in the research. I am indebted to my supervisor for steering me in the right direction throughout the process.

I also wish to acknowledge the Head of the department, Professor. (Mrs.) Yasangika Sandanayake and all staff members of the Department of Building Economics, University of Moratuwa, for the immense assistance and guidance during the course of this research and for more than two years of my academic career. My sincere gratitude is also extended towards all members of the non-academic staff of the Department of Building Economics for their support.

I am deeply indebted to all experts who were involved in the interview series and questionnaire survey, sharing their valuable knowledge and experience. Without their passionate participation and input, the study could not have been successful.

I also thank my beloved parents, my family, my friends, and all my well-wishers for supporting me in countless ways throughout this dissertation and my life.

Thusharika A.P.J.N.

November 2022

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

ABRIVIATIONS

FIDIC	:	Federation Internationale Des Ingenieurs Counseil
BOQ	:	Bill of Quantities
CRCCI	:	Cooperative Research Centre for Construction Innovation
GDP	:	Gross Development Percentage
AEC	:	Architectural, Engineering, and Construction
AECO	:	Architectural, Engineering, Construction, and Organization

1.0 CHAPTER ONE: INTRODUCTION

1.1 Background

The construction industry is different from other industries; it is complex, huge, and involves many stakeholders (Schonbeck et al., 2021). Most of the construction industry outputs are social development or infrastructure developments such as real estate, transportation systems, public facilities, and industry factories (Xiao & Hao, 2021). Infrastructure projects play a major role in community development and have significantly contributed to the economic growth of the country (Martinsuo et al., 2019).

Infrastructure projects are characterised by unquantifiable externalities, negotiated compromises, high levels of uncertainty and complexity, and large inevitable investments (Babatunde et al., 2020). Every infrastructure project should pass through several stages, such as project planning, approval, contract awards, project construction, operation, and continuous maintenance (Sharma et al., 2022). Initially, at the pre-contract stage, infrastructure projects face difficulties due to several reasons: land acquisitions, utility relocations, environmental, and forest and other clearances (Babatunde & Perera, 2017). During the post-contract period, infrastructure projects face more constraints like environmental issues, public constraints, and approvals from different authorities (Sharma et al., 2022). Therefore, infrastructure projects are considered to have a complex nature, and project managers have a considerable demand level to complete the projects, fulfilling the quality component without exceeding the project budget and time (Alhammadi et al., 2021).

The key objectives of the projects are to be completed on time, within the client's budget, and the quality requirements of the employer (Nguyen et al., 2018). Khlaifat et al. (2019) explained if the construction project is completed within the time at completion, the pre-estimated budget, and the client's quality requirement, the project becomes a success. During the last two decades, the characteristics of construction projects have become more complex. This complexity led to a lengthy

and relational process of construction projects in which claims are virtually ensured (Schonbeck et al., 2021).

A claim is defined as a legal action to obtain money, property, or the enforcement of the innocent party's right protected by law against another party (Parikh et al., 2019). Le-Hoai et al. (2018) further expressed that a claim is the seeking of compensation or consideration of the damage by one of the parties to a contract based on expressed or implied contract provisions.

Various methods can classify construction claims based on related parties and their responsibilities, legal basis, rights claimed, and characteristics of claims (Yousefi et al., 2016). By considering parties and their responsibilities, construction claims divide into three categories as claims against clients, claims against contractors, and claims against other parties (Khekale & Futane, 2015). Claims against the contractor narrow down into delay claims, termination claims, tort claims, defect claims, and other claims (Parikh et al., 2019).

Defects claims are inevitable in projects irrespective of the project's complexity (Zaneldin, 2020). Defects are defined as which are not performed as per the requirements of the construction contract (Milion et al., 2017). Further, defect assessment requires the examination of the terms and conditions in the contract to identify the requirement (Lin et al., 2016).

Construction contracts have two types of defects: patent defects and latent defects (Lundkvist et al., 2014). Patent defects are open and obvious and discovered during regular inspection (Vasquez-Hernandez & Botero, 2019). Those defects are identified during the work period or during the defect's liability period (Abondu et al., 2015). Latent defects are apparently or readily detectable after more years of project completion or long after the defect liability period; they and not easily discovered during the inspections (Vasquez-Hernandez & Luis, 2019).

The defects liability period considers the project defects and what happens when a defect is discovered during that period and it concludes with a review of the law of damages and economic loss (Milion et al., 2017). Construction defect claims are

primarily categorised into four types, design defects, workmanship defects, material defects, and subsurface defects (Fawzy & El-adaway, 2015).

Causes of defect claims are identified as negligent work, carelessness of workers, bad quality of work, fraud and breach of product liability, and subcontractors' improper work (Paton-Cole & Aibinu, 2020). Heavy rain, flooding, improper approvals, breach of government regulations, and the productivity of plant and labour also lead to defect claims (Loulakis & Mclaughlin, 2011).

Improperly managed defects result in increased project costs, project delays, damaged business relationships, and undermined team spirit (Zaneldin, 2020). The effects of defect claims can also be identified as other burdensome project management problems (Le-Hoai et al., 2018). Gad et al. (2020) explained that time and cost overruns, financial embarrassment, and damaged business relationships are the claims' effects.

As per Kumaraswamy (1997), the prevention of claims is better when it converts to conflicts and disputes. A comprehensive understanding of the causes of claims needs planning and controlling of claims in projects (Shahhosseini & Hajarolasvadi, 2018). Parchamijalal et al. (2021) explained that at the pre-contract stage, fair distribution of risk between contract parties and proper contract documentation is identified as strategies to manage the claims. Getting environmental permits and selecting appropriate insurance programmes are identified as claim mitigation methods (Shrestha et al., 2020). In construction projects, defects are very common incidents, and the nature and type of defects can vary dramatically (Ryu et al., 2016). However, minor or major defects, discovered long after the completion of the project, and defending against defect claims are difficult processes (Milion et al., 2017).

However, infrastructure projects may become a risk to all contractual parties if the claims are not identified, managed, or avoided from the commencement stage to the completion stage (Jalal et al., 2021). Infrastructure developments are required to attain efficiency in the economy, social equity, and proper environmental structure (Jin et al., 2012). In many developing countries, issues claims have led to overall underdevelopment and poor performance that delay completion in the construction

industry (Jalal et al., 2019). Sultan and Alaghbari (2021) explained that the underdevelopment of the construction industry adversely affect a country's economic development.

1.2 Research Problem

According to the analytical forecasting made by Mckinsey Global Institute in 2017, among most of the global infrastructure investment projects, nearly two-thirds (63%) were made during the period between 2017 and 2035 would have to be in emerging economies. Sri Lankan government investments in infrastructure in 2015, 2016, 2017, 2018, and 2019 were 5.1%, 4.5%, 4.6%, 4.3%, and 4.1% of the GDP, respectively (The Central Bank of Sri Lanka, 2019). Projects in recent years are more complex, and they have high uncertainty levels (Xiao & Hao, 2021). Due to that complexity, claims are inherent characteristics (Nguyen et al., 2018).

Furthermore, the project risk and the occurrence of defects have increased due to the expansiveness and complexity of projects (Stamatiou et al., 2019). Moreover, claims are more vital in infrastructure projects than other projects (Gad et al., 2020). As stated by Sandanayake (2021), most claims finally boil down to exceeding the cost, quality, and completion time of the projects; those causes must be prevented. Hence, claim management is important for project success (Kikwasi, 2021).

Several research studies have explored the methods of claims management in the international and Sri Lankan contexts (Sandanayake, 2021). Shahhosseini and Hajarolasvadi (2018) explained that fair contract risk allocation, proper contract documentation, and expert involvement are claim management strategies. According to Kikwasi (2021), maintaining a claim avoidance checklist and risk register are also claim management strategies.

However, only a few research studies have attempted to identify causes, effects, and management strategies on claims internationally as well as in the Sri Lankan context (Sandanayake et al., 2021). Hence, a research gap still exists for defect claims management in infrastructure projects in Sri Lanka (Chathuranga & Pasindu, 2018).

Especially the causes, consequences, and prevention strategies are not investigated in the literature sufficiently (Gad et al., 2020). Thus, defect claims still remain prevalent as a bad effect on the success of the infrastructure projects in Sri Lanka. Therefore, it is essential to perform research regarding the management of defect claims in infrastructure projects.

1.3 Aim

This study aims to investigate how to manage defect claims in infrastructure projects in Sri Lanka.

1.4 Objectives

- Identify common types of defect claims in infrastructure projects in Sri Lanka
- Identify the most significant types of defect claims in infrastructure projects in Sri Lanka
- Identify the most significant causes of defect claims in infrastructure projects in Sri Lanka
- Identify the most significant consequences for the above-identified causes of defect claims in infrastructure projects in Sri Lanka
- Propose suitable strategies to manage defect claims in infrastructure projects in Sri Lanka

1.5 Scope and Limitation

This research focused on infrastructure projects which use FIDIC conditions of contract.

1.6 Methodology

a. Literature Review

A comprehensive literature survey was conducted to identify the research gap and existing theoretical findings on types of defects claims, causes, consequences, and management strategies for infrastructure projects by referring textbooks, journals, conference proceedings, articles, dissertations, reports, and other electronic sources.

b. Expert Interviews

Expert interviews were held to moderate the literature survey findings and identify the relevancy of defect claim types, causes, effects, and management strategies in infrastructure projects in Sri Lanka. Data collected through interviews were analysed via manual content analysis.

c. Questionnaire surveys

A questionnaire survey was conducted to identify the most significant types, causes, and effects of defect claims and strategies to manage defect claims in infrastructure projects in Sri Lanka. Data collected via the questionnaire survey were analysed using the relative importance index and standard deviation.

1.7 Chapter breakdown

A detailed description of each chapter of the report is provided below, mainly composed of five chapters. Each chapter has a corresponding discussion.

Chapter I (Introduction)

Establish the research foundation by expressing the study background, the research problem engaging on literature and industry gap, the aim and objectives of the study, research methodology, and scope and limitations.

Chapter II (Literature Review)

Critically investigate the theoretical background on types, causes, effects, and management strategies of defect claims in infrastructure projects.

Chapter III (Research Methodology)

Explains the research method that should follow with data collecting and data analysing methods, including all research processes.

Chapter IV (Research Findings and analysis)

Presents the study findings using analysed data gathered through expert interview outputs and detailed questionnaire outputs.

Chapter V (Conclusion and Recommendations)

Concludes the research findings and suggests recommendations and paths for further research areas.

1.8 Summary

This chapter reviewed the background to the defects claims in infrastructure projects, identified the nature of the construction industry, the features of infrastructure projects, definitions of claims, the legal basis of the claims, defects claims, causes and effects of claims to the project, and management strategies of claims.

In light of the above findings, several researchers have done claims management in the international context, but only a few research works have explored the Sri Lankan context. Also, only very few research studies have evaluated defect claims internationally, and no research has been reported in the Sri Lankan context. Hence, a research gap was identified as the defects claims management in infrastructure projects in the Sri Lankan construction industry. The authors further identified the aim, research objectives, scope and limitations, methodology, and the chapter breakdown for the research topic. Chapter 02 provides a detailed description of the literature findings on the defects claims in infrastructure projects.

2.0 CHAPTER TWO: LITERATURE SYNTHESIS

2.1 Introduction

Chapter One accomplishes the research aim and objectives, and Chapter Two intends to present a comprehensive literature review regarding the research area and establish context based on the findings and observations of different authors. Basically, it identifies the overview of the construction projects, claims in construction projects, types of defects claims, the concept of defects claims, and the inter-relationship between the defects claims and the infrastructure projects. Next, the chapter will identify the common types of defect claims, identify the causes of defects claims, and then the consequences of defect claims from those causes. Finally, the chapter will examine comprehensive, realistic strategies to avoid defects claims in infrastructure projects from key stakeholder perspectives.

2.2 Construction Projects

A construction project is an organised process: it may be construction, renovating, refurbishing, or other (Abdel-Galil et al., 2020). Nguyen et al. (2018) explained that a project has a series of interrelated activities conducted with proper methods to complete the project successfully. Moreover, construction projects involve civil engineers, quantity surveyors, architects, and more professionals with a series of work activities organised to construct tangibly assembling buildings or infrastructure projects (Schonbeck et al., 2021). The construction project process typically starts with the client's requirements, developed step-by-step, implemented with a project brief, project feasibility studies, authority approvals, design, and construction (Nguyen et al., 2018).

Currently, the construction industry has become more complex, and a series of interrelated activities are carried out repeatedly or continuously to successfully complete the project (Senouci et al., 2017). Further, Sutrisna et al. (2018) explained that construction industry output products do not have similar characteristics likes manufacturing industry products and defined the complexity and differences in the construction industry to other industries.

Typically, construction projects are one-offs, meaning financing and project briefs are put as one to provide a unique design (Abdel-Galil et al., 2020). Normally after the project is complete, the project team is disbanded, and most of the time, they will not work together again (Khlaifat et al., 2019). This is the difficulty in developing the ideas or relationships and gained experiences carried forward to success in the next projects (Senouci et al., 2017).

Construction projects are comprised of smaller activities, which require a vast range of multiple disciplines working in collaboration (Sayed et al., 2020). Many people, with different professionals, are involved in projects, with the structure and composition of the project team changing based on project requirements (Damoah et al., 2018). The project manager coordinates the projects and should get support from professionals such as engineers, architects, facility managers, consultants, and more (Sayed et al., 2020). The project roles separate into different disciplines based on contractual arrangements, roles and responsibilities such as clients, consultants, contractors, and subcontractors can make construction projects adversarial (Damoah et al., 2018). This can result in opposition, confrontation, conflict, claims, disputes, and even hostility (Nguyen et al., 2018).

2.3 Claims in Construction Projects

Claims arise between the parties of construction contracts (Alqershy & Kishore, 2021). “A construction claim can be defined as request a compensation or damages by either party to the contract; usually the Contractor, caused by failure of the other party to fulfil his part of obligations as specified in the contract” (Zaneldin, 2020). A claim defines especially the instances where a conflict or disagreement of one party has been written in the document to get compensation and reviewed by the other contractual party and still has the possibility to solve at the site (Nasirzadeh et al., 2019). The claims definition is simply presented as a request for compensation for damages incurred by the liable party agreed upon within the contract (Alqershy & Kishore, 2021).

Sibanyama et al. (2012) argued that in a construction contract, typically, claims are raised by the innocent party. Causes of claims are insufficient information changes,

unforeseen circumstances, shortages, the act of God, and mainly conflicts. Shen et al. (2017) further explained that claims might increase project costs and lengthen project completion dates. Furthermore, claims arise about time extensions for the project, loss and expenses, and liquidated damages (Assaf et al., 2019). The construction project contract sets out exactly what constitutes a claim and how it is processed and also associates with claim specialists (Fawzy & El-adaway, 2015).

However, claims must be properly constituted and detailed into documents like causes and effects needs to be analytically demonstrated, and proper legal entitlement must be established by providing contemporary records, and additional costs backed up with full supporting documents to succeed the claim application (Assaf et al., 2019).

As explained by Dhaval et al. (2019), unmerited claims should not be made, and claimants should avoid unnecessary statements when requesting settlement figures from the defendant party and approve a reasonable amount of settlement figures without recourse to expensive legal action. Hence, required management resources might be better utilised elsewhere.

2.4 Types of Claims

Many ways can categorise construction claims based on different criteria (Zaneldin, 2020). Out of all categories, one may have to categorise based on the involved parties and responsibilities as claims against the contractor, claims against the client, and claims against other contract parties (Fawzy & El-adaway, 2015). Figure 2.1 provides a narrow breakdown of the above categorised key types of construction claims (Fawzy & El-adaway, 2015).

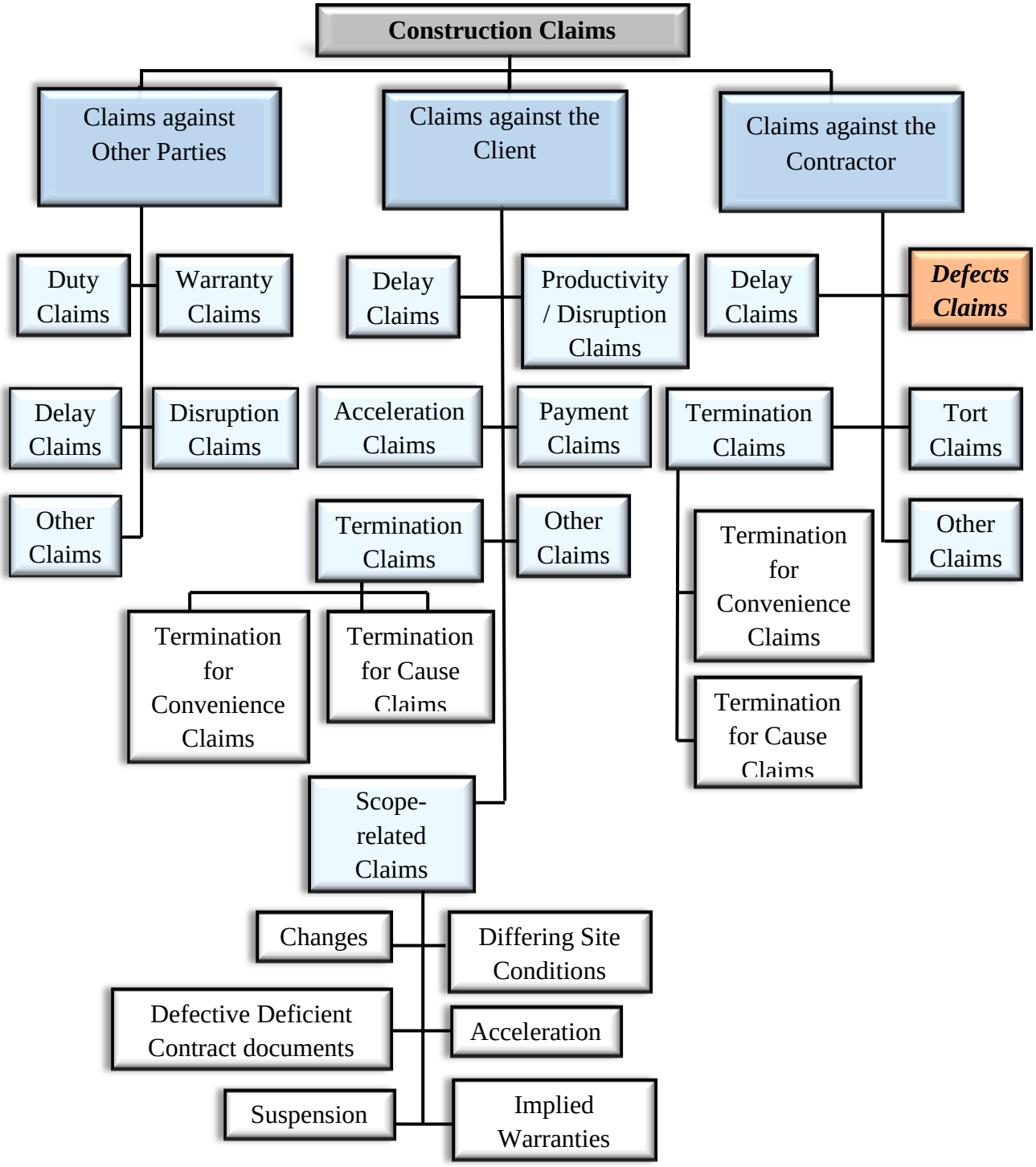


Figure 2.1: Claim Categorisation based on the involved parties and responsibilities

Source: (Fawzy & El-adaway, 2015).

Figure 2.1 illustrates the types of construction claims based on the parties and their responsibilities are in detail.

There are five types of claims against the contractor: defect claims, delay claims, termination claims, tort claims, and other claims.

2.5 Defects claims

The type and nature of defects in every construction project can vary dramatically (Milion et al., 2017). The most dangerous effect of defects is the physical injury to people and damage to property (Milion et al., 2017). If defects increase, the possibility to happen injury and property damage is severe, and thus, it requires extra expenses to correct the losses or damages (Lin et al., 2016). Such defect types are defined as passive defects, which use insurance policies to claim construction defects (Vidal & Ajibade, 2021). Most defects responsibility remains with the contractor (Sandanayake et al., 2021).

Defects are of two categories, such as latent defects and patent defects (Zaneldin, 2020). Patent defects are known defects or readily obvious defects during the inspection, and those defects are on the subsurface level or merely aesthetic; easily accessing and repairing the issue is not invasive (Fawzy & El-adaway, 2015). Latent defects are concealed or not readily observable, and those defects are not readily found through inspection (Zaneldin, 2020). Hence, latent defects become more problematic than patent defects (Fawzy & El-adaway, 2015). Therefore, patent defects are easily rectified before handing over the project to the employer. On the other hand, latent defects remain concealed long after the original work is completed and require expensive remedial work to rectify (Alaa et al., 2015).

Defects claims happen due to many reasons, such as deficiency in design drawings or construction projects, poor workmanship, use of disqualified or improper materials, poor maintenance with improper manuals, and manufacturing issue of the materials (Stamatiou et al., 2019). The durability of the project structure might be weak or not constructed properly. Not taking expansive soil conditions into account may result in foundation structure cracks moving, shifting, or flooding and subsequent damage to the building (Stamatiou et al., 2019). Further, during the operational and maintenance period of the project, defects may arise due to usage failures and improper maintenance of the structure or the system (Ni- Fhloinn, 2017).

2.5.1 Types of defect claims

Any deficiency in a building or infrastructure project, considered a construction defect, arises due to defective architectural designs, lack of planning of the project, lack of proper construction, and improper supervision (Milion et al., 2017). Construction project defects occur due to the use of improper workmanship to construct the building or infrastructure projects or failures in designing structures as intended by the client. This happens due to the defective professional's workmanship (Hopkin et al., 2017). Moreover, a material defect arises from improperly designed materials and constructions using defective materials (Elizabeth et al., 2018). Common construction defects are mechanical problems, electrical issues, and thermal and moisture protection happen due to operational and maintenance defects (Sandanayake et al., 2021).

Construction projects typically have classifications of defect claims: design defects, construction defects, material defects, subsurface defects, workmanship defects, and operational and maintenance defects (Hopkin et al., 2017).

Table 2.1 illustrates the types of defect claims and the respective authors who have identified or discussed them in their studies.

Table 2.1: Types of Defect Claims identified by past researchers

Types \ Authors	Defect Claims									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Design Defects	□		□				□	□	□	
Material defects	□	□				□				□
Construction defects	□			□			□		□	
Subsurface defects					□		□			
Operational and Maintenance defects		□								
Workmanship defects		□								
A-(Ni-Fhloinn 2017) B- (Jingmond & Agren, 2015) C- (Elizabeth et al., 2018) D- (Jonsson & Gunnelin, 2019) E- (Lundkvist et al., 2014) F- (Sandanayake et al., 2021). G- (Shen et al., 2017) H- (Shahhosseini & Hajarolasvadi, 2021) I- (Aibinu et al., 2011)										

2.5.1.1 Design Defects

Design engineers and Architects are the design professionals for the project (Ni-Fhloinn, 2017). Those professionals built-up structural and architectural designs and systems for the projects (Jonsson & Gunnelin, 2019). Professionals' mistakes or lack of information during the pre-contract stage can result in defects (Jingmond & Agren, 2015). Most deficiencies relate to outside of the building with the specified building codes (Ni-Fhloinn, 2017). Elizabeth et al. (2018) explained that, for example, a design defect is an improperly designed roof, which may result in intrusion, water penetration, inadequate structural support, and poor drainage.

2.5.1.2 Material Defects

Material defects arise due to errors in the material manipulation and fabrication process (Elizabeth et al., 2018). Using low-quality material cause defects in projects (Ni-Fhloinn, 2017). An authorised party may have provided low-quality material intentionally, or the production company supplied the material to the market without being aware of the poor quality of the product (Lin et al., 2016). Defective material usage causes significant problems such as cracks in the concrete under pressure, deteriorating flashing, windows that leak, and inferior asphalt roofing shingles. Even when properly installed, inferior products may fail to function and perform adequately (Ni-Fhloinn, 2017).

2.5.1.3 Construction Defects

Improper quality workmanship can result in multiple defects in construction projects (Lundkvist et al., 2014). Many construction defects happen as they are not up to code or intentionally covered by a contractor (Lin et al., 2016). Most defects become visible after completing the project, which increases the damage (Jingmond & Agren, 2015). Water intrusion throughout part of the building structure, including doors, windows, or roof openings, is an example of a construction defect; it may lead to the growth of mould (Lander et al., 2016). Electrical and mechanical problems, dry rot in lumber, cracks in foundations, and plumbing leaks may also happen due to construction defects (Sandanayake et al., 2021).

2.5.1.4 Subsurface defects

Subsurface soil risk is the highest unknown risk in the construction industry. Hence, the subsurface should be properly investigated to ensure a sufficiently stable foundation and adequate drainage (Mehany & Grigg, 2015). If a project structure is constructed without investigating expansive soil conditions in the design, it may result in foundation cracks, subsidence, or floor slabs forcing the structure to move, flood, or shift, creating a high probability of damage to the whole building (Sandanayake et al., 2021). If the soils are not properly designed, compacted, and prepared for sufficient drainage, probably the construction project will experience problems such as shifting, subsidence, moving, or flooding (Lundkvist et al., 2014).

2.5.1.5 Operational and Maintenance defects

Operational and maintenance defects happen due to the owner's usage failures or improper maintenance of the structure or the system (Ni-Fhloinn, 2017). For example, not maintaining an exterior sealant may let water in. In winter, the temperature of an HVAC system is too low, which may cause pipes to freeze and block (Elizabeth et al., 2018).

2.5.1.6 Workmanship defects

The appropriate workmanship skill is essential for completing a project successfully (Lin et al., 2016). Careless work or workers not following a proper protocol may produce a low-quality project than expected by the client (Jingmond & Agren, 2015). Water leakages happen if the plumbing installation works are incorrect and damage the structure of the project; this is considered a defect (Sandanayake et al., 2021).

2.5.2 Causes of defect claims

At the time of entering into a contract, all Parties involved in the project have their own expectations to gain their own benefits (Do et al., 2022). Danuri and co-workers explained that an employer expects to complete the project within the planned budget and time duration and with the expected quality agreed in the contract document (Danuri et al., 2018). Furthermore, the contractor's organization expects higher

profits from the projects to achieve their long-term business plans from the project (Le-Hoai et al., 2018).

Finally, Do et al. (2022) stated that defect claims are inevitable in infrastructure projects. As explained by Cakmak and Cakmak (2014), a considerable number of research works have been undertaken to recognise defect claim causes in construction projects.

Table 2.2 illustrates the causes of defect claims, the causes of claims, and the respective Authors who have identified or discussed them in their studies.

Table 2.2: Causes of Defect Claims/Causes of Claims identified by past researchers

Authors / Causes	Defect Claims						Claims							
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Improper Allocation of Management of risk	□		□					□	□	□				
Improper Project Management	□													
Carelessness of workers	□									□				
Fraud and breach of product liability	□				□			□						
Heavy rain	□	□			□									
Flooding		□												
Improper Approvals	□	□												
Breach Government Regulations		□							□					
Negligent Works				□		□		□						
Ambiguities arise in the contract document				□										
Different interpretations of the contract clauses					□			□						
Unfair risk allocations						□		□						
Administrative Management				□										
Variations initiated by the client				□		□								
Payment delays					□									
Quality of the work		□						□						
Unrealistic Tendering		□						□						
Market inflation				□				□						
Unrealistic								□		□				

Authors / Causes	Defect Claims						Claims							
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
expectations														
Late giving of possession to the site			□					□						
Confusing requirements of the client		□				□								
Change of Scope/ Scope definition								□		□				
Delays in work Progress/ Time extension								□						
Validity of a claim in the presence of notice requirements								□						
Time for issuing Taking-Over certificates								□						
Design errors and omissions in design drawings											□			
Change of conditions								□		□				
Defective designs								□						
Inadequate specifications								□		□				
Insufficient available information								□						
Unclear contractual terms in the contract document								□						
Inadequate contract drafting								□						
Change in government codes								□						
Adverse weather								□		□				
Labour disputes/ Union strikes							□							
Contract acceleration								□		□				
Time targets that are not realised											□			
Investigate incomplete locations									□		□			
Unplanned disruptions, suspensions, or stopped work orders									□		□	□		
Inexperienced bidders are allowed bid for the project										□				

Authors / Causes	Defect Claims						Claims							
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Act of God									☐			☐	☐	
Buildability issues													☐	
Financial failures of the contractor							☐					☐		☐
Inaccurate topographical data							☐							☐
Inexperienced contractors														☐
The productivity of plant and labour												☐		
Subcontractor failures							☐		☐					
Global financial crisis							☐							
Impact of the construction project on the surrounding environment								☐						
Difficult to get statutory approval for alternative cost-saving designs												☐		

A- (Jonsson & Gunnelin, 2019), B-(Jingmond & Argen, 2015), C- (Sandanayake et al., 2021), D-(Hopkin et al., 2017), E- (Lin et al., 2016), F- (Lundkvist et al., 2014), G- Mishmish & El-Sayegh, 2018), H- (Do et al., 2022), I-(Le-Hoai et al., 2018), J- (Shahhosseini & Hajarolasvadi, 2021), K-(Sibanyama et al., 2012), L- (Shen et al., 2017), M- (Zaneldin, 2020), N- (Aibinu et al., 2011).

Current studies in Table 2.2 have shown the many causes of claims and defect claims, which may disrupt project completion. Furthermore, contract parties are uncertain about the contract signed because of errors in contract documents and scope changes (Lin et al., 2016). These factors contribute to arising claims during the construction period (Sandanayake et al., 2021).

Improper allocation and management of risks, improper project management, carelessness of workers, improper approvals, and heavy rain and flooding may lead the defect claims in the construction industry (Jonsson & Gunnelin, 2019). Further, unrealistic expectations of project participants, administrative management, inadequate specification, late giving possessions, and project acceleration are some other causes for claims (Le-Hoai et al., 2018).

When project parties enter a contract, all parties take all project risks and must be aware of such possible risks (Kamal et al., 2019). A contract document defines the parties' risks and the possibility of unfair risk allocations between parties (Gurgun & Koc, 2022). These may also cause defect claims (Sandanayake et al., 2021).

A contractor's poor project management is recognised as a leading cause of claims (Osei-Kyei et al., 2018). Jingmond and Agren (2015) explained that carelessness of workers, fraud and breach of products' liability are causes to defect claims. Thus, Jonsson and Gunnelin (2019) revealed that heavy rain, flooding, improper approvals, breach of government regulations, and negligent work produce claims**.**

2.5.3 Consequences of defect claims

The success of construction projects depends on various reasons (Nguyen, 2015). When a claim arises during the execution stage of the project, it can affect fulfilling the project's success (Dhaval et al., 2019).

Table 2.3 illustrates the consequences of defect claims, the consequences of claims, and the respective authors who have identified or discussed them in their studies.

Table 2.3: Consequences of Defect Claims/Consequences of Claims identified by past researchers

Authors / Consequences	Defect Claims						Claims					
	A	B	C	D	E	F	G	H	I	J	K	L
Damage Business relationships	□		□	□				□	□	□		
Arise disputes							□					
Delay the Project completion date				□			□			□		
Cost overrun				□				□				
Deterioration of the delivered product quality	□			□								
Loss of productivity		□		□		□						
Fraud and breach of products liability					□	□						
Undermine team spirit		□							□			
Waste of the client's money												□
Loss of profit								□				
Abandon of project								□				
Escalation of Cost											□	

Authors / Consequences	Defect Claims						Claims					
	A	B	C	D	E	F	G	H	I	J	K	L
Non-Completion of the Project												
Share information with project parties												

A- (Milion et al., 2017), B- (Iyer et al., 2020), C- (Lin et al., 2016), D- (Kikwasi, 2021), E-(Hopkin et al., 2017), F- (Lundkvist et al., 2014), G- (Do et al., 2022), H- (Shahhosseini & Hajarolasvadi, 2021), I- (Alaa et al., 2015), J- (Fazliani & Charoenngam, 2015), K- (Zaneldin, 2020), L- (Aibinu et al., 2011).

As shown in Table 2.3, current studies have proved the consequences of the claims and defect claims. Alaa et al. (2015) explained that the claims always affect the project's success. If the construction claims are not managed, it may delay project completion, increase project cost, damage business relationships, and undermine team spirit (Lin et al., 2016). The above statements were supported by Kikwasi (2021), who expressed that claims arise constantly. If not managed, they may incur cost overrun, time overrun, deterioration of the product quality, loss of productivity, reduction in profit investments, and damage to business relationships.

In the Sri Lankan construction industry, claims will not be implemented and submitted in some situations due to the fear of losing business relationships between project parties (Dharmarathna, 2018). Such incidents influence the success of a construction project because, under those situations, one contract party has to bear the unfair loss. If those circumstances happen continuously, the contractor will lose the project profit (Withanage, 2017).

According to Aibinu et al. (2011), claims' prevention costs are lower than remedial costs arising after the claims. Therefore, it may be advisable to practise management strategies from the early stage of the project to manage claims (Kikwasi, 2021).

2.5.4 Strategies to manage defect claims

Claim situations arise during the construction process (Withanage, 2017). The method to manage those claims is using claim mitigation strategies (Milion et al., 2017). The claim management strategies provide teamwork by using those strategies

to prevent claims arise (Withanage, 2017). Further, management of the claim helps to keep a long-term relationship between parties to the contract (Kikwasi, 2021).

Table 2.4 illustrates the strategies to manage defect claims and the respective authors who have identified or discussed them in their investigations.

Table 2.4: Strategies to Manage Defect Claims/Strategies to Manage Claims identified by past researchers

Authors / Strategies	Defect Claims						Claims					
	A	B	C	D	E	F	G	H	I	J	K	L
Maintain a Risk Register	□		□					□	□	□		
Risk avoidance checklist	□											
Proper constructer management	□									□		
Use Insurances								□	□			
Prepare proper contract Documents		□										
Proper Coordination between all contract documents		□										
Proper Contract Administration		□										
Select the most suitable procurement method		□							□			
Equitable Sharing of Risks between contract parties					□	□		□				□
Negotiation in the event of differentiating in matter	□				□							
Early Notification	□							□				
Inspection of Work						□			□			
Conduct regular Site Meetings			□	□					□			□
Keep Records											□	
Clear and frequent communication							□				□	
Create, implement, and utilise a logical and user-friendly schedule				□						□		
Inspect the quality												□
Scope Assessment										□		□
Distribute required information												□
Third-party review of project design at the tender stage								□		□		
A reasonable cost-sharing ratio between the client								□		□		

Authors / Strategies	Defect Claims						Claims					
	A	B	C	D	E	F	G	H	I	J	K	L
and the contractor												
Providing sufficient time for bidders to submit their bids								□				
Prequalification of the main contractor								□				
Use of named subcontractors rather than nominated subcontractors								□				
Setting contingency plans							□					
Monitoring system set up by the main contractor							□					
Support from top management to the project team							□			□		
Proper identification of roles and responsibilities										□		□

A- (Sandanayake et al., 2021) B- (Milion et al., 2017), C- (Lin et al., 2016), D- (Lundkvist et al., 2014), E- (Kikwasi, 2021), F- (Jingmond & Agren, 2015), G- (Shahhosseini & Hajarolasvadi, 2018), H- (Mishmish & El-Sayegh, 2018), I- (Ní-Fhloinn, 2017), J- (Le-Hoai et al., 2018), K- (Zaneldin, 2020), L- (Shen et al., 2017).

Table 2.4 indicates that current studies provide strategies to manage defect claims. Further, contract administrators and project parties must implement and control the claim management strategies to project success (Zaneldin, 2020). Contract forms include a provision to implement a risk register, which may help decide on risk events (Ameyaw & Chan, 2015).

Risks identified in previous projects are included in the risk register and updated during the construction process to proceed without risk events (Mohammadi & Birgonul, 2016). Further, the risk registers initially recognise the associated risks in the project, then identify and suggest a procedure to manage the probable risks and quantify the cost and time required to manage the risks (Le-Hoai et al., 2018). Dastyar et al. (2018) proved this statement by explaining that the risk register recognises possible risk events, and management strategies and risks must be shared with the project's team members. They should be able to achieve the required time, cost, and quality of the project by managing those risks.

According to Bakhary et al. (2017), the risk mitigation checklist is implemented to minimise/eliminate claim causes, mitigate the risk of claims and reduce the efforts to minimize the risk events during the projects. During the project pre-contract stage, contract parties include strategic and visionary activities to risk management and decide the most suitable procurement strategy to minimise the risk events (Zaneldin, 2020).

Construction management is necessary to implement procedures to understand the project, contract, and work programme of the project (Ameyaw & Chan, 2015). Frequent communication with contract parties is not sufficient to manage claims. Regular meetings and progress assessments have to be conducted with the participation of the project parties to identify issues arising in the project (Kikwasi, 2021). Further, record keeping, scope assessment, and monitor the project system are important requisites to manage the claims at the right time in a positive and objective manner (Bock, 2018). Furthermore, Kikwasi (2021) expressed that monitoring project progress can be visible, and the employer could understand the project progress and help to identify the contractor's performance. Moreover, contract administrators should monitor project programme, which needs regular updating. This administrates the construction project progress and manages the claims (Ameyaw & Chan, 2015).

2.6 Infrastructure Projects

Infrastructure is the primary facilities and systems that support the function of households, firms, cities, and all areas of the country, including the services necessary for its economy to function (Jensen, 2017). However, infrastructure projects consist of private and public structures such as roads, tunnels, railways, bridges, sewer, water supply, telecommunications, and electrical grids (Brace, 2020). Infrastructure projects mean the modernisation, rehabilitation, expansion or operation of project designs, construction, development and operation of new infrastructure facilities, or the rehabilitation, modernisation, expansion or operation of existing infrastructure facilities (Matar et al., 2017).

Infrastructure projects mainly focus on the development of services, systems, and facilities of the country (Xiao & Hao, 2021). The development of infrastructure is the driving force of the socioeconomic development of any nation and is associated with the environmental, economic, industrial, and social priorities of the country (Sharma et al., 2022). In addition, construction trends emphasise technology and other innovative advancements to contribute to our well-being and economic growth (Babatunde & Perera, 2017). When driving to work every day, humans consume products and services related to different infrastructure types (Earnest, 2015). Predominantly, nine infrastructure construction types are identified based on the role they play in our lives (Brace, 2020). Those identified infrastructure project types are aviation projects, bridge constructions, communicational projects, power and energy projects, railroad infrastructure projects, road projects, water projects, waste management projects, and hazardous waste management projects (Mohammadali et al., 2019).

Aviation infrastructure projects develop and maintain airports and airplanes, and bridge construction consists of maintaining and newly-constructing bridges throughout the country, including highly trafficked highway projects (Vilventhan & Kalidindi, 2012). The communication infrastructures focus on the connection between business and government agencies and the nation through cables, satellites, and other technologies (Yih et al., 2016).

Electrical infrastructure deals with power; it includes power grids, electrical lines, and alternative energy, whereas railroad infrastructure consists of railway lines, subways, and light rail systems, including tunnels, bridges, and steel structures (Xiao & Hao, 2021). Road infrastructure construction projects build roads, streets, and highway systems to facilitate the transportation system within the country (Babatunde & Perera, 2017). Water infrastructure involves sustainable water projects to purify wastewater to make it safe for drinking (Aksorn & Charoenngam, 2015). Waste management infrastructure is improved by treating, eliminating, and storing hazardous materials (Bayat et al., 2019).

2.7 Issues in infrastructure projects

The public sector has heavily invested in large infrastructure projects in the form of mega projects (Ibrahim et al., 2019). However, implementing such mega projects requires a challenging environment, many resources, and social and financial impacts (Jensen, 2017). Due to those difficulties, infrastructure projects face many difficulties during the pre-contract and post-contract stages. At the initial stage of the pre-contract face, difficulties occur due to various reasons, such as feasibility studies, planning and approval of the project, land acquisitions, environmental, forests and other clearances (Gonzalez-Ruiz et al., 2019). Therefore, the complexity of infrastructure projects places extensive demand and higher responsibility on project parties to complete the projects on time, with expected quality components, agreed budget, and more investment returns (Babatunde & Perera, 2017).

2.8 Stakeholders in the construction industry

Stakeholders are defined as persons with contractual responsibility and interest or concern in construction project process activities (Olatunde et al., 2021). Stakeholders vary based on various factors, and a construction project has different stakeholder types (Zhang et al., 2022). It is important to recognise project stakeholders to engage and involve them during the project's progress, divide project constraints and threats or success of the project, and deal with them appropriately (Dang et al., 2019).

Construction organisations and projects involve many stakeholders with different characteristics, categorised as internal stakeholders and external stakeholders (Zhang et al., 2022). Those stakeholders impact the projects directly, indirectly, and respectively (Jensen, 2017). Direct stakeholders are identified as the Employer, Contractor, and Engineer, while indirect stakeholders are the suppliers, authorities, and subcontractors (Jensen, 2017). Every stakeholder is liable to the project (Olaniran, 2015). The contractor is responsible for planning, coordinating, and conducting construction activities, leading, executing, supervising, inspecting, and completing the construction project within the agreed budget and time frame (Khoso et al., 2021). A contractor is responsible for the entire construction procedure and

determining the optimal methods to complete the project as specified in the contract documents (Olaniran, 2015).

2.9 Why defect claim management is important in infrastructure projects

Construction defects claims are inevitable in construction projects and depend on the project's complexity (Xiao & Hao, 2021). Infrastructure projects are more complex than other construction projects because infrastructure projects require more time to complete and higher budgets with quality components (Alhammadi et al., 2021). Hence the number of defects claims in infrastructure projects has continued to increase in recent years (Milion et al., 2017). Therefore, all projects suffer from potential defects claims (Parikh et al., 2019).

Defect claims lead to significant project damage, such as cost overruns and delayed completion (Milion et al., 2017). More time and money are required to rectify defects and quality assurance procedures for the rectification procedures in projects (Kikwasi, 2021). Further, vast sums of money from the contractors' profits also diminish due to defect claims (Plebankiewicz & Malara, 2020). In addition, defect claims increase the risk of death and injury, impact the contractor's reputation, waste the time of contract parties, and decrease the contractor's morale (Jalal et al., 2021).

However, the client and the contractor must take precautions to prevent defect claims from happening (Chi et al., 2015). Thus, the construction industry's claim management procedure should be clear and understood by all contract parties to learn how to manage them (Milion et al., 2017). They also must focus on management strategies to manage construction defect claims (Xiao & Hao, 2021). Construction defect claim management involves a combination of inspections, the use of technology to record information regarding defects, and quality assurance practices (Alaa et al., 2015). Therefore, contractual parties ensure defects and errors quickly and efficiently (Plebankiewicz & Malara, 2020).

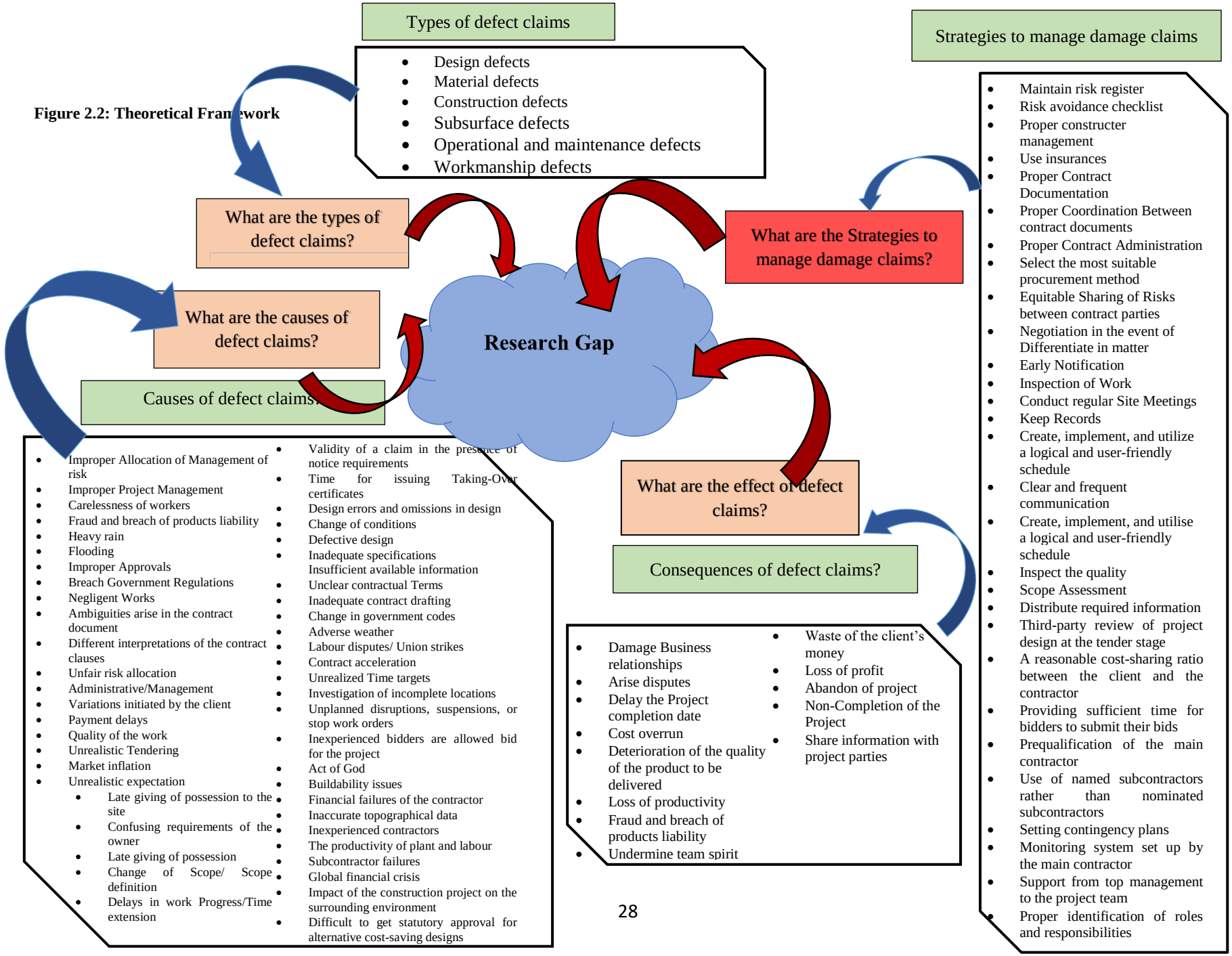
There need to be more information related to defect claims in the infrastructure projects in the Sri Lankan construction industry. This research, therefore, aims to identify and rank the existing causes and consequences of defect claims according to

their relative importance in the infrastructure projects in the construction industry and suggest appropriate strategies to manage the defect claims.

2.10 Literature Framework

The research path is discussed in the theoretical and conceptual framework, and it assists in grounding the research steadily to the related theoretical concepts (Adom & Huissein, 2018). Furthermore, the author's framework uplifts the research findings to a meaningful position where they become acceptable in the research field and saves the research generalizability. It can be considered the blueprint of a research guide (Grant & Osanloo, 2014). Moreover, those authors presented a framework using an existing theory in a particular field of inquiry that reflects and/or reveals the hypothesis of a research study. Figure 2.2 demonstrates the theoretical framework for this study.

Figure 2.2: Theoretical Framework



2.11 Summary of this chapter

Defect claims are unavoidable in construction projects and have a critical impact on them. Throughout the literature review, definitions of claims, types of defect claims, causes of defect claims, and defect claim mitigation strategies are presented. It further identifies the current situation of defect claims in construction projects. A defect claim mitigation theoretical framework was developed according to literature findings. Chapter Three describes the applicable research methodology of the study.

3.0 CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

Chapter Two presented literature review findings and addressed the research topic considering available literature. The purpose of this research chapter is to scientifically solve the research problem and discuss the management of defect claims, which were suitable for this research to achieve the aim and objectives of the study. Chapter three discussed the research methodology, including research design, research approach, research techniques, and data analysis techniques.

3.2 Research Design

A Research Design interprets the flow from the study background to the research conclusion process (Akhtar, 2016). According to Singh (2006), the ultimate object of research is to interpret research findings related to the research problem and verify that the research objectives are accomplished. Basically, a research plan includes four main categories: What is the used strategy? What is the framework? From whom will the research data be collected? How will the research data be collected and analysed? (Kumar, 2011).

3.3 Research Approach

The basic justification for conducting the research which identifies why and how it is conducted (Johnston, 2014). Further, the research approach can be defined as a method of arranging research activities and integrating data collection to accomplish objectives and aims (Thurairajah et al., 2006).

3.3.1 Available Research Approaches

Quantitative, Qualitative, and Mixed are the three main research approaches (Kumar, 2019). The commonly used basic research methods are quantitative and qualitative approaches (Kothari, 2004). Quantitative research collects and analyses statistical data, focusing on measurement range, phenomenon frequency, and scale (Kumar, 2011). Furthermore, the author pointed out that quantitative research methods

allowed an understanding of how to match the factors with research data and literature survey findings. Qualitative research interprets the approach of collecting and analysing data to explore and explain a phenomenon and often the form of a case study of a particular instance (Johnson et al., 2007).

This research approach helps to understand the research structure, research process, and driving forces of a research problem (, 2014). The mixed approach has been used when qualitative or quantitative approaches alone would not provide satisfactory results (Johnston, 2014). Furthermore, the mixed approach is considered a combination of the above two qualitative and quantitative methods.

3.3.2 Selected Research Approach for this study

Mixed method designs can offer pragmatic advantages when studying difficult research questions (McCusker & Gunaydin, 2015) and have been applied in simple and complex research (Lund, 2012). The fundamental of the mixed method strategy is merging quantitative and qualitative methods and using their own strengths to avoid weaknesses (Tashakkori & Teddlie, 1998).

Using a mixed method can increase the broader awareness of researchers that do not apply quantitative and qualitative approaches (McKim, 2017). Even though the mixed method may generally be more effective for research on unsafe groups than qualitative or quantitative methods in isolation, such a joint method encounters some logistic challenges (Lund, 2012). The proposed qualitative research approach is used to gather the validation of the literature findings and identify the new causes, effects, and management strategies from interviews with experts.

On the other hand, a quantitative approach with a questionnaire survey was built based on information collected through literature and interviews to formulate ranks. Therefore, the exploratory sequential mixed method design was used.

3.4 Research Strategy

The five identified strategies are survey, experiment, case study, archival analysis, and history. Saunders et al. (2019) identified numerous forms of research strategies,

named surveys, experiments, archival research, case study, ethnography, action research, grounded theory, and narrative inquiry. The survey is the systematic path of information collected from selected entities to provide quantitative representations of the large population characteristics of which the entities are members (Groves et al., 2004). As explained by Jansen (2010), a survey strategy is also used to collect data for qualitative studies. Survey experiments are easy to implement and identify some difficulties in making conclusions from traditional survey data (Gaines et al., 2006; Zhang et al., 2006). Therefore, this research used the survey strategy for data collection.

3.5 Research Methods

A research method is an instrument or the behaviour within which a research technique is chosen or built up (Kothari, 2004). Research methods are used for data collection and analysis, which are the tools and techniques for completing the research and providing advice on practical issues of performing the research in an attractive and clear manner (Walliman, 2011). Therefore, research methods consist of forms of data collection, data analysis, and data interpretation (Creswell, 2014).

3.6 Data collection technique

Dawson (2002) explained five data collection methods: interviews, questionnaire surveys, case studies, experiments, and archival records. The suitability of the data collection technique varies depending on the research problem. Accordingly, for this research, semi-structured interviews were selected as a preliminary survey data collection technique. Moreover, a questionnaire survey acted as a detailed survey to achieve research objectives.

3.6.1 Semi-structured interviews

Interviews are recognised as one of the best methods for data collection with an in-depth view (Punch, 2014). An interview guideline topic consists of the literature findings, the interviewer's experience, knowledge of the research area, and preliminary work (King, 2004). The interview types are categorised as structured, semi-structured, and unstructured; the most generic type is semi-structured, prepared

based on the particular framework which enables discussion and evaluation of the responses obtained (Walliman, 2011; MacDonald & Headlam, 2011). In this research, semi-structured interviews were applicable to get the validation and opinion from the experts regarding the research findings applicable to the research area.

3.6.2 Questionnaire Survey

A questionnaire survey is a widely used method for data collection. It includes questions written by the researcher and answers given by respondents (Kumar, 2011). The questionnaire survey aims to find significant and valid information (Taherdoost, 2016). Thus, the accuracy and consistency of a questionnaire survey create a significant mode of research methodology: reliability and validity. Therefore, the questionnaire survey is conducted for this research to rank the gathered information from literature and interview.

3.6.3 Data Analysis

The data analysis follows the data collection process (Saunders et al., 2009). The process of data analysis is to summarise the collected data analytically and logically (Basit, 2003). Further, it provides easily understood results for research questions (Kapur, 2018). Selecting the data analysis method depends on the research approach (Basit, 2003). Content analysis is employed for this research to analyse the interview output, and the relative importance index and standard deviation were used to analyse the questionnaire survey output.

- **Interview Analysis**

Content analysis is the favoured method to analyse qualitative information in documented data such as texts, media, and physical items, and it depends on research questions (Fellows & Liu, 2015). According to Gheyle and Jacobs (2017), content analysis gathered the data codifying to pre-defined categories (codes) to find patterns for presentations and information reporting. Selecting the coding method varies depending on the research size, time, and cost constraints (Baist, 2003). Manual coding enhanced the concentration on the data sets and distraction regarding

the procedure instead of the contextual sense of data (Saldana, 2013: Cope, 2014). Therefore, content analyses with manual coding were used due to the above reasons.

- **Questionnaire analysis**

The prepared questionnaire survey focuses on the research objectives and the research problem. This study applied the Likert scale to rank the causes, effects, and strategies according to their significance (Pescaroli et al., 2020). Mean is an arithmetic average widely used to measure central tendency (Fellows & Liu, 2015).

- **Relative importance index**

The relative importance index was used to identify the behaviour of types of defect claims, causes of defect claims, consequences of defect claims, and strategies to manage defect claims. The ranking used those factors according to the relative importance index value. Relative importance indices (RII) are shown in the below formula.

$$\text{RII} = \frac{\sum Wxn}{\text{Axn}} X100\%$$

Where,

W - The constant expressing the weighting given to each response

A - The highest weighting

n - The frequency of responses

N - Total number of responses

As per the Likert scale used in the questionnaire survey, scale 5 refers to very high significant factors and scale 3 refers to neutral factors and distribute with five scales. When all responses obtain 3 on the scale, the RII value will be 0.6, and when all responses obtain 4, the RII value will be 0.8. Therefore, as expressed by Holt (2014), factors that obtained RII values of 0.700 or more are considered highly significant in

this study. In addition, factors with the lowest SD values are considered as most precise factors.

- **Standard Deviation**

A mean weighted rating is calculated to identify the behaviour of the types of defect claims, causes of defect claims, effects of defect claims, consequences of defect claims, and strategies to manage defect claims.

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

Where

x_i: Stands for Response for the attributes

$\bar{x}$: Mean of the data set

Xi: Each value of the population

n: The number of respondents

3.7 Research Process

Figure 3.1 summarises the research process according to the above-described research methodology.

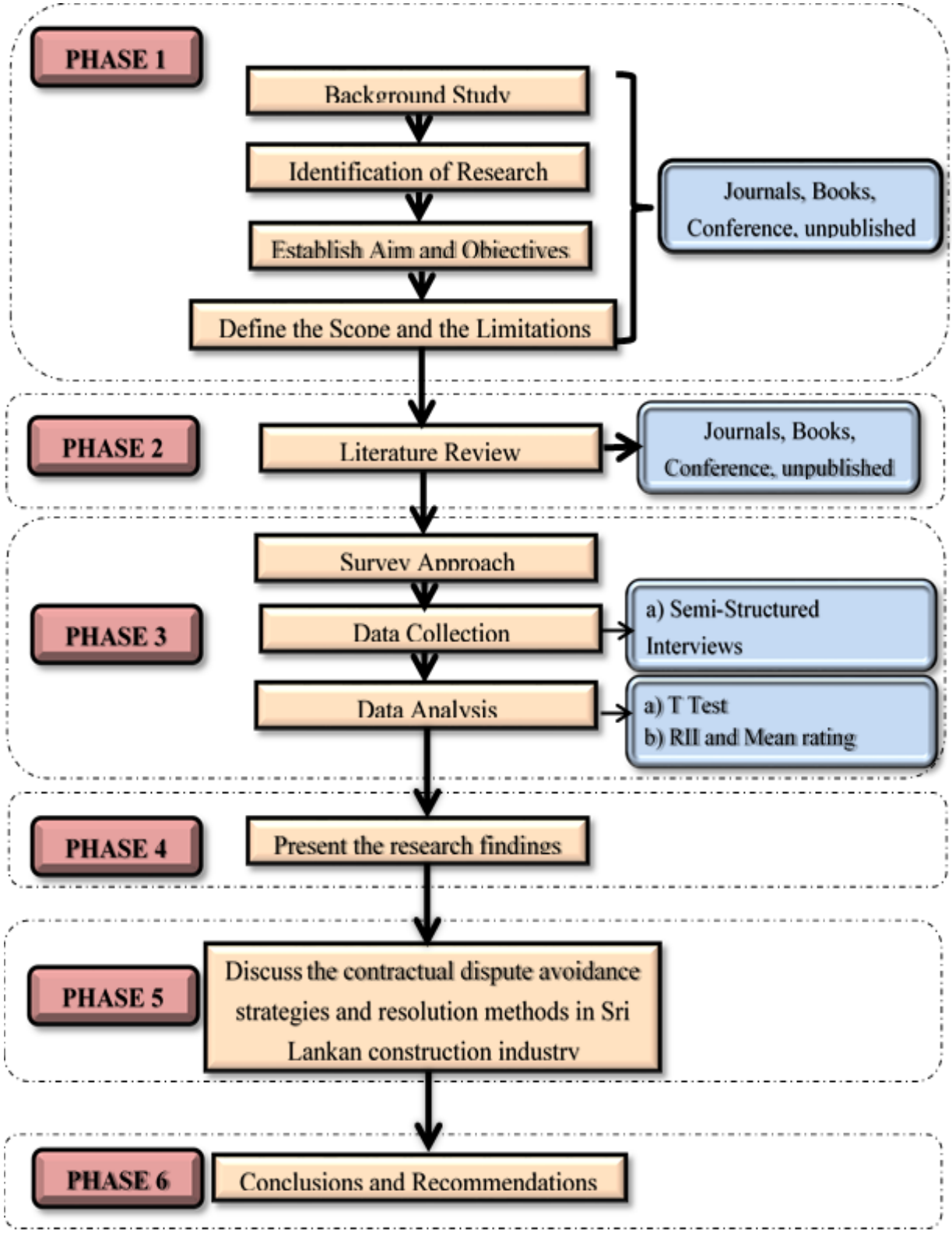


Figure 3.1: Research Process

3.8 Summary

The methodology chapter discusses how to fulfil the aim and objectives of the study. The mixed method is used as the research method where expertise will be interviewed to collect information, followed by a questionnaire survey based on the information gathered from the literature and interviews. Empirical data collected from the interview and the questionnaire survey will be analysed via content analysis and T-test, RII, and Mean rating, respectively.

4.0 CHAPTER FOUR: RESEARCH DATA ANALYSIS

4.1 Introduction

Chapter Three describes the research methodology of the study. Chapter Four of the study focuses on data collection and analysis through expert interviews and questionnaire surveys and, finally, a review of the analysed data. The main types of defects claims, causes of defects claims, consequences of defect claims, and the precautions to mitigate defects claims are presented throughout this chapter.

4.2 Expert Interviews

Eight semi-structured interviews were held using the purposive sampling method with experts in the construction industry who have more than ten years of experience. Further, respondents were interviewed based on the developed guidelines provided in Appendix A. Finally, all information gathered from the semi-structured interviews was used to develop a questionnaire survey for data collection and in-depth analysis.

4.2.1 Objectives of Expert Interviews

Expert interviews are important to collect expertises' theoretical and practical knowledge. The main objective of the expert interviews was to identify types, causes, consequences, and strategies specific to defect claims in infrastructure projects conducted in Sri Lanka.

4.2.2 Respondents of Expert Interviews

Eight professionals with more than ten years of work experience in claims management in infrastructure projects were interviewed. Table 4.1 shows the respondents' profiles.

Table 4.1: Preliminary survey sample respondents' profile

Respondent 01 (I-01)	Contract Administrator	20 years
Respondent 02 (I-02)	Contract Administrator	15 years
Respondent 03 (I-03)	Contract Administrator	10 years
Respondent 04 (I-04)	Project Manager	10 years
Respondent 05 (I-05)	Project Manager	12 years
Respondent 06 (I-06)	Project Manager	11 years
Respondent 07 (I-07)	Quantity Surveyor	20 years
Respondent 08 (I-08)	Quantity Surveyor	15 years

Table 4.1 revealed that interviewee professionals hold and positions of contract administration roles, either completely or partially.

4.3 Analysis of Expert Interview Findings

The respondents' opinions related to generic causes, consequences, and strategies were analysed using the content analysis method. Interview outputs were carried further to the questionnaire survey. The key findings of expert interviews are described as follows.

4.4 Findings of Expert Interviews

Firstly, types of defect claims in infrastructure projects were identified. The causes, consequences, and strategies of defect claims in infrastructure projects were also recognised. Compared to other construction projects, infrastructure projects are complex and require experts' experience. There are many preliminary causes to be identified compared to the other claims in infrastructure and other construction projects. Hence, consequences of defect claims in infrastructure projects compared to the other projects were identified. Furthermore, various defect claim strategies were identified to create the questionnaire survey of data analysis.

4.4.1 Types of defect claims

Six (06) types of defect claims were identified through the literature review and specified by the respondents. The respondents identified specification defects as a new type of defect claim. Therefore, seven (07) defect claim types were considered to the questionnaire survey.

Table 4.2 illustrates the identified types of defect claims before and after the expert interviews for the infrastructure projects.

Table 4.2: Types of Defect Claims

Before Expert Interviews	After Expert Interviews
Design defects	Design defects
Material defects	Material defects
Construction defects	Construction defects
Subsurface defects	Subsurface defects
Operational and Maintenance defects	Operational and Maintenance defects
Workmanship defects	Workmanship defects
	Specification defects

All respondents (I-01, I-02, I-03, I-04, I-05, I-06, I-07, I-08) expressed that design defects, material defects, and construction defects are the most common defect claim types. Further, interviewee I-01 stated, "*Operational and maintenance defects as another type of defect claim"*, supported by interviewees I-03, I-04, I-05, and I-07. Interviewees I-02, I-05, and I-08 expressed surface defects and workmanship defects as types of defect claims. Interviewees I-01, I-05, and I-06 stated speciation defects as a defect type claimed in infrastructure projects.

4.4.2 Causes of defect claims

Fifty (50) causes of defect claims related to general construction projects were identified in the literature review. However, at the end of the expert interviews, eighteen (18) causes from the literature were narrowed down to seven (07) causes. Two (02) causes from the literature were removed, and seven (07) new causes were identified. Ultimately forty-four (44) causes were listed and carried forward to the questionnaire survey.

Table 4.3 summarises the causes of claims and defect claims identified through the literature survey and causes of defect claims related to the infrastructure projects identified in the expert interviews. Newly-identified causes are presented in bold letters.

Table 4.3: Causes of Defect Claims

Before Expert Interviews	After Expert Interviews
Improper project management	Improper project management
Fraud and breach of product liability	Fraud and breach of product liability
Improper approvals	Improper approvals
Breach government regulations	Breach government regulations
Different interpretations of the contract clauses	Different interpretations of the contract clauses
Administrate management	Administrate management
Payment delays	Payment delays
Unrealistic tendering	Unrealistic tendering
Market inflation	Market inflation
Late giving of possession of the site	Late giving of possession of the site
Delays in work progress	Delays in work progress
Change of conditions	Change of conditions
Inadequate specifications	Inadequate specifications
Insufficient available information	Insufficient available information
Unclear contractual terms in the contract document	Unclear contractual terms in the contract document
Change in government codes	Change in government codes
Labour disputes/Union strikes	Labour disputes/Union strikes
Contract acceleration	Contract acceleration
Time targets that are not realized	Time targets that are not realized
Investigation of incomplete locations	Investigation of incomplete locations
Unplanned disruptions, suspensions, or stopped work orders	Unplanned disruptions, suspensions, or stopped work orders
Act of God	Act of God
Buildability issues	Buildability issues
Financial failures of the contractor	Financial failures of the contractor
Inaccurate topological data	Inaccurate topological date
The productivity of plant and labour	The productivity of plant and labour
Subcontractor failures	Subcontractor failures
Global financial crisis	Global financial crisis
Impact of the construction project on the surrounding environment	Impact of the construction project on the surrounding environment
Difficult to get statutory approval for alternative cost-saving designs	Difficult to get statutory approval for alternative cost-saving designs
Heavy rain	
Flooding	*Adverse weather*
Adverse weather	
Carelessness of workers	
Negligent work	*Bad quality of work*
Quality of the work	

Before Expert Interviews	After Expert Interviews
Improper allocation of management of risk	
Unfair risk allocations	*Unfair risk allocation*
Variations initiated by the client	
Confusing requirements of the client	*Arise variations due to the scope change*
Unrealistic expectations	
Change of scope/Scope definition	
Design errors and omissions in design drawings	*Design issues*
Defective designs	
Inexperienced bidders allowed to bid for the project	
Inexperienced Contractor	*Selected inexperienced contractors*
Inadequate contract drafting	
Ambiguities arise in the contract document	*Improper Contract document preparation*
Validity of claim in the presence of notice requirements	
Time for issuing taking over certificates	
	Lack of resources
	Inadequate and inexperienced professionals employed
	Site conditions
	Deviations from pre-determined planned works
	Political interface
	Bankruptcy
	Import/export restrictions

All respondents revealed that improper project management is an important cause of defects claims. As explained by interviewee I-02's own words, defect claims are raised due to *"... poor project management. Due to that, work quality becomes low. This is a cause of the number of defects"*. This statement was supported by interviewee I-03, by saying that *"the selection of an inappropriate project team caused construction project defects"*. He further expressed that fraud and breach of product liability, and improper approvals caused the defects claims.

As per the respondents I-01, I-02, I-06, and I-07, failure to allocate reasonable, proportionate risks in a contract identified other major causes of the defects claims. Respondent I-03 explained, *"allocation of unfair risk between contract parties' effect to arise defect claims. Allocating risk to the wrong party makes it difficult to control the project risks. If the risk events occur, this will affect the whole project".* Further, I-02, I-04, and I-05 respondents explained differences might be happening within the

contract parties' perception regarding the risk allocation under the contract provisions, and this caused defect claims to arise.

Respondents I-01 and I-07 explained that defective designs, errors, or mistakes in the design lead to defects in construction projects. Interviewee I-05 further validated the above responses by explaining, *"…design drawing errors delays project completion and increase the project cost and that subject arise defect claims".* This statement was supported by I-02 and I-08 respondents explaining that finalising the drawings before the commencement of the construction project may increase design errors and defective designs will subjected to arise defect claims.

Respondent I-06 expressed that *"Variations suggested by the client are a major issue in construction projects"*. Interviewee I-04 revealed, *"selecting inexperienced contractors, subcontractor failures, and bad quality work also cause the defect claims"*. Similarly, interviewees I-03 and I-05 explained that unrealistic tendering and contract acceleration also trigger the output of poor-quality work.

According to interviewees I-03, I-05, I-06, and I-08, lack of resources, employing inadequate and inexperienced professionals, site conditions, deviations of pre-determined planned works, political interface, bankruptcy, and import and export restrictions are the newly-identified causes of defects claims in infrastructure projects.

4.4.3 Consequences of defect claims

Fourteen (14) types of defect claims were identified through the literature review as applicable to general construction projects. However, at the end of the expert interviews, five (05) consequences from the literature have been narrowed down to two (02) consequences; three (03) new consequences were also identified.

Table 4.4 illustrates the identified consequences of defect claims before and after the expert interviews for the infrastructure projects. Newly-identified consequences are presented in bold letters.

Table 4.4: Consequences of Defect Claims

Before Expert Interviews	After Expert Interviews
Damage Business relationships	Damage Business relationships
Arise disputes	Arise disputes
Delay the Project completion date	Delay the Project completion date
Deterioration of the delivered product quality	Deterioration of the delivered product quality
Loss of productivity	Loss of productivity
Fraud and breach of product liability	Fraud and breach of product liability
Undermine team spirit	Undermine team spirit
Loss of profit	Loss of profit
Share information with project parries	Share information with project parties
Cost overrun	
Waste of Clients' money	*Cost overrun*
Escalation of cost	
Abandon of project	
Non-completion of the project	*Abandon of project*
	Loss of clients' confidence regarding consultants
	Added investment risks
	Produce low-quality projects

All respondents expressed that a delay in project completion date is the major effect of defects claims in construction projects. Interviewee I-04's own words explained that *"... delay in project completion has a significant effect to arise defect claims".* This statement was supported by respondent I-02 explaining, *"delay in completion of construction projects is a universal phenomenon and construction projects are no exceptions for that incident".* The explained defects have a major influence over the successful completion of the project. This induces rising claims and disputes and lengthy dispute-resolving processes, and suspension of works happens due to the disputes that delay project completion.

Respondent I-05 expressed that cost overrun is another major effect due to the defects claims in the construction projects. Furthermore, respondent I-03 explained that *"insufficient funds of employer will get delay the contractor's interim payments".* Further, interviewee I-06 expressed that *"...required huge cost for defect rectifications, defect investigations, and other expenses due to defect claims".* Similarly, interviewee I-08 explained that another major effect of defects claim is the

cost overrun. The reason for that is the contractor needs a huge amount of money for defects rectifications, investigations, supervision charges and other expenses.

Interviewees I-03 and I-04 expressed that a damaged business relationship is the other major effect of to defect claim. Similarly, respondent I-01 revealed, *"damaged contract parties' business relationship in a claim situation loses the parties' intention to work together in future projects. Clients are reluctant to give any future projects to the contractors who have not completed the project properly".* Respondents I-07 and I-08 validated the above statement.

Deterioration of the delivered product quality and fraud breach product liability happens due to defect claims. Interviewees I-02, I-06, and I-07 expressed the loss of client confidence regarding consultants, adding investment risks, and producing low-quality products, are the newly-identified causes of defects claims in infrastructure projects.

4.4.4 Strategies to manage defect claims

Twenty-eight (28) strategies to manage claims were identified through the literature review as being applicable to general construction projects. However, at the end of the expert interviews, four (04) strategies from the literature were narrowed down to two (02) strategies, and five (05) new strategies were also identified. Therefore, ultimately thirty-one (31) causes were listed and carried forward to the questionnaire survey.

Table 4.5 shows the management strategies of claims identified as being applicable to defect claims in the infrastructure projects before and after the expert interviews. Newly-identified management strategies are presented in bold letters.

Table 4.5: Strategies to Manage Defect Claims

Before Expert Interviews	After Expert Interviews
Maintain Risk Register	Maintain Risk Register
Risk avoidance checklist	Risk avoidance checklist
Proper constructer management	Proper constructer management
Use Insurances	Use Insurances
Proper Contract Administration	Proper Contract Administration

Before Expert Interviews	After Expert Interviews
Select the most suitable procurement method	Select the most suitable procurement method
Equitable Sharing of Risks between contract parties	Equitable Sharing of Risks between contract parties
Negotiation in the event of differentiating in matter	Negotiation in an event of differentiate in matter
Early Notification	Early Notification
Conduct regular Site Meetings	Conduct regular Site Meetings
Keep Records	Keep Records
Clear and frequent communication	Clear and frequent communication
Create, implement, and utilise a logical and user-friendly schedule	Create, implement, and utilise a logical and user-friendly schedule
Scope Assessment	Scope Assessment
Distribute required information	Distribute required information
Project design should review by the third party	Project design should review by the third party
A reasonable cost-sharing ratio between the client and the contractor	A reasonable cost-sharing ratio between the client and the contractor
Providing sufficient time for bidders to submit their bids	Providing sufficient time for bidders to submit their bids
Prequalification of the main contractor	Prequalification of the main contractor
Use of named subcontractors rather than nominated subcontractors	Use of named subcontractors rather than nominated subcontractors
Setting contingency plans	Setting contingency plans
Monitoring system set up by the main contractor	Monitoring system set up by the main contractor
Support from top management to the project team	Support from top management to the project team
Proper identification of roles and responsibilities	Proper identification of roles and responsibilities
Prepare proper Contract Documents	
Proper Coordination Between all the contract documents	*Prepare proper contract documents*
Inspection of Work	
Inspect the quality	*Establish quality control measures*
	Built good team spirit
	Enough resources should be provided
	Adequate use of professionals should be employed
	Good client financial capability
	Functional site layout must be assessed and provided

Seven respondents (out of the eight), named I-02, I-03, I-04, I-05, I-06, I-07, and I-08, expressed that fair contractual risk allocation with the project parties can mitigate most of the defects claims. Interviewee I-04 expressed that *"…equally sharing the risk between contract parties is the vital strategy to manage defect claims".* Other respondents explained the fair distribution of risks between parties is satisfying, and all parties to the contract may manage the defect claims. Further, I-02 and I-03 stated that maintaining a risk register and risk avoidance checklist is an early identification mechanism of defects claim situations.

Interviewee I-04 explained that negotiations in an event to differentiate the matter could manage the defect claims in projects. Further, interviewee I-07 stated that *"contract administrators have the capacity to early identify ongoing issues in construction projects and negotiate with the project parties before those issues turn into claims. Most of those claims have the possibility to mitigate or avoid at the implement stage".* Further, interviewee I-05 explained conducting regular site meetings, clear and frequent communication, distributing required information and record keeping are the strategies to manage defects claims during the construction period.

Interviewee I-06 stated proper contract administration is the other important strategy to manage defects claims. Further, interviewee I-07 stated that to manage defects claims, *"Proper contract administration is the most important strategy. It means contract parties should follow the procedures mentioned in the contract agreement, and contract administrators should administer the parties to follow those procedures".* Interviewees I-01, I-03, and I-04 stated that appropriate construction management, a monitoring system set up by the main contractor, scope assessment, and implementation of logical and user-friendly schedules are the other significant strategies to manage defects claims. Moreover, the contract administrator should act as an impartial person to the contract parties, giving fair determination in a claims situation.

Respondents I-02 and I-06 expressed insufficient time for submission of the bid also affected to increase defects claims. Further, I-05 and I-08 stated that the limited time period for bidding creates many errors in pricing, which ultimately result in the disqualification of sub-contractors' selection. However, a third party can be implemented to overcome those barriers, prequalification of the main contractor, use of specified named subcontractors without appointing nominated subcontractors, and review of the project design. Adequate alternatives should be provided to complete the project within a tight time schedule and functional site layout. Further, building good team spirit, providing sufficient resources, adequate employment of professionals, good financial capacity, and functional site layout must be assessed and provided. These are newly-identified strategies to manage defects claims.

4.5 Questionnaire Survey

The Questionnaire Survey was conducted using the literature review results and expert interview outputs. Mainly the questionnaire survey was conducted with professionals who have experience with claims in infrastructure projects. Survey data were collected through the questionnaire, as shown in Appendix B.

4.6 Objectives of the Questionnaire Survey

A questionnaire survey aims to determine the most significant causes, consequences, and strategies of defects claims in infrastructure projects. The ranking was done to reach the goals mentioned above.

4.7 Respondents in the Questionnaire Survey

Fifty-six (56) questionnaires were distributed among professionals in construction projects with a minimum of 1-5 years of experience in claims management in infrastructure projects. Thirty-two (32) responses were received, and the response rate of the questionnaire was above 50%.

The respondents were comprised of three types of professionals: contract administrators, project managers, and quantity surveyors. Further, professionals with at least 1-5 years of work experience in claims management and infrastructure projects were considered, and Table 4.4 summarises the details of respondents' work experience.

Table 4.6: Working Experience of Respondents

Profession	Working experience in the Claims Management						Working Experience in infrastructure Projects					
	1-5	5-10	10-15	15-20	20-25	Total	1-5	5-10	10-15	15-20	20-25	Total
Contract Administrators	1	1	3	3	1	**9**	6	3				**9**
Project Managers	1	2	3	1		**7**	6	1				**7**
Quantity Surveyors	2	4	5	3	2	**16**	11	3	2			**16**
Total	**4**	**7**	**11**	**7**	**3**	**32**	**23**	**7**	**2**	**0**	**0**	**32**

According to Table 4.6, nine contract administrators, seven project managers, and sixteen quantity surveyors form the total number of respondents.

Considering the experience in claims management, 04 of the total sample have 1-5 years of experience, 07 of the total sample have 5 -10 years of experience, 11 of the total sample have 10 -15 years of experience, 07 of the total sample have 15 -20 years of experience, and 03 of the total sample have 20-25 years of work experience.

Considering the infrastructure projects experiences, 23 of the total sample have 1-5 years of experience, 07 of the sample have 5-10 years of work experience, and 02 of the sample have 10-15 years of work experience in infrastructure projects.

4.8 Findings and analysis of the Questionnaire Survey

Identified specific causes, consequences, and strategies of defects claims were sort-out in the expert interviews and amalgamated and carried further to the questionnaire survey. Identified types, causes, consequences, and strategies of defect claims were ranked using their significance. The ranking was done based on the mean rating and standard deviation statistical analysis methods. Finally, the key findings of the questionnaire survey are described as follows.

4.8.1 Significant types of defects claims

After expert interviews, 07 types of defect claims were identified and brought forwarded to the questionnaire survey. However, after the questionnaire survey, the types were sorted according to the relative importance index, and standard deviation ranked the types of defect claims based on their significance, calculated based on the Likert scale score.

Table 4.7 shows the significance of the type of defects claims in infrastructure projects along with the relative importance index, standard deviation, and ranking.

Table 4.7: Significance of Types of Defect Claims

Types of Defect Claims	Relative Importance Index	Std. Dev.	Rank
Construction defects	**0.913**	**0.461**	**1**
Workmanship defects	**0.906**	**0.761**	**2**
Design defects	**0.900**	**0.508**	**3**
Material defects	**0.875**	**0.660**	**4**
Specification defects	**0.613**	**0.564**	**5**
Operational and Maintenance defects	**0.591**	**0.501**	**6**
Subsurface defects	**0.532**	**0.659**	**7**

The significance of types of defect claims has expanded within the RII value of 0.913 to 0.532 with different SD. RII is the mean value calculated based on the Likert scale score given by the respondents for the defect claim types. Likert scale 5 is referred to the very high significant factors, and scale 3 is referred to the neutral factors and is distributed with five scales. Therefore, factors which obtained RII values of **0.700** or more are considered as high significant or most significant. Accordingly, from all the seven (07) types of defects claims, four (04) types were identified as most significant in infrastructure projects.

The standard deviation (SD) value shows the variance of scores given by each respondent for defect claim types. Therefore, when the standard deviation (SD) value of a defect claim type is close to zero, it signifies that the variability of the scores given by the respondents for that particular type of defect claim is low. In other words, the similarity of the scores given by the respondents for that type of defect claim is high. Therefore, if the standard deviation (SD) value is low, the accuracy of the identified significance or the ranking is high.

Four **(04)** types of defect claims were identified as most significant in infrastructure projects, and *construction defects* were identified as the first-ranked type of defect claims, with a 0.913 RII value. The next most significant type of defect claim is *workmanship defect claim* with an RII value of 0.916. The *design defect claim* and

material defect claim received 0.900 and 0.875 relative importance index values and ranked the third and fourth places, respectively.

Specification defects claim, operational and maintenance defects claim, and *subsurface defects received* 0.613, 0.591, and 0.532 *RII* values, respectively, and were identified as non-significant causes of defect claims. All the defect claim types' SD values were close to zero, denoting the high accuracy of data.

4.8.2 Significant causes of defects claims

Forty-four (44) causes of defect claims were finalised within the expert interviews and brought forwarded to the questionnaire survey. However, after the questionnaire survey, the causes were sorted according to the mean rating and standard deviation, ranked the causes of defect claims based on their significance, calculated based on the Likert scale score. Bold italic texts in the table refer to the causes modified during the expert interview. On the other hand, newly-identified causes by the expert interviewees are in bold text in the table.

Table 4.8 illustrates the significance of causes of defects claims in infrastructure projects with the mean rating, standard deviation, and ranking.

Table 4.8: Significance of Causes of Defect Claims

Causes of Defect Claims	Relative Importance Index	Std. Dev.	Rank
Subcontractor failures	**0.894**	**0.761**	**01**
Inadequate and inexperienced professionals employed	**0.856**	**0.681**	**02**
Site conditions	**0.850**	**0.842**	**03**
Improper approvals	**0.838**	**0.821**	**04**
Bad quality of work	**0.831**	**0.654**	**05**
Inaccurate topological date	**0.825**	**0.811**	**06**
Lack of resources	**0.819**	**0.723**	**07**
Improper project management	**0.813**	**0.678**	**08**
Selected inexperienced contractors	**0.805**	**0.806**	**09**
Inadequate specifications	**0.800**	**0.874**	**10**
Design issues	**0.788**	**0.791**	**11**
Insufficient availability of information	**0.769**	**0.754**	**12**
Import/export restrictions	**0.763**	**0.793**	**13**
The productivity of plant and labour	**0.756**	**0.717**	**14**

Causes of Defect Claims	Relative Importance Index	Std. Dev.	Rank
Contract acceleration	**0.750**	**0.862**	**15**
Buildability issues	**0.744**	**0.981**	**16**
Arise variations due to the scope change	**0.744**	**1.021**	**16**
Labour disputes/Union strikes	**0.738**	**0.681**	**18**
Impact of the construction project on the surrounding environment	**0.731**	**1.025**	**19**
Deviations from pre-determined planned works	**0.731**	**0.631**	**19**
Time targets that are not realised	**0.731**	**0.761**	**19**
Bankruptcy	**0.725**	**0.864**	**22**
Unfair risk allocation	**0.719**	**0.791**	**23**
Financial failures of the contractor	**0.713**	**0.763**	**24**
Delays in work progress	**0.706**	**1.120**	**25**
Fraud and breach of product liability	**0.700**	**1.048**	**26**
Adverse weather	**0.681**	**0.654**	**27**
Market inflation	**0.675**	**0.717**	**28**
Political interface	**0.638**	**0.842**	**29**
Investigation of incomplete locations	**0.609**	**0.793**	**30**
Improper Contract document preparation	**0.588**	**0.862**	**31**
Late giving of possession of the site	**0.513**	**0.874**	**32**
Global financial crisis	**0.493**	**0.998**	**33**
Payment delays	**0.488**	**1.143**	**34**
Change of conditions	**0.475**	**0.791**	**35**
Breach government regulations	**0.456**	**1.012**	**36**
Act of God	**0.444**	**1.025**	**36**
Unplanned disruptions, suspensions, or stopped work orders	**0.438**	**1.523**	**38**
Change in government codes	**0.381**	**0.907**	**39**
Administrate management	**0.356**	**1.276**	**40**
Different interpretations of the contract clauses	**0.332**	**1.313**	**41**
Difficult to get statutory approval for alternative cost-saving designs	**0.319**	**1.061**	**42**
Unrealistic tendering	**0.309**	**1.027**	**43**
Unclear contractual terms in the contract document	**0.302**	**1.043**	**44**

The causes of defects claims with 0.700 or greater than 0.700 of RII values were considered as most significant causes. Such causes were ranked according to the descending order of the RII value. In addition, causes with the lowest SD value were considered as most precise causes. All causes of defect claims had expanded within the RII value of 0.894 to 0.302 with different SDs.

Based on the relative importance index value, the most significant cause of defect claims is *subcontractor failures* with a 0.894 RII value. The inexperienced and unqualified subcontractor's works result in project defects. It has direct and indirect effects on the work of the main contractor. Many subcontractors are involved in infrastructure projects, and subcontractor failures are also considered significant causes for defects claims.

Furthermore, *inadequate and inexperienced professionals employed* were identified as the cause to occur defects claims. Employing inexperienced employees demands significantly more time, resources, and effort in onboarding and affects the quality of the work.

Site conditions and *improper approvals* are the next highest-ranked causes of defect claims. The success of the project affects site conditions, such as the quality of roads, quality of labours, professionals, local work, labour rules and regulations, climatic conditions, air and water conditions, and existing ground surface conditions. Those situations directly impact the rise of defect claims in infrastructure projects. Improper approvals also directly manipulate defects in projects.

Bad quality of work is the fifth-ranked significant cause of defects claims. High cost is required to rectify the defects of bad quality work. *Inaccurate topological data* is the other most significant cause that may affect project defects. The seventh-ranked cause is the *lack of resources.* Resource management is required if there is a lack of resources. Otherwise, it directly increases defects claims in projects.

Improper project management and *selected inexperienced contractors* are the other most significant causes of defects claims. Poor project management may lead to several negative effects on the projects. Inexperienced contractors may not be familiar with the procedures, methods, legalities, and regulations of the industry. Therefore, numerous mistakes may induce project defects.

The tenth, eleventh, and twelfth-ranked most significant defect causes are *inadequate specifications*, *design issues*, and *insufficient availability of information*, respectively. Specifications are written documents that specify the quality of the

materials, manufacturing methods and installation procedures, supplementary drawings, and installation methods of the project. If the specification is inadequate, the possibility of providing a defective project is high.

In addition, in a project where the design and construction are done by two separate parties, it is rare to communicate with both parties before commencing construction. The information should be transferred onsite to facilitate construction. Unavailability of information and design issues also affects defective works in projects.

Import-export restrictions are another most significant factor that causes defects claims. Infrastructure project works require massive amounts of imported materials and equipment from the international market. Importing these items is difficult due to import and export restrictions imposed by the government. Therefore, locally available materials and equipment may have to be used, which affects the construction quality.

Further, the *productivity of the plant, labour, and contract acceleration* are other significant causes of defect claims. If the plant and labour productivity becomes lower, accelerating the project to achieve the expected completion dates may decrease the efficiency of workers—this may have a higher possibility of defective work.

Buildability issues creates variations due to the scope change, and *labour disputes/Union strikes* are identified as the next most significant causes. The concept of buildability enhances the knowledge regarding construction and operation to improve project cost efficiency and project quality. Therefore, buildability issues, scope changes, and labour disputes/union strikes are causes of the increased defect claims. The *impact of the constructor project on the surrounding environment* and *deviations of pre-determined planned works* are other most significant causes for defect claims.

In addition, *time targets that are not realised*, *bankruptcy*, and *unfair risk allocation* are the nineteenth, twenty-second, and twenty-third ranked significant causes. If the

time targets are not realised, then the efficiency of projects becomes low, and bankruptcy causes project failure.

Construction projects are unique, and each and every project party carries their own risks. Unfair risk allocation may induce defects in construction projects.

Moreover, *financial failures of the contractor*, *delays in work progress,* and *fraud and breach of product liability* are identified as significant causes of defect claims. Financial failures may directly affect the construction progress of the project. It may decrease the project quality. However, fraud and breach of product liability also cause rising defect claims.

Adverse weather, market inflation, political interference, investigation of incomplete location, improper contract document preparation, delay on giving possession, global financial crisis, payment delays, breach government regulations, act of God, unplanned disruptions, suspensions or stop work orders, change in government codes, administrate management, different interpretations of the contract provisions, difficult to get statutory or authority approval for alternatives to cost-saving design proposals, unrealistic tendering, and unclear contractual terms are identified as non-significant causes of defect claims, since their RII values were below 0.700 and SD value was high.

4.8.3 Significant consequences of defect claims

After the expert interviews, 14 consequences of defect claims were identified, and the questionnaire survey was done through those finalised consequences. However, after the questionnaire survey, the significance of the consequences was measured based on mean rating and standard deviation results calculated through the Likert scale and ranked the consequences of defect claims. Bold italic texts in the table refer to the consequences modified during the expert interview. On the other hand, consequences newly identified by the expert interviewees are in bold text.

Table 4.9 shows the significance of the consequences of the defect claims in infrastructure projects, along with the mean rating, standard deviation and ranking.

Table 4.9: Significance of Consequences of Defect Claims

Consequences of Defect Claims	Relative Importance Index	Std. Dev.	Rank
Cost overrun	**0.894**	**0.983**	**01**
Deterioration of the delivered product quality	**0.819**	**0.756**	**02**
Produce low-quality projects	**0.800**	**0.841**	**03**
Damage Business relationships	**0.750**	**0.823**	**04**
Share information with project parties will be limited	**0.744**	**0.759**	**05**
Loss of profit	**0.731**	**0.783**	**06**
Loss of client confidence regarding consultants	**0.725**	**0.980**	**07**
Delay the Project completion date	**0.719**	**1.016**	**08**
Added investment risks	**0.700**	**0.785**	**09**
Abandon of project	**0.688**	**0.746**	**10**
Fraud and breach of product liability	**0.669**	**1.002**	**11**
Loss of productivity	**0.656**	**0.875**	**12**
Undermine team spirit	**0.506**	**0.743**	**13**
Arise disputes	**0.450**	**1.646**	**14**

The consequences of defect claims with 0.700 or greater than 0.700 RII value were considered the most significant. They were ranked according to the descending order of the RII value. In addition, consequences with the lowest SD value are considered the most precise. All consequences of defect claims had expanded within the RII value of 0.894 to 0.450 with different SDs.

In general construction projects, *cost overrun* can be regarded as the most common consequence considering the detailed information in the table. Many negative results may occur due to the cost overrun: labour and wage issues, material supply issues, time extensions, claims, etc.

Deterioration of the quality of the product to be delivered and *produce low-quality products* were the next two rankings in terms of the consequences of the defect claims. Basically, these consequences happen due to defects in construction projects. Hence the probability of occurrence is comparatively high in these two consequences in infrastructure projects.

In addition, *damaged business relationship* was the other consequence, which is more likely to occur in infrastructure projects due to the defect claims. The literature

findings and expert interview results expressed that defect claims damage business relationships among parties, and thus, contract parties will not willing to work as a team in future projects. Clients are reluctant to involve in any project with the contractors who did the defects in earlier projects. Hence most contractors are concerned about defect claims as it destroys the relationship with the client.

Loss of profit and *loss of client confidence regarding consultants* were identified as the next most frequent consequences. In infrastructure projects, defect rectifications are more costly than in other construction projects. Hence, contractors lose their profits from the projects. If defects appear, clients worry about the quality of the project. Hence, the client loses the confidence of the project participants.

Delay in the project completion date is ranked as the eighth consequence of defect claims in infrastructure projects. According to research findings, bad quality of works, subcontractor failures, site conditions, changes in the project scope by the client, variation work orders issued by the client and the consultant due to design changes, and errors or omissions are some causes that delay the project completion date.

The *added investment risk* was identified as another highly frequent consequence of the defect claims in infrastructure projects. Investment risk is defined as the probability or likelihood to occur losses relative to the parties' expected profit on any particular investment. Any defects of this nature incur investment risks.

Abandonment of the project, fraud and breach of product liability, loss of productivity, and undermined team spirit increase disputes which take RII values below 0.700. Such consequences are identified as non-significant consequences of defect claims.

4.8.4 Suitable strategies to manage defect claims

Thirty-one (31) strategies to manage defect claims have been finalised within the expert interviews and forwarded to the questionnaire survey. The finalised strategies were sorted according to mean rating and standard deviation, and the strategies were

ranked based on their significance using results calculated through the Likert scale. Bold italic texts in the table refer to the strategies modified during the expert interview. On the other hand, strategies newly identified by the expert interviewees are in bold text in the table.

Table 4.10 illustrates the strategies to manage defect claims in infrastructure projects along with the mean rating, standard deviation, and ranking.

Table 4.10: Significance of Strategies of Management of Damage Claims

Strategies for Defect Claims	Relative Importance Index	Std. Dev.	Rank
Clear and frequent communication	**0.919**	**0.499**	**01**
Distribute required information	**0.913**	**0.619**	**02**
Establishing quality control measures	**0.906**	**0.671**	**03**
Keep Records	**0.900**	**0.718**	**04**
Early Notification	**0.894**	**0.761**	**05**
Use of named subcontractors rather than nominated subcontractors	**0.888**	**0.914**	**06**
Create, implement, and utilise a logical and user-friendly schedule	**0.881**	**0.875**	**07**
Monitor the system set up by the contractor	**0.875**	**0.907**	**08**
Scope Assessment	**0.856**	**0.924**	**09**
Conduct regular Site Meetings	**0.850**	**0.880**	**10**
Built good team spirit	**0.831**	**0.847**	**11**
Adequate use of professionals employed	**0.800**	**0.845**	**12**
Negotiation in situations of differentiating in matter	**0.794**	**0.325**	**13**
Top management and all parties support the project team	**0.781**	**0.673**	**14**
Use Insurances	**0.775**	**0.718**	**15**
Project design should review by a third party	**0.769**	**0.499**	**16**
Prequalification of the main contractor	**0.763**	**0.896**	**17**
Maintain Risk Register	**0.756**	**0.478**	**18**
Risk avoidance checklist	**0.756**	**0.753**	**18**
Equitable Sharing of Risks between contract parties	**0.750**	**0.463**	**20**
Enough resources should be provided	**0.738**	**0.721**	**21**
Setting contingency plans	**0.731**	**1.086**	**22**
Functional site layout must be assessed and provided	**0.719**	**0.541**	**23**
Proper identification of roles and responsibilities	**0.713**	**0.634**	**24**
Providing sufficient time for bidders to submit their bids	**0.675**	**0.753**	**25**
Prepare proper contract documents	**0.644**	**1.025**	**26**
Good client financial capability	**0.631**	**0.973**	**27**
Proper Contract Administration	**0.488**	**1.362**	**28**
Proper constructer management	**0.481**	**1.545**	**29**

Strategies for Defect Claims	Relative Importance Index	Std. Dev.	Rank
A reasonable cost-sharing proportion between the contract parties	**0.394**	**1.513**	**30**
Select the most suitable procurement method	**0.444**	**1.385**	**31**

Defect claim management strategies have expanded within RII values of 0.919 to 0.444 with different SDs. Strategies with an RII value of 0.700 or greater have been considered the most significant. Those strategies were ranked according to the descending order of the RII value. In addition, the lowest SD value strategies are considered the most precise strategies.

All strategies were ranked based on test results. *Clear and frequent communication* strategy and *distribute required information* were ranked as the most significant strategies for managing defect claims. Communication is one of the most powerful strategy for sharing information between project participants. Communication should clarify objectives, expectations, progress, achievements, recognition, and, of course, all the information regularly. Also, the distribution of information requires getting the right information to the right person at the right time. This will help prevent most incidents from happening before they grow into defects.

The defect in claim management strategy ranked third is *establishing quality control measures.* Quality control measures confirm that product quality is maintained or upgraded. This procedure can be done by specialised or trained personnel, creating benchmarks for product quality and product testing.

Keep records is identified as the next strategy. Record keeping provides more benefits: monitoring the progress and financial statements, tracking the basis of the property, and early identification of defective work. Trained personnel can do this procedure by creating benchmarks for product quality.

Early notification is another identified significant strategy. During the project, stakeholders must give prior warning of anything that may affect the works or

increase costs as soon as they become aware of them. Then the parties may hold early warning meetings to discuss how to mitigate or avoid impacts on the project.

The *use of named subcontractors rather than nominated subcontractors* is the sixth most significant strategy in infrastructure projects. Inexperienced and unqualified subcontractors' works result in raising project defects.

The seventh strategy that should be highly significant is to *create, implement, and utilise a logical and user-friendly schedule*. This increase the project efficiency. *Monitor the system set-up by the contractor* is considered the next strategy to manage the defect claims in the infrastructure projects. Using a monitoring system to collect and analyse data to verify such activities are implemented according to plan and that the expected products and services are delivered as expected. This support minimises the defect claims.

Scope assessment and *conduct regular site meetings* can be considered the ninth and tenth significant strategies to manage defect claims, respectively. Scope assessment identifies project changes and can be communicated among the stakeholders to minimise the defect claims at an early stage. Conducting regular site meetings enhances communication amoung the parties and overcomes claims at an early stage.

Built good team spirit is another significant strategy to manage defects claims because working as a team, sharing information, and decision-making power minimise the claims at an early stage.

Adequate use of professionals should be employed, negotiation in the situations of differentiate in matter, and *top management and all parties support the project team* are other most significant strategies to manage defect claims. If the professionals involved in the project support top management to enhance the standards and quality of the project, ultimately, the company value increases. Negotiation is the other strategic discussion that resolves an issue in a way acceptable to all parties.

Use insurance is the other most significant strategy. Insurance is a way of managing risks, and project parties can transfer the potential loss that happened during the risk to the insurance company for the defective situations by paying for a fee, defined as the premium. *Project design should review by a third party* if the other defect claim strategy is identified. Most experienced and qualified bidders can be selected for the projects at the tender stage. In addition, *pre-qualifications of the main contractor* are identified as another defect claim management strategy.

Maintain risk register, risk avoidance checklist, and *equitable Sharing of Risks between contract parties* are identified as other significant strategies for managing defect claims. Risks are identified as potential events that are internal or external to the construction project. If risks happen, it will cause a project to fail to achieve one or more objectives. However, maintaining a risk register and checklist and sharing the risks minimise the defects happening at an early stage of the project in infrastructure projects.

In addition, *enough resources should be provided* is derived as the other strategy. However, the absence/poor quality equipment, productivity, and efficiency are negatively impacted, and more defects happen in construction projects. *Setting contingency plans* is a defect claim management strategy identified in the study. A good contingency plan can prevent the occurrence of unexpected events, and it reduces the defects claims in infrastructure projects.

Functional site layout must be assessed and provided is the other significant strategy to manage defect claims. An effective and accurate site layout plan helps to ensure the works are undertaken efficiently and safely. The other identified strategy is the *proper identification of contractual parties' roles and responsibilities.* Every party has key responsibilities to understand the meaning of the terms and consider the importance of each and every role and responsibility of project stakeholders. Such strategies may minimise defect claims in projects.

Providing sufficient time duration for contractors to submit their bids, prepare proper contract documents, good client financial capability, proper contract administration, proper construction management, prepare proper contract document, reasonable cost-sharing proportion between the contract parties, and *select the most appropriate procurement method* had RII values lower than 0.700. Hence those strategies were identified as non-significant strategies for managing defect claims in infrastructure projects.

4.9 Pattern Matching of the Research

The discussion makes a comparative analysis between the research findings of this study and the literature findings. The results of this research also discuss how to bridge the research gap. Findings on most significant types of defect claims, most significant causes of defect claims, most significant consequences of defect claims, and most significant strategies to manage defect claims to fulfil the gap are listed in Tables 4.11, 4.12, 4.13, and Table 4.14. In pattern matching, only the most significant findings were compared with literature.

4.9.1 Significant types of defect claims

Past researchers have identified types of defect claims in construction industry projects.

Table 4.11 compares the most significant types of defect claims identified from this study and their identification in past research works.

Table 4.11: Comparison of most significant types of defect claims with the literature findings

Authors / Types	Defect Claims									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Construction defects	☐			☐			☐		☐	
Workmanship defects		☐								
Design Defects	☐		☐				☐	☐	☐	
Material defects	☐	☐				☐				☐
Sources: A- (Fhloinn, 2017), B- (Jingmond & Agren, 2015), C- (Elizabeth et al., 2018), D- (Jonsson & Gunnelin, 2019), E- (Lundkvist et al., 2014), F- (Sandanayake et al., 2021), G- (Shen et al., 2017), H- (Shahhosseini & Hajarolasvadi, 2021) I- (Aibinu et al., 2011).										

Previous research studies have identified all the most significant types of defect claims (04 types) in construction projects. The present investigation revealed that construction defects are the most significant defect type in infrastructure projects. Similarly, this was identified (but not in the infrastructure projects) by Ni-Fhloinn (2017), Jonsson and Gunnelin (2019), Shen et al. (2017), and Aibinu et al. (2011). Other types of defect claims were also identified in past research works. The literature findings were validated from the data collection.

4.9.2 Significant causes of defect claims

Past researchers have identified the causes of defect claims, causes of claims commonly both.

Table 4.12 compares the most significant causes of defect claims identified from this study and their identification in past research works.

Table 4.12: Comparison of the most significant causes of defect claims with the literature findings

Authors / Causes	Defect Claims						Claims							
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Subcontractor failures							□		□					
Inadequate and inexperienced professionals employed														
Site conditions														
Improper Approvals	□	□												
Bad quality of the work	□	□		□		□		□		□				
Inaccurate topographical data							□							□
Lack of resources														
Improper Project Management	□													
Selected inexperienced contractors										□				□
Inadequate specifications								□		□				
Design issues								□			□			
Insufficiency of the available information								□						
Import/export														

Causes \ Authors	Defect Claims						Claims							
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
restrictions														
The productivity of plant and labour												□		
Contract acceleration								□		□				
Buildability issues													□	
Arise variations due to the scope change		□		□		□		□		□				
Labour disputes/ Union strikes							□							
Impact on the construction project to the surrounding environment								□						
Deviations from pre-determined planned works														
Time targets that are not realised											□			
Bankruptcy														
Unfair risk allocation	□		□			□		□	□	□				
The financial failure of the contractor							□					□		□
Delays in work Progress								□						
Fraud and breach of products liability	□				□			□						

Sources: A- (Jonsson & Gunnelin, 2019), B- (Jingmond & Argen, 2015), C- (Sandanayake et al., 2021), D- (Hopkin et al., 2017), E- (Lin et al., 2016), F- (Lundkvist et al., 2014), G- Mishmish & El-Sayegh, 2018), H- (Do et al., 2022), I- (Le-Hoai et al., 2018), J- (Shahhosseini & Hajarolasvadi, 2021), K- (Sibanyama et al., 2012), L- (Shen et al., 2017), M- (Zaneldin, 2020), N- (Aibinu et al., 2011).

The six most significant causes of defect claims identified from semi-structured interviews and the other twenty (20) most significant defect claim causes identified by researchers are shown in Table 4.12. Out of fourteen, six researchers identified causes, *Bad quality of work* and *unfair risk allocations*. Five researchers identified *Arise variations due to the scope change, and* three researchers identified *Financial failures of the contractor* and *Fraud and breach of product liability.*

However, two research authors have identified *Subcontractor failures, improper approvals, inaccurate topographical data, selected inexperienced contractors, inadequate specifications, design issues,* and *contract acceleration* as causes of defect claims. *Improper project management, insufficiency of the available information, the productivity of plant and labour, buildability issues, labour disputes/union Strikes, the impact of the construction project on the surrounding environment, time targets that are not realised* and *delays in work progress* are eight causes identified from the literature identified by one researcher. In addition, *Inadequate and inexperienced professionals employed, site conditions, lack of resources, import/export restrictions, deviations of pre-determined planned works* and *Bankruptcy* are the most significant causes not recognised in any past research.

4.9.3 Significant consequences of defect claims

Most past researchers have identified the consequences of defect claims for infrastructure projects.

Table 4.13 presents the comparison between the most significant consequences of defect claims identified from this study and their identification in past research works.

Table 4.13: Comparison of most significant consequences of defect claims with the literature findings

Consequences \ Authors	Defect Claims						Claims					
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Cost overrun				□				□			□	□
Deterioration of the delivered product quality	□			□								
Produce low-quality projects												
Damage Business relationships	□		□	□				□	□	□		
Share information with project parties											□	
Loss of profit								□				
Loss of client confidence regarding consultants												
Delay the Project				□			□			□		

Consequences \ Authors	Defect Claims						Claims					
	A	B	C	D	E	F	G	H	I	J	K	L
completion date												
Added investment risks												

Sources: A- (Milion et al., 2017), B- (Iyer et al., 2020), C- (Lin et al., 2016), D- (Kikwasi, 2021), E- (Hopkin et al., 2017), F- (Lundkvist et al., 2014), G- (Do et al., 2022) H-(Shahhosseini & Hajarolasvadi, 2021), I- (Alaa et al., 2015), J- (Fazliani & Charoenngam, 2015), K- (Zaneldin, 2020), L- (Aibinu et al., 2011).

This study revealed *Cost overrun* is the most significant consequence of defect claims in an infrastructure project, identified by four researchers: Kikwasi (2021), Shahhosseini and Hajarolasvadi (2021), Zaneldin (2020), and Aibinu et al. (2011). *Deterioration of the quality of the product to be delivered, Damage business relationships, Share information with project parties, Loss of profit,* and *Delay in the project completion date* are identified by Milion et al. (2017), Lin et al. (2016), Kikwasi (2021), Do et al. (2022), Shahhosseini and Hajarolasvadi (2021), Alaa et al. (2015), Fazliani and Charoenngam (2015), and Zaneldin (2020). *Produce low-quality projects, Loss of client confidence in consultants*, and *Added investment risks* are the newly-identified causes of defect claims in infrastructure projects.

4.9.4 Significant strategies to manage defect claims

The research gap indicates that most strategies are identified for claims management in the construction industry. The most significant strategies for the management of defects claims in infrastructure projects were identified in this survey to fulfil the research gap.

Table 4.14 compares the most significant strategies identified from this study with their identification in past research.

Table 4.14: Comparison of most significant strategies to manage defect claims with the literature findings

Strategies \ Authors	Defect Claims						Claims					
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Maintain Risk Register	□		□					□	□	□		
Clear and frequent communication							□				□	
Distribute required information												□
Establishing quality control measures						□			□			□
Keep Records											□	
Early Notification	□							□				
Use of named subcontractors rather than nominated subcontractors								□				
Create, implement, and utilise a logical and user-friendly schedule				□						□		
Monitor the system set-up by the contractor							□					
Scope Assessment										□		□
Conduct regular Site Meetings			□	□					□			□
Built good team spirit												
sufficient use of professionals must be employed												
Negotiation in the event of differentiating in matter	□				□							
Top management and all parties support the project team							□			□		
Use Insurances								□	□			
Project design should review by a third party								□		□		
Prequalification of the main contractor								□				
Maintain Risk Register												
Risk avoidance checklist	□											
Equitable Sharing of Risks between contract parties					□	□		□				□
Enough resources should be provided												
Setting contingency plans							□					
Functional site layout must be assessed and provided												
Proper identification of roles and responsibilities										□		□

Strategies \ Authors	Defect Claims						Claims					
	A	B	C	D	E	F	G	H	I	J	K	L

Sources: A- (Sandanayake et al., 2021), B- (Milion et al., 2017), C- (Lin et al., 2016), D- (Lundkvist et al., 2014), E- (Kikwasi, 2021), F- (Jingmond & Agren, 2015), G- (Shahhosseini & Hajarolasvadi, 2018), H- (Mishmish & El-Sayegh, 2018), I- (Ni-Fhloinn, 2017), J- (Le-Hoai et al., 2018), K- (Zaneldin, 2020), L- (Shen et al., 2017).

The five most significant strategies to manage defect claims have been identified from semi-structured interviews, as shown in Table 4.14. Other twenty (20) most significant strategies to manage defect claims have been identified by researchers and are indicated in Table 4.14.

Maintain risk register is the most significant strategy identified by Sandanayake et al. (2021), Lin et al. (2016), Mishmish and El-Sayegh (2018), Ni-Fhloinn (2017), and Le-Hoai et al. (2018). *Conduct regular site meetings* and *Equitable sharing of risks* are the strategies identified by four researchers out of eleven. *Establishing quality control measures* is another most significant strategy identified by Jingmond and Agren (2015), Ni-Fhloinn (2017), and Shen et al. (2017). *Clear and frequent communication, Early Notification, Create, implement, and utilize a logical and user-friendly schedule, Scope Assessment, negotiation in the situations of differentiate in matter, top management and all the parties support to the project team, Use Insurances, project design should review by third party,* and *Proper identification of roles and responsibilities* are the strategies identified by the two researchers. *Risk avoidance checklist* strategy was identified by Sandanayake et al. (2021).

Shahhosseini and Hajarolasvadi (2021) identified *monitor the system set up by the contractor* and s*etting contingency plans,* whereas Mishmish and El-Sayegh (2018) identified two most significant strategies: the *use of named subcontractors rather than nominated subcontractors,* and *prequalification of the main contractor*. *Keep records* was identified as another most significant strategy by Zaneldin (2020). In

addition, *distribute required information* is the most significant strategy identified by Shen and co-workers (Shen et al., 2017).

4.10 Summary

Results obtained from the semi-structured interview and questionnaire survey were analysed in this chapter. Outcomes were discussed by critically reviewing them against the literature findings. Validation, modification, and suggestions were obtained during the expert interview. The questionnaire was implemented based on the expert interview outputs to identify the most important types, causes, consequences, and strategies to manage defect claims. The outcomes of the questionnaire data collection were analysed and reviewed with the literature findings.

5.0 CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The conclusion and recommendations chapter comprises the conclusion made by research outcomes and how the research gap was fulfilled. This chapter includes a comprehensive conclusion to each and every research objective examined in the study. Furthermore, this provides recommendations which add more facts to the objectives. The chapter discusses research limitations and, finally, identifies and introduces further research areas for future studies.

5.2 Conclusions

Facts and information on the subject were collected, and gaps in the literature were clarified through literature surveys. The expert interviews and questionnaire survey helped achieve the research aim and objectives in the analysis and discovery section. The achievement of the objectives was discussed in each chapter. Chapter Five provides an overall summary of findings and explanations of how each objective was achieved.

5.3 Objective 01- Identify common types of defect claims in infrastructure projects in Sri Lanka

The first objective was achieved based on the literature review and validated through expert interviews. Eight expert interviews were conducted in addition to the literature review to validate Objective 01. Mainly, six (06) claim types applicable to general construction projects were identified through the literature review. The expert interview validated that these six (06) types of claims are applicable to defect claims in infrastructure projects. The expert interview identified specification defect as the newly-identified type of defect claim. Finally, all seven (07) types of defect claims were listed that are applicable to defect claims in infrastructure projects and carried forward to the questionnaire round.

5.4 Objective 02 - Identify the significant types of defect claims in infrastructure projects in Sri Lanka

Objective 02 was achieved via the questionnaire survey. After the expert interview, seven (07) types of defect claim types were identified. They were ranked from high to low based on the relative importance index calculation. From the outcome, construction defect claims were identified as the most significant type of defect claim. The second and third most significant defect claims are workmanship defects and design defects. Material defects are also identified as the most significant type of defect claims. Specification defects, operational and maintenance defects, and subsurface defects were recognised as non-significant defect claim types.

5.5 Objective 03 - Identify the significant causes of defect claims in infrastructure projects in Sri Lanka

The causes of defect claims identified in the entire expert interviews and literature review were ranked to accomplish the third objective of this study. The literature review identified fifty (50) causes for claims. Those identified causes were validated through expert interviews. Thirty (30) causes were directly applied for the defect claims, twenty (20) causes were narrowed down to seven (07) causes, two (02) causes identified through literature review were rejected, and seven (07) causes were newly identified.

Forty-four (44) causes for defect claims were identified after the expert interview. Then ranking was done based on the relative importance index calculation and ranked from high to low. With reference to the relative importance index, subcontractor failures, inadequate and inexperienced professionals employed, site conditions, improper approvals, bad quality of work, inaccurate topological data, lack of resources, improper project management, selected inexperienced contractors**,** inadequate specifications, design issues, unavailability of information, import/export restrictions, the productivity of plant and labour, contract acceleration, buildability issues, arise variations due to the scope change, labour disputes/union strikes, the impact of the constructor project on the surrounding environment and deviations of

pre-determined planned works, time targets that are not realised, bankruptcy, unfair risk allocation, the financial failure of the contractor, delays in work progress, and fraud and breach product liability were identified as a top ranked twenty-six (26) most significant causes of defect claims in infrastructure projects. In addition, eighteen (18) causes of defect claims were identified as non-significant causes.

5.6 Objective 04 - Identify the significant consequences for the above identified causes of defect claims in infrastructure projects in Sri Lanka

Consequences of claims have been identified according to research findings. Fourteen (14) consequences were mainly determined for defect claims through the literature review. Based on the expert interview, nine (09) factors were validated as consequences of defect claims in infrastructure projects. Further, five (05) factors were narrowed down to two (02) factors. Three (03) consequences were newly-identified through the expert interview.

Considering the consequences identified above, they were ranked using the relative importance index results of the questionnaire survey. With reference to the relative importance index, cost overrun, deterioration of the quality of the product to be delivered, produce low-quality projects, damage to business relationships, sharing information with project parties, loss of profit, loss of client confidence in consultants, delay the project completion date, and added investment risks were identified as the most significant consequences of defect claims in infrastructure projects. Abandon of project, fraud and breach of product liability, loss of productivity and undermined team spirit, and rising disputes were identified as non-significant consequences of defect claims.

5.7 Objective 05 - Propose suitable strategies to manage defect claims in infrastructure projects in Sri Lanka

The final objective is to determine the strategies to manage defect claims in infrastructure projects. The literature review identified twenty-eight (28) strategies to manage claims. Those identified strategies were validated through the expert interview. Twenty-four (24) strategies were directly applied to the defect claims, four

(04) strategies were narrowed down to two (02) strategies, and five (05) strategies were newly-identified. After the expert interview, thirty-one (31) management strategies for defect claims were identified.

This was followed by the ranking based on the questionnaire survey output. Considering the outcomes of the questionnaire survey result, clear and frequent communication, distribution of required information, establishing quality control measures, keeping records, early notification, use of named subcontractors without appointing nominated subcontractors, creating, implementing, and utilising a logical and user-friendly schedule, monitor the system set up by the contractor, and scope assessment was identified as the most significant defect claim management strategies in the projects cycle.

In addition, conduct regular site meetings, build good team spirit, sufficient use of professionals must be employed, negotiate situations of differentiating matters, top management and all parties support the project team, use insurance, at the tender stage third party should review the project design, prequalification of the main contractor, maintain risk register, risk avoidance checklist, equitable sharing of risks, enough resources should be provided, setting contingency plans, functional site layout must be assessed and provided, and proper identification of roles and responsibilities were the identified top-ranked most significant strategies to manage defect claims. Moreover, seven (07) defect claim management strategies were identified as non-significant.

5.8 Recommendations

Infrastructure projects are the most important project type in today's construction industry. This infrastructure will help many developing countries to develop their economy faster. Therefore, infrastructure projects are essential for a country's development, and they will provide many benefits to the country.

Nevertheless, these infrastructure projects are massive and require more money; they are more complex than other construction projects. Therefore, claims are inevitable in infrastructure projects, and defect claims mostly affect infrastructure projects.

The research provides good guidance to manage defect claims in infrastructure projects, with the appropriate claim management strategies from the pre-contract stage. The outcomes revealed that the contractor could overcome the defect claims using critical strategies, such as clear and frequent communication of project issues on required information with the project parties through regular site meetings, keeping records of important information, keeping monitoring systems, proper supervision, sufficient use of professionals must be employed, and maintain risk register, take risk avoidance precautions, and equitably share the risks between contract parties. Setting contingency plans and using insurance are also used as defect claims management strategies.

Therefore, it is recommended that the contractor should maintain the qualified and proper staff on the site to establish quality control measures. Further, the contractor must employ proper supervision and clear and frequent communication between contract parties to share information and discuss the existing situation of the project, and maintain and monitor the risk register, to help manage the defects claims in infrastructure projects in the construction industry. Finally, parties can use insurance to transfer the defects claims situations to the third party if defects management becomes difficult.

5.9 Limitations

This research study is limited only to infrastructure projects in Sri Lanka. The results could be different if they referred to different types of claims. If this research was done for other claim types in infrastructure projects and building projects, together or separately, the result might have different outputs.

5.10 Further Research

Some further research areas are proposed for the future by considering the limitations and as guidance for researchers on this subject.

1. Management of defect claims in building construction projects in the construction industry
2. Management of termination claims in construction projects in the construction industry
3. Management of damage claims in construction projects construction industry

REFERENCES

Abdel-Galil, E., Ibrahim, A. H., & Alborkan, A. (2020). Assessment of transaction costs for construction projects. *International Journal of Construction Management*, DOI: 10.1080/15623599.2020.1738204

Aibinu, A. A., Ling, F. Y. Y., & Ofori, G. (2011). Structural equation modelling of organizational justice and cooperative behavior in the construction project claims process: Contractors' perspectives. *Construction Management and Economics*, *29*(5), 463-481. DOI: 10.1080/01446193.2011.564195

Akhtar, I. (2016). *Research Design.* SSRN Publication. doi:https://dx.doi.org/10.2139/ssrn.2862445

Aksorn, P., & Charoenngam, C. (2015). Sustainability factors affecting local infrastructure project. *Facilities*, *33*(1/2), 119-143. http://dx.doi.org/10.1108/F-01-2013-0005

Alaa, A., Mahmoud, H., & Omar, A. K. (2015). Use of building defect diagnosis in construction litigation: Case study of a residential building. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, C4515007/1- C4515007/11. doi:10.1061/(ASCE)LA.1943-4170.0000177

Alhammadi S. A., Tayeh, B. A., Alaloul W. S., & Jouda, A. F. (2021). Occupational health and safety practice in infrastructure projects. *International Journal of Occupational Safety and Ergonomics*, DOI: 10.1080/10803548.2021.2013034

Alqershy, M. T. & Kishore, R. (2021). Construction claims prediction using ANN Models: A case study of the Indian construction industry. *International Journal of Construction Management*, DOI: 10.1080/15623599.2021.1955322

Assaf, S., Hassanain, M. A., Abdallah, A., Sayed, A. M. Z., & Alshahrani, A. (2019). Significant causes of claims and disputes in construction projects in Saudi Arabia. *Built Environment Project and Asset Management, 9*(5), 597-615. https://doi.org/10.1108/BEPAM-09-2018-0113

Babatunde, S. O., Ekundayo, D., Udeaja, C., & Abubakar, U. O. (2020). Stakeholder perceptions of drivers for, and barriers to, the incorporation of sustainability in PPP infrastructure projects in Nigeria. *Open House International*, *45*(4), 373-386. https://doi.org/10.1108/OHI-05-2020-0037

Babatunde, S. O. & Perera, S. (2017). Barriers to bond financing for public-private partnership infrastructure projects in emerging markets: A case of Nigeria. *Journal of Financial Management of Property and Construction*, *22*(1), 2-19. https://doi.org/10.1108/JFMPC-02-2016-0006

Basit, T. N. (2003). Manual or electronic? The role of coding in qualitative data analysis. *Educational Research, 45*(2), 143–154. doi:10.1080/0013188032000133548

Bayat, F., Noorzai, E., & Golabchi, M. (2019). Identifying the most important public–private partnership risks in Afghanistan's infrastructure projects. *Journal of Financial Management of Property and Construction, 24*(3), 309-337. https://doi.org/10.1108/JFMPC-08-2018-0045

Brace, I. (2020). Object-oriented systems engineering for networked infrastructure projects. *Australian Journal of Multi-Disciplinary Engineering*, *16*(1), 54-66. DOI: 10.1080/14488388.2020.1782571

Central Bank of Sri Lanka. 2019. *CBSL Annual Report 2019: Economic and social infrastructure.* [accessed 2020 March 12]. https://www.cbsl.gov.lk/sites/default/files/cbslweb_documents/publications/annual_report/2019/en/7_Chapter_03.pdf.

Cakmak, E., & Cakmak, P. I. (2014). An analysis of causes of disputes in the construction industry using analytical network process. *Procedia-Social and Behavioral Sciences*, *109*(2), 183-187. doi:10.1016/j.sbspro.2013.12.441

Chi, C. S. F., Ruuska, I., & Xu, J. (2015). Environmental impact assessment of infrastructure projects: A governance perspective. *Journal of Environmental*

Planning and Management, 59(3), 393-413. DOI: 10.1080/09640568.2015.1013623

Cope, D. G. (2014). Computer-assisted qualitative data analysis software. *Oncology Nursing Forum, 41*(3), 322-323. doi:10.1188/14.ONF.322-323

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4 ed.). California: SAGE Publications.

Damoah, I. S., Mouzughi, Y., & Kumi, D., K. (2018). The effects of government construction projects abandonment: Stakeholders' perspective. *International Journal of Construction Management,* 1-18. doi:10.1080/15623599.2018.1486172

Dang, N. T. H., Nicholas, C., Raufdeen, R., Anthony, W. (2019). Stakeholder influence pathways in construction projects: Multi case study. *Journal of Construction Engineering and Management*, *145*(9), 05019011/1–05019011/14. doi:10.1061/(ASCE)CO.1943-7862.0001680

Dawson, C. (2002). *Practical research methods: a user-friendly guide to mastering research techniques and projects.* Oxford: How To Books Ltd. http://nuir.nkumbauniversity.ac.ug/xmlui/bitstream/handle/20.500.12383/988/A%20Practical%20Research%20Methods%20-%20C.Dawson.pdf%20(%20PDFDrive%20).pdf?sequence=1

Dharmarathna, R. G. L. R. (2018). *Contractual Issues in Construction and Operation of Commercial Buildings in Sri Lanka* (Unpublished bachelor's dissertation). Department of Building Economics, University of Moratuwa, Sri Lanka.

Dhaval, P., Joshi, G. J., & Patel, D. A. (2019). Development of prediction models for claim cause analyses in highway projects. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 11*(4), 04519018/1-04519018/11. doi:10.1061/(ASCE)LA.1943-4170.0000303

Do, S. T., Nguyen, V. T., Tran, C. N. N., & Aung, Z. M. (2022). Identifying and evaluating the key claim causes leading to construction delays. *International Journal of Construction Management,*
DOI: 10.1080/15623599.2022.2030508

Earnest, J. (2015). Post-conflict reconstruction: A case study in Kosovo. *International Journal of Emergency Services*, *4*(1), 103-128. doi.org/10.1108/IJES-02-2015-0009

Elizabeth, B., William, M., & Caroline, M. C. (2018). Emerging patterns in construction defect litigation: Survey of construction cases. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 10*(4), 03718003/1-03718003/8. doi:10.1061/(ASCE)LA.1943-4170.0000277

Fawzy, S. A., El-adaway, I. H., Saussine, L. P., Wahab, M. S. A., & Hamed, T. H.

(2018). Claims for extension of time and additional payment under common Law FIDIC: Civil law analysis. *Journal of Legal Affairs and Dispute Resolution in Engineering and construction*, *10*(4), 06518002/1-06518002/13. DOI: 10.1061/(ASCE)LA.1943-4170.0000276

Fawzy, S. A., El-adaway, I. H. (2015). Global total cost claims within common law legal systems: Application to the world bank contract. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 7*(2), 04514005/1-04514005/7. doi:10.1061/(ASCE)LA.1943-4170.0000155

Fellows, R. F., & Liu, A. M. (2015). Research methods for construction (4th ed.). Chichester, West Sussex, UK: John Wiley & Sons.

Gad, G. M., Davis, B., Shrestha, P. P., & Fathi, M. (2020). Legal and contractual issues in lump sum design build implementation on large-scale airport projects. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction,* *12*(1), 05019011/1-05019011/10. doi.org/10.1061/(ASCE)LA.1943-4170.0000364

Gaines, B., Kuklinski, J., & Quirk, P. (2007). The logic of the survey experiment re-examined. *Political Analysis*, 1-20. doi:10.1093/pan/mpl008

Gheyle, N., & Jacobs, T. (2017). *Content analysis: A short overview*

Gonzalez-Ruiz, J. D., Arboleda, A., Botero, S., & Rojo, J. (2019). Investment valuation model for sustainable infrastructure systems: Mezzanine debt for water projects. *Engineering Construction and Architectural Management, 26*(5), 850-884. https://doi.org/10.1108/ECAM-03-2018-0095

Groves, R., Fowler, F., Couper, M., Lepkowski, J., Singer, E., & Tourangeau, R. (2004). *Survey methodology.* Hoboken, NJ: John Wiley & Sons

Hopkin, T., Lu, S. L., Rogers, P., & Sexton, M. (2017). Key stakeholder's perspectives towards UK new build housing defects. *International Journal of Building Pathology and Adaptation, 35*(2), 110-123. https://doi.org/10.1108/IJBPA-06-2016-0012

Ibrahim, M. N., Thorpe, D., & Mahmood, M. N. (2019). Risk factors affecting the ability for earned value management to accurately assess the performance of infrastructure projects in Australia. *Construction Innovation, 19*(4), 550-569. https://doi.org/10.1108/CI-07-2018-0058

Jalal, M. P., Noorzai, E., & Roushan, T. Y. (2019). Root cause analysis of the most frequent claims in the building industry through the SCoP3E Ishikawa diagram. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 11*(2). https://doi.org/10.1061/(ASCE)LA.1943-4170.0000289

lal, M. P., Roushan, T. Y., Noorzai, E., & Alizadeh, M. (2021). A BIM-based

construction claim management model for early identification and visualization of claims. *Smart and Sustainable Built Environment, 10*(2), 227-257. https://doi.org/10.1108/SASBE-10-2019-0141

Jansen, H. (2010). The logic of qualitative survey research and its position in the field of social research methods. *Qualitative Social Research, 11,* 1-21. doi:http://www.qualitative-research.net/Forum Qualitative Sozialforschung/ Forum: Qualitative Social Research (ISSN 1438-5627)

Jensen, J. W. (2017). Habitat restoration incentives for major infrastructure projects. *Environmental Practice, 19*(4), 206-217. DOI: 10.1080/14660466.2017.1366235

Jingmond, M. & Agren, R. (2015). Unravelling causes of defects in construction. *Construction Innovation, 15*(2), 198-218. https://doi.org/10.1108/CI-04-2014-0025

Jin, X., Tan, H. C., Zuo, J., & Feng, Y. (2012). Exploring critical success factors for developing infrastructure projects in Malaysia: Main contractors' perspective. *International Journal of Construction Management, 12*(3), 25-41. DOI: 10.1080/15623599.2012.10773193

Johnson, R. B., Onwueegbuzie, A. J., & Turner, L. A. (2007). Towards a definition of mixed methods research. *Journal of Mixed Methods Research, 1*(2), 112-133. doi:10.1177/1558689806298224

Johnston, A. (2014). Rigour in research: Theory in the research approach. *European Business Review, 26*(3), 206-217. doi:10.1108/EBR-09-2013-0115

Jonsson, A. Z., & Gunnelin, R. H. (2019). Defects in newly-constructed residential buildings: Owners' perspective. *International Journal of Building Pathology and Adaptation, 37*(2), 163-185. https://doi.org/10.1108/IJBPA-09-2018-0077

Kapur, R. (2018). Research Methodology: Methods and Strategies. https://www.researchgate.net/publication/324588113_Research_Methodology_Methods_and_Strategies?enrichId=rgreq-88a9b557975e2f349e161fb75b0e29a8-XXX&enrichSource=Y292ZXJQYWdlOzMyNDU4ODExMztBUzo2MTY3NDMxNTYzMjY0M

Khekale, C., & Futane, N. (2015). Management of claims and disputes in construction industry. *International Journal of Science and Research, 4*(5), 848-856. https://www.ijsr.net/archive/v4i5/SUB154227.pdf

Khlaifat, D. M., Alyagoub, R. E., Sweis, R. J., & Sweis, G. J. (2019). Factors leading

to construction projects' failure in Jordon. *International Journal of Construction Management*, *19*(1), 65-78. DOI: 10.1080/15623599.2017.1382092

Khoso, A. R., Yusof, A. M., Chai, C., & Laghari, M. A. (2021). Robust contractor evaluation criteria classification for modern technology public construction projects. *Journal of Public Procurement, 21*(1), 53-74. https://doi.org/10.1108/JOPP-06-2020-0053

Kikwasi, G. J., (2021), Claims in construction projects: How causes are linked to effects. Journal of Engineering Design and Technology, https://doi.org/10.1108/JEDT-06-2021-0312

King, N. (2004). Essential Guide to Qualitative *Methods in Organizational Research.* (C. Cassell, & G. Symon, Eds.) London: SAGE Publications Ltd.

Kothari, C. R. (2004). *Research methodology, methods and techniques* (2 ed.). Jaipur: New Age International (Pvt.) Limited. http://www.modares.ac.ir/uploads/Agr.Oth.Lib.17.pdf

Kumar, R. (2019). *Research methodology: A step-by-step guide for beginners* (5th ed.). https://books.google.lk/books?id=J2J7DwAAQBAJ&dq=research+methodology&lr=&source=gbs_navlinks_s

Kumar, R. (2011). *Research methodology: a step by step guide for beginners* (3 ed.). London: SAGE Publications Inc. http://www.sociology.kpi.ua/wp-content/uploads/2014/06/Ranjit_Kumar-Research_Methodology_A_Step-by-Step_G.pd

Kumaraswamy, M. M. (1997). Conflicts, claims and disputes in construction. *Engineering Construction and Architectural Management*, *4*(2), 95–111. doi.org/10.1108/eb021042

Lander, F., Nielsen, K. J., & Lauristen, J. (2016). Work injury trends during the last three decades in the construction industry. *Safety Science, 85*(2), 60-66. doi.org/10.1016/j.ssci.2015.10.013.

Le-Hoai, L., Dang, C. N., Lee S. B., & Lee, Y. D. (2018). Benchmarking claim causes against contractors in emerging markets: Empirical case study. *International Journal of Construction Management*, *19*(4), 307-316. doi.org/10.1080/15623599.2018.1435156

Lin, Y., Chang, J., & Su, Y. (2016). Developing construction defect management system using BIM technology in quality inspection. *Journal of Civil Engineering and Management, 22*(7), 903-914. DOI: 10.3846/13923730.2014.928362

Loulakis, M. C., & McLaughlin, L. P. (2011). Arizona upholds statute of repose

defense for construction defect claims. *Civil Engineering Magazine Archive*. *81*(8), 88-88. https://doi.org/10.1061/ciegag.0000701

Lund, T. (2012). Combining qualitative and quantitative approaches: Some arguments for mixed methods research. *Scandinavian Journal of Educational Research, 56*(2), 155-165. doi:10.1080/00313831.2011.568674

Lundkvist, R., Meiling, J. H., & Sandberg, M. (2014). A proactive plan-do-check-act approach to defect management based on a Swedish construction project. *Construction Management and Economics, 32*(11), 1051-1065. DOI: 10.1080/01446193.2014.966733

MacDonald, S., & Headlam, N. (2011). *Research methods handbook.* Manchester: Centre for Local Economic Strategies. http://www.cles.org.uk/wp-content/uploads/2011/01/Research-Methods-Handbook.pdf

Matar, M., Osman, H., Georgy, M., Abou-Zeid, A., & El-Said, M. (2017). A systems engineering approach for realizing sustainability in infrastructure projects. *HBRC Journal, 13*(2), 190-201. DOI: 10.1016/j.hbrcj.2015.04.005

Martinsuo, M. M., Vourinen, L., & Killen, C. (2019). Lifecycle-oriented framing of value at the front end of infrastructure projects. *International Journal of Managing Projects in Business, 12*(3), 617-643. https://doi.org/10.1108/IJMPB-09-2018-0172

McCusker, K., & Gunaydin, S. (2015). Research using qualitative, quantitative or mixed methods and choice based on the research. *Perfusion*, 537-542. doi:10.1177/0267659114559116

McKim, C. A. (2017). The value of mixed methods research: A mixed methods study. *Journal of Mixed Methods Research, 11*(2), 202-222. doi:10.1177/1558689815607096

McKinsey Global Institute. (2017). [accessed 2017 Dec 16]. https://www.mckinsey.com/mgi/overview.

Mehany, M. S. H. M., & Grigg, N. (2015). Causes of road and bridge construction claims: Analysis of Colorado department of transportation projects. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, *7*(2), 04514006/1-04514006/7. doi.org/10.1061/(ASCE)LA.1943-4170.0000162

Milion, R. N., Alves, T. D. C. L., & Paliari, J. C. (2017). Impacts of residential construction defects on customer satisfaction. *International Journal of Building Pathology and Adaptation, 35*(3), 218-232. https://doi.org/10.1108/IJBPA-12-2016-0033

Mishmish, M., & El-Sayegh, S. M. (2018). Causes of claims in road construction

projects in the UAE. *International Journal of Construction Management, 18*(1), 26-33. DOI: 10.1080/15623599.2016.1230959

Mohammadali, N., Mehdi, S., Reza, Z. M., & Suzanne, W. (2019). Innovation management and construction phases in infrastructure projects. *Journal of Construction Engineering and Management, 145*(2), 04018135/1-04018135/9. doi:10.1061/(ASCE)CO.1943-7862.0001608

Mohammadi, S. & Birgonul, M. T. (2016). Preventing claims in green construction projects through investigating the components of contractual and legal risks. *Journal of Cleaner Production, 139*(6), 1078-1084. doi.org/10.1016/j.jclepro.2016.08.153

Nasirzadeh, F., Carmichael, D. G., Jarban, M. J., & Rostamnezhad, M. (2019). Hybrid fuzzy-system dynamics approach for quantification of the impacts of construction claims. *Engineering, Construction and Architectural Management, 26*(7), 1261-1276. https://doi.org/10.1108/ECAM-08-2017-0150

Nguyen, T. H. D., Chileshe, N., & Rameezdeen, R. (2018). External stakeholder strategic actions in construction projects: A Vietnamese study. *Construction Management and Economics, 36*(8), 443-458. DOI: 10.1080/01446193.2018.1432866

Nguyen, T. M. (2015). *Claims in Building Projects in Public Sector: Case Study in Mekong Area, Vietnam*. (Master's Thesis, University of Can Tho). https://www.researchgate.net/publication/265220044

Ni-Fhloinn, D. (2017). Liability in negligence for building defects in Ireland, England and Australia: Where statute speaks, must common law be silent. *International Journal of Law in the Built Environment, 9*(3), 178-192. https://doi.org/10.1108/IJLBE-06-2017-0019

Olaniran, O. J. (2015). The effects of cost-based contractor selection on construction project performance. *Journal of Financial Management of Property and Construction, 20*(3), 235-251. https://doi.org/10.1108/JFMPC-06-2014-0008

Olatunde, N. A., Awodele, I. A., & Odeyinka, H. A. (2021). Stakeholder identification methods used in private organizations' projects in Nigeria. *Frontiers in Engineering and Built Environment, 1*(2), 217-229. https://doi.org/10.1108/FEBE-05-2021-0023

Osei-Kyei, R., Chan, A. P. C., Chen, Y. Y. C., & Dansoh, A. (2018). Root causes of conflict and conflict resolution mechanisms in public-private partnerships: Comparative study between Ghana and China. *Cities, 87*(2), 185-195. doi.org/10.1016/j.cities.2018.10.001

Parchamijalal, M., Moradi, S., & Zahibi, S. M. (2021). Claim management office

maturity model (CMOMM) in project-oriented organizations in the construction industry, *Engineering, Construction and Architectural Management*, https://doi.org/10.1108/ECAM-04-2021-0301

Parikh, D., Joshi, G. J., & Patel, D. A. (2019). Development of prediction models for claim cause analyses in highway projects. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, *11*(4), 04519018/1-04519018/11. doi.org/10.1061/(ASCE)LA.1943-4170.0000303

Pescaroli, G., Velazquez, O., Al, I., Galasso, C., Kostkova, P., & Alexand, D. (2020). A Likert scale-based model for benchmarking operational capacity, organizational resilience, and disaster risk reduction. *International Journal of Disaster Risk Science, 11*(3), 404-409. doi:10.1007/s13753-020-00276-9

Punch, K. F. (2014). *Introduction to social research: quantitative and qualitative approaches* (3 ed.). Thousand Oaks: SAGE Publication Ltd.

Ryu, H., Son, K., & Kim, J. A. (2016). Loss prediction model for building construction projects using insurance claim payout. *Journal of Asian Architecture and Building Engineering*, *1*(3), 441- 446. doi.org/10.3130/jaabe.15.441.

Sandanayake, M., Yang, W., Chhibba, N. & Vrcelj, Z. (2021). Residential building defects investigation and mitigation: A comparative review in Victoria,

Australia, for understanding the way forward. *Engineering, Construction and Architectural Management*, https://doi.org/10.1108/ECAM-03-2021-0232

Sayed, M., Abdel-Hamid, M., & El-Dash, K. (2020). Improving cost estimation in construction projects. *International Journal of Construction Management*, DOI: 10.1080/15623599.2020.1853657

Schonbeck P., Lofsjogard M., & Ansell A. (2021). Exploring the applicability of configuration information in construction projects. *Intelligent Buildings International*, 13(2), 91-102. DOI: 10.1080/17508975.2020.1785831

Saldana, J. (2013). *The coding manual for qualitative researchers* (2 ed.). SAGE Publications Ltd. https://books.google.lk/books/about/The_Coding_Manual_for_Qualitative_Resear.html?id=V3tTG4jvgFkC&redir_esc=y

Sandanayake, M., Yang, W., Chhibba, N., & Vrcelj, Z. (2021). Residential building defects investigation and mitigation: A comparative review in Victoria, Australia, for understanding the way forward. *Engineering, Construction and Architectural Management*, https://doi.org/10.1108/ECAM-03-2021-0232

Saunders, M. N., Lewis, P., & Thornhill, A. (2019). Understanding research philosophy and approaches to theory development. *Research Methods for Business*, 128-170. http://oro.open.ac.uk/id/eprint/53393

Senouci, A., Alsarraj, A., Gunduz, M., & Eldin, N. (2017). Analysis of change orders in Qatari construction projects. *International Journal of Construction Management, 17*(4), 280-292. DOI: 10.1080/15623599.2016.1211973

Shahhosseini, V., & Hajarolasvadi, H. (2018). A conceptual framework for developing a BIM-enabled claim management system. *International Journal of Construction Management, 90*(1), 1-15. doi.org/10.1080/15623599.2018.1512182

Sharma, V. K., Sharma, S. K., & Singh, A. P. (2022). Risk enablers modeling for infrastructure projects using Bayesian belief network, *International Journal of Construction Management, 22*(6), 993-1010. DOI: 10.1080/15623599.2019.1678218

Shen, W., Tang, W., Yu, W., Duffield, C. F., Hui, F. K. P., Wei, Y., & Fang, J. (2017). Causes of contractors' claims in international engineering procurement construction projects. *Journal of Civil Engineering and Management, 23*(6), 727-739. DOI: 10.3846/13923730.2017.1281839

Shrestha, P. P., Davis, B., & Gad, G. M. (2020). Investigation of Legal Issues in Construction Manager at Risk Projects: Case study of airport projects. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 12*(3), 04520022/1-04520022/11.

doi.org/10.1061/(ASCE)LA.1943-4170.0000404

Sibanyama, G., Muya, M., & Kaliba, C. (2012). An overview of construction claims: A case study of the Zambian construction industry. *International Journal of Construction Management*, *12*(1), 65-81. DOI: 10.1080/15623599.2012.10773185

Singh, Y. K. (2006). Fundamental of research methodology and statistics (1st ed.). https://books.google.lk/books/about/Fundamental_Of_Research_Methodology_And.html?id=zrFw-bt6PKIC&redir_esc=y

Stamatiou, D. R. I., Kirytopoulos, K. A., Ponis, S. T., Gayialis, S., & Tatsiopoulos, L. (2019). A process reference model for claims management in construction supply chains: The contractors' perspective. *International Journal of Construction Management*, *19*(5), 382-400. DOI: 10.1080/15623599.2018.1452100

Sultan, B., & Alaghbari, W. (2021), Construction industry sustainable development indicator for low income developing countries: Yemen as a case study. *International Journal of Construction Management,* doi:10.1080/15623599.2021.1951429

Sutrisna, M., Ramanayaka, C. D. D., & Goulding, J. C. (2018). Developing work breakdown structure matrix for managing offsite construction projects.

Architectural Engineering and Design Management, 14(5), 381-397. DOI: 10.1080/17452007.2018.1477728

Taherdoost, H. (2016). Validity and reliability of the research instrument; How to test the validation of a questionnaire/survey in a research. *International Journal of Academic Research in Management, 5*(3), 28-36. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3205040

Tashakkori, A., & Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative.* Thousand Oaks: Sage.

Thurairajah, N., Haigh, R. P., & Amaratunga, R. (2006). Leadership in construction partnering projects : Research methodological perspective. *Salford: Research Institute for Built and Human Environment* (pp. 35-48). University of Salford. http://usir.salford.ac.uk/id/eprint/9893/1/leadership_in_construction.pdf

Vidal, P. P., Ajibade, A. A. (2021). Construction defects and disputes in low rise residential buildings. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 13*(1), 05020016/1-05020016/15. doi:10.1061/(ASCE)LA.1943-4170.0000433

Vilventhan, A., & Kalidindi, S. N. (2012). Approval risks in transportation infrastructure projects in India, In *Proceedings of the 2012 Construction Research Congress*, (pp. 2250-2259).

https://doi.org/10.1061/9780784412329.226

Withanage, K. T. (2013). *Implementation of RIBA plan of work at pre-contract stage to minimize conflicts of construction projects in Sri Lanka* (Unpublished bachelor's dissertation). Department of Building Economics, University of Moratuwa, Sri Lanka.

Walliman, N. (2011). Research methods: the basics (1 ed.). London, UK: Routledge. https://edisciplinas.usp.br/pluginfile.php/2317618/mod_resource/content/1/BLOCO%202_Research%20Methods%20The%20Basics.pdf

Xiao, H., & Hao, S. (2021). Public participation in infrastructure projects: An integrative review and prospects for the future research. *Engineering, Construction and Architectural Management*, https://doi.org/10.1108/ECAM-06-2021-0495

Yih, C. H., Robert, L., Jun, W., Xiangyu, W., & Zeyu, Z. (2016). Comparative analysis on the adoption and use of BIM in road infrastructure projects. *Journal of Management in Engineering*, 05016021/1-05016021/13. doi:10.1061/(ASCE)ME.1943-5479.0000460

Yousefi, V., Yakhchali, S. H., Khanzadi, M., Mehrabanfar, E., & Saparauskas, J. (2016). Proposing a neural network model to predict time and cost claims in construction projects. *Journal of Civil Engineering and Management, 22*(7),

967-978. DOI: 10.3846/13923730.2016.1205510

Zaneldin, E. K. (2020). Investigating the types, causes and severity of claims in construction projects in the UAE. *International Journal of Construction Management, 20*(5), 385-401. doi.org/10.1080/15623599.2018.1484863

Zhang, H. M., Chong, H. Y., Zeng, Y., & Zhang, W. (2022). The effective mediating role of stakeholder management in the relationship between BIM implementation and project performance. *Engineering, Construction and Architectural Management,* https://doi.org/10.1108/ECAM-04-2020-0225

Zhang, S., Huang, L. H., & Yu, D. H. (2006). An Analysis of information systems research in Chinese mainland. *Communications of the Association for Information Systems, 17(2),* 785-800. doi:10.17705/1CAIS.01735

Appendix-01

STRUCTURED INTERVIEW GUIDELINE (Blank)

COVERING LETTER FOR INTERVIEW GUIDELINE

Department of Building Economics,
University of Moratuwa.
……

Dear Sir/Madam,

Conducting an Interview for a Dissertation

I am a student of the Department of Building Economics, University of Moratuwa. I am currently conducting research under the module of "**Dissertation**" on the topic of "**Management of Defect Claims in Infrastructure Projects**". The mode of data collection is deemed as a one-to-one interview.

The interviews will be conducted with experienced professionals in the construction industry. I have identified you as a potential participant who could provide me with valuable information for this research. Therefore, I would like to interview you for **approximately 30-40 minutes** with my research literature findings and your expert opinion. The medium of collecting data will be **voice recording (with the permission of the interviewee)** to collect data more precisely.

The information collected through this interview will not be disclosed to any other party, and confidentiality will be retained. It should be used only for the purpose of the dissertation. I solicit you to facilitate my research by providing your valuable knowledge and opinion regarding this research topic.

Thank you.

Yours faithfully,

…….
Thusharika A.P.J.N.

Dissertation Supervisor:
CH. QS Prof. (Mrs.) Perera B.A.K.S.

01: Aim of the study

The aim of this study is to investigate how to manage defect claims in infrastructure projects in Sri Lanka.

02: Objectives of the study

- Identify common types of defect claims in infrastructure projects in Sri Lanka
- Identify the significant types of defect claims in infrastructure projects in Sri Lanka
- Identify significant causes of defect claims in infrastructure projects in Sri Lanka
- Identify significant consequences for the above-identified causes of defect claims in infrastructure projects in Sri Lanka
- Propose suitable strategies to manage defect claims in infrastructure projects in Sri Lanka

03: Details of the Respondent

- Profession: ……..
- Designation: ……...
- Number of years of experience in the construction industry: ……
- Key experience related to this topic: ……..
  ……
- Date: ……

04: General Perception

What are the special features of Infrastructure Projects? Are they different to other civil engineering projects?.....
…….
…….

05: What are the common types of defect claims in infrastructure projects in Sri Lanka?

Item	Types of Defect Claims	Applicability to infrastructure projects		Modifications	Remarks
		Yes	No		
1	Design defects				
2	Material defects				
3	Construction defects				
4	Subsurface defects				
5	Operational and Maintenance defects				
6	Workmanship defects				
	New Types of defect claims (Please Specify)				

06: What are the causes of defect claims in infrastructure projects in Sri Lanka?

Item	Causes of defects claims	Applicability of defect claims in infrastructure projects		Modifications	Remarks
		Yes	No		
1	Improper Allocation of Management of risk				
2	Improper project management				
3	Carelessness of workers				
4	Fraud and breach of product liability				
5	Heavy rain				
6	Flooding				
7	Improper approvals				
8	Breach government regulations				
9	Negligent Works				
10	Ambiguities arise in the contract document				
11	Different interpretations of the				

Item	Causes of defects claims	Applicability of defect claims in infrastructure projects		Modifications	Remarks
		Yes	No		
	contract clauses				
12	Unfair risk allocations				
13	Administrate management				
14	Variations initiated by the client				
15	Payment delays				
16	Quality of the work				
17	Unrealistic tendering				
18	Market inflation				
19	Unrealistic expectations				
20	Late giving of possession to the site				
21	Confusing requirements of the client				
22	Change of Scope/ Scope definition				
23	Delays in work Progress/ Time extension				
24	Validity of a claim in the presence of notice requirements				
25	Time for issuing Taking-Over certificates				
26	Design errors and omissions in design drawings				
27	Change of conditions				
28	Defective designs				
29	Inadequate specifications				
30	Insufficient available information				
31	Unclear contractual terms in the contract document				
32	Inadequate contract drafting				
33	Change in government codes				
34	Adverse weather				
35	Labour disputes/ Union strikes				
36	Contract acceleration				
37	Time targets that are not realised				
38	Investigate incomplete locations				
39	Unplanned disruptions, suspensions, or stopped work orders				
40	Inexperienced bidders are allowed bid for the project				
41	Act of God				

Item	Causes of defects claims	Applicability of defect claims in infrastructure projects		Modifications	Remarks
		Yes	No		
42	Buildability issues				
43	Financial failures of the contractor				
44	Inaccurate topographical data				
45	Inexperienced contractors				
46	The productivity of plant and labour				
47	Subcontractor failures				
48	Global financial crisis				
49	Impact of the construction project on the surrounding environment				
50	Difficult to get statutory approval for alternative cost-saving designs				
	New Causes of damage claims (Please Specify)				

07: What are the consequences of defect claims in infrastructure projects in Sri Lanka?

Item	Effects of defect claims	Applicability of defect claims in infrastructure projects		Modifications	Remarks
		Yes	No		
1	Damage Business relationships				
2	Arise disputes				
3	Delay the Project completion date				
4	Cost overrun				
5	Deterioration of the quality of the product to be delivered				
6	Loss of productivity				
7	Fraud and breach of product liability				
8	Undermine team spirit				
9	Waste of the client's money				
10	Loss of profit				

11	Abandon of project				
12	Escalation of cost				
13	Non-completion of the project				
14	Share information with project parries				
	New effects of damage claims (Please Specify)				

08: What are the strategies to manage defect claims in infrastructure projects in Sri Lanka?

Item	Strategies to manage defect claims	Applicability of defect Claims in infrastructure projects		Modifications	Remarks
		Yes	No		
1	Maintain Risk Register				
2	Risk avoidance checklist				
3	Proper constructer management				
4	Use Insurances				
5	Prepare proper contract Documents				
6	Proper Coordination between all contract documents				
7	Proper Contract Administration				
8	Select the most appropriate procurement method				
9	Equitable Sharing of Risks between contract parties				
10	Negotiation in the event of Differentiate in matter				
11	Early Notification				
12	Inspection of Work				
13	Conduct regular Site Meetings				
14	Keep Records				
15	Clear and frequent communication				
16	Create, implement, and utilise a logical and user-friendly schedule				
17	Inspect the quality				
18	Scope Assessment				
19	Distribute required information				
20	Third-party review of project				

Item	Strategies to manage defect claims	Applicability of defect Claims in infrastructure projects		Modifications	Remarks
		Yes	No		
	design at the tender stage				
21	The reasonable cost-sharing ratio between the client and the contractor				
22	Providing sufficient time for bidders to submit their bids				
23	Prequalification of the main contractor				
24	Use of named subcontractors rather than nominated subcontractors				
25	Setting contingency plans				
26	Monitoring system set up by the main contractor				
27	Support from top management to the project team				
28	Proper identification of roles and responsibilities				
	New strategies for damage claims (Please Specify)				

09: Additional comments to improve the study

There were some factors with similar meanings and combined factors that need further study.

Thank you.

Appendix-02

QUESTIONNAIRE SURVEY (Blank)

COVERING LETTER FOR THE QUESTIONIRE SURVEY

Department of Building Economics,
University of Moratuwa.
……

Dear Sir/Madam,

Conducting a Questionnaire Survey for Dissertation

I am a student of Department of Building Economics, University of Moratuwa. I am currently conducting a research under the module of "**Dissertation**" on the topic of "**Management of Defect Claims in Infrastructure Projects**". The mode of data collection is deemed as a Questionnaire survey.

The Questionnaire survey will be conducted with experienced professionals in the construction industry. I have identified you as a potential participant who could provide me with valuable information to this research.

The information collected through this interview will not be disclosed to any other party and confidentiality retained. It will be used only for the purpose of the dissertation. I solicit you to facilitate my research by providing your valuable knowledge and opinion regarding this research topic.

Thank you.

Yours faithfully,

…….
Thusharika A.P.J.N.

Dissertation Supervisor:
CH. QS Prof. (Mrs.) Perera B.A.K.S

SECTION 1: Background Information of Respondents

1.1 Type of the organization *(Please tick in the relevant box)*

Contractor ☐ **Client** ☐ **Consultant** ☐

1.2 Designation of the respondent……..

1.3 Profession -……..

1.4 Experience

1.4.1 Number of years of experience in the Claims Management in Sri Lankan Construction Industry (Please tick with a "✓").

0-5 Years ☐

5-10 Years ☐

10-15 Years ☐

15-20 Years ☐

20-25 Years ☐

1.4.2 Number of years of experience in the Infrastructure Projects in Sri Lankan Construction Industry (Please tick with a "✓").

0-5 Years ☐

5-10 Years ☐

10-15 Years ☐

15-20 Years ☐

20-25 Years ☐

SECTION 2: Defect Claim Management

Apply cross (X) on one of the numbers based on the Likert Scale of 1 to 5, based on your experience and knowledge.

Original Scale 5 to 1 in the descending order	Each scale represents the **following rating:** **1= Very Low** degree of agreement **2= Low** degree of agreement **3= Medium** degree of agreement **4= High** degree of agreement **5= Very High** degree of agreement

1. **How do you rate the following as "Common types of Defect Claims" in Infrastructure Projects?**

Types of Defect Claims	Significance				
	1	2	3	4	5
Design defects					
Material defects					
Construction defects					
Subsurface defects					
Operational and Maintenance defects					
Workmanship defects					
Specification defects					

2. **How do you rank the following as the "Causes for Defect Claims" in the above areas of defect claims?**

Causes of Defect Claims	Significance				
	1	2	3	4	5
Improper project management					
Fraud and breach of product liability					
Improper approvals					
Breach government regulations					
Different interpretations of the contract clauses					
Administrate management					

Causes of Defect Claims	Significance				
Payment delays					
Unrealistic tendering					
Market inflation					
Late giving of possession of the site					
Delays in work progress					
Change of conditions					
Inadequate specifications					
Insufficient available of information					
Unclear contractual terms in the contract document					
Change in government codes					
Labour disputes/Union strikes					
Contract acceleration					
Time targets that are not realised					
Investigation of incomplete locations					
Unplanned disruptions, suspensions, or stopped work orders					
Act of God					
Buildability issues					
Financial failures of the contractor					
Inaccurate topological date					
The productivity of plant and labour					
Subcontractor failures					
Global financial crisis					
Impact of the construction project on the surrounding environment					
Difficult to get statutory approval for alternative cost-saving designs					
Adverse weather					
Bad quality of work					
Unfair risk allocation					
Arise variations due to the scope change					
Design issues					
Selected inexperienced contractors					
Improper Contract document preparation					
Lack of resources					
Inadequate and inexperienced professionals employed					
Site conditions					
Deviations from pre-determined planned works					
Political interface					
Bankruptcy					
Import/export restrictions					

3. What are the consequences of Defect Claims, generally and specifically, in the Infrastructure Projects in Sri Lanka? Please rank according to the significance of each consequence. (Please tick with a "✓")

Consequences of Defect Claims	Significance				
	1	2	3	4	5

Consequences of Defect Claims	Significance				
Damage Business relationships					
Arise disputes					
Delay the Project completion date					
Deterioration of the delivered product quality					
Loss of productivity					
Fraud and breach of product liability					
Undermine team spirit					
Loss of profit					
Share information with project parties					
Cost overrun					
Abandon of project					
Loss of client confidence regarding consultants					
Added investment risks					
Produce low-quality projects					

4. How do you rank the following as the "Strategies to Manage Defect Claims"? Please rank according to the significance of each strategy. (Please tick with a "✓")

Strategies to Manage Defect Claims	Significance				
	1	2	3	4	5
Maintain Risk Register					
Risk avoidance checklist					
Proper constructer management					
Use Insurances					
Proper Contract Administration					
Select the most suitable procurement method					
Equitable Sharing of Risks between contract parties					
Negotiation in the event of differentiating a matter					
Early Notification					
Conduct regular Site Meetings					
Keep Records					
Clear and frequent communication					
Create, implement, and utilise a logical and user-friendly schedule					
Scope Assessment					
Distribute required information					
Project design should be reviewed by a third party					
A reasonable cost-sharing ratio between the client and the contractor					
Providing sufficient time for bidders to submit their bids					
Pre-qualifications of the main contractor					
Use of named subcontractors rather than nominated subcontractors					
Setting contingency plans					
Monitoring system set up by the main contractor					
Support from top management to the project team					

Strategies to Manage Defect Claims	Significance				
Proper identification of roles and responsibilities					
Prepare proper contract documents					
Establish quality control measures					
Build good team spirit					
Enough resources should be provided					
Adequate use of professionals should be employed					
Good client financial capability					
Functional site layout must be assessed and provided					

Thank you.