Scholarly Paper

Investigating the Relationship between Reworks and Contractual Claims: The Salience of Contract Conditions

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Abstract: Statistics show a high rate of contractual claims in construction projects, impacting the construction industry's progress negatively. Rework is one of the main underlying factors that generate contractual claims. Rework and contractual claims follow a mutual routine. Despite a large number of studies on the causes and impacts of rework on project performance, there has been limited research examining the relationship between claims and rework on the basis of contract documents. The paper first attempts to expose the sources of rework through a systematic literature review and then assesses rework causes that fail to be addressed in construction contract documents. The review results identified 37 root causes as the most common rework contributors to construction projects classified into five groups. The list of rework causes served as a starting point for searching the contractual issues through a questionnaire survey. Accordingly, a relative importance index was used for analysis of the primary data collected from the survey. The result first prioritized the importance level of rework causes in generating contractual claims, preceding rework causes that are not addressed adequately through standard form of contract conditions in construction projects. Findings of the investigations revealed that the general conditions of contract do not address the causes of rework adequately. Therefore, contract documents need improvement to cover contractual claims incidences due to rework. Lack of addressing rework causes in the general conditions of contract triggers recommendations for revising the contract clauses that ultimately lead to improved claim handling and dispute avoidances. **DOI: 10.1061/(ASCE)LA.1943-4170.0000519.**

Introduction

In the construction industry, a broad range of stakeholders with various requirements are connected through a contract. The contractual approach of the project parties determines the successful level of project delivery (Gunduz and Elsherbeny 2020). Ineffective management of contracts between client and contractor often leads to conflict and claims. The client side of the contract asks for the highest quality of the project, and the contractor side attempts to cover the scope of work using its optimal resources and meeting its financial targets. Adding to that, clients usually change their expectations, which increases project uncertainties (Wang et al. 2019). Increasing the numbers of uncertainties in the construction project may result in contractual claims. Contractual claims are generally issued for covering losses and expenses, liquidated damages, or extensions of time (Hwang and Yang 2014; Hansen et al. 2020; Kim and Skibniewski 2020). When a claim arises, both sides of the contract follow their interests on a contractual basis. However, the contractor's goal would be to cover the expenses by searching the contract clauses with respect of unforeseen circumstances (El-adaway et al. 2018).

The unavoidable occurrence of contractual claims has been discussed sufficiently in the complicated nature of construction projects. According to Moza and Paul (2018), the quality of contract documents is one of the sources of claims and conflicts. Because the adverse effects of a claim are predictable by the contractual parties, the occurrence of dispute cases is preventable. Thus, the method of dealing with the claim and reimbursing its impacts needs to be defined. If the contractual parties successfully reach an agreement, the claim would be managed; otherwise, it results in disputes. Overall, the claim progression procedure has been placed in the contract conditions to legitimize claim assessment and avoid the occurrence of disputes (Abdul-Malak et al. 2020). Furthermore, the mechanisms of claim assessments and their solutions are almost always addressed in the standard forms of contract conditions in the construction industry. However, understanding the contractual terms among these contracts is not easy for all construction practitioners because the conditions are articulated by legal entities (Raj et al. 2009).

A comprehensive review of the literature revealed insufficient research identifying the relationship of rework and claim. How contractual claims are affected and may result in dispute has not been studied yet under rework circumstances. Therefore, there is a need to investigate the causes of rework in association with contractual construction claims. Because contractual claims are referred to in the contract conditions (Jelodar et al. 2016), rework causes generating such claims can also be referenced to the same conditions. For example, a claim could cover the client's changes when appropriately incorporated into the contract's relevant clause. Concurrently, the imposed changes may result in rework occurrence. Due to the similarity of the causes between claim and rework in this example, the relevant contract conditions for addressing change can be utilized for addressing rework. This paper attempts to provide the basis for further research on contract conditions and their potential to address rework by identifying relationships between claims and rework causes. As a result, it is necessary to characterize this relationship first through examining their common root causes. The reported study in this paper uses a review approach to identify common causes of rework and then explores the relationship between rework and claims. The objectives of this study include the following:

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Note. This manuscript was submitted on April 15, 2021; approved on September 30, 2021 No Epub Date. Discussion period open until 0, 0; separate discussions must be submitted for individual papers. This paper is part of the ***Journal of Legal Affairs and Dispute Resolution in Engineering and Construction***, © ASCE, ISSN 1943-4162.

1. To identify rework causes that generate contractual claims and establish the relationship between rework and claim, and
2. To investigate if rework is addressed adequately in the general conditions of the contract in construction project.

The study examines the standard form of contract for building and civil engineering construction NZS 3910-2013 (Standard New Zealand 2013) as the most commonly used contract document in New Zealand construction projects for achieving Objective 2. NZS 3910 has been designed to be flexible for industry uses and includes the required provisions to cover a variety of engineering and building projects with different administration methods.

Need to Explore Contract Conditions in Rework Circumstances

To some extent, contract conditions have been shaped in a standard format in the construction projects of many countries. Based on the literature review, claims and associated disputes can be related to contract conditions, so their underlying causes, such as rework, can systematically be linked to the contract conditions. From the literature it can be implied that rework triggers a claim, and poor contract conditions make the scenario even more complicated (Besaiso et al. 2018). This paper intends to make contribution to rework by improving contract management on construction projects. Rework causes are very complex and interrelated. Many researchers have studied rework in the design and construction stages of projects but studying rework in the procurement stage is very limited. The contract document is the main output of the procurement stage of a project, and poor contract documentation has been identified as a major contributing factor to the occurrence of rework (Love et al. 2006; Mendis et al. 2013, 2015). In addition, contract provisions play a critical role in claim handling and can prevent disputes. Therefore, the focus of the research reported in this paper is to understand the relationship between rework and contractual claims and explore the adequacy of the conditions of the contract in addressing their common causes. Understanding this relationship is vital because it ultimately serves as a framework for improving the general conditions of the contract. Proposing further recommendations for revising the current format of contract conditions to address rework would result in better management of claims and disputes. It could enhance the contract provisions as part of the solution for claim handling that is incorporated into dispute prevention.

Common Sources of Claim and Rework in Construction Projects

There is an interdependent relationship between rework and contractual claims of construction projects (Palaneeswaran et al. 2014; Ajayi and Oyeyipo 2015). Correlation coefficient analysis through neural network modeling showed that contractual claims and rework were significantly related (Palaneeswaran et al. 2006). Therefore, rework consistently pushes contractors looking for claims to compensate for cost and delayed time, specifically when rework influences the budget and critical path of the project. Despite a strong correlation between rework and claims, the investigation of their relationship is limited in the literature; however, extensive research has been dedicated to each subject separately. Due to the scarcity of empirical research, this paper aims to examine claims under rework manifestations. Rework has been introduced as one of the causes of claims in various studies (Love and Curtin 2020; Eze and Idiake 2018; Wang et al. 2019; Banwo et al. 2015). Rework, and claims, cause overruns and delays that ultimately lead to poor project performance. The effects of rework on a construction project have been studied in Nigeria and the result showed that contractual claims are reduced when rework triggers are eliminated (Eze et al. 2018a). Causes of rework can be examined under various claim situations. Take an example of a material shortage in the market that generally ends with using alternative material, but the contractor needs to obtain the client's preapproval for the material replacement. In this way, contractors save their position to be eligible for a claim in the future, while using alternative material is one of the root causes of rework in many projects.

The sources of claim and rework are common in many circumstances. For example, when changes occur, they cannot be isolated due to the existing interrelated chain of cause and effect. If the contractors are not sure about compensation for rework costs, they are unlikely to perform requested changes with priority, and therefore claims appear. Jelodar et al. (2016) categorized causes of claims into three main groups: (1) project uncertainties, (2) contract and process, (3) people, and behavior. The causes of claims in United Arab Emirates (UAE) construction projects were investigated and the results identified seven types of claim to be contract ambiguity, delay, acceleration, changes, extra work, errors and omissions, and site conditions. The investigation then concluded that the main root causes were related to variation orders, delays by the owner, material changes, and variations in quantities (Zaneldin 2020). Further investigation into the International Federation of Consulting Engineers (FIDIC) contract conditions to determine the priority of the claim and dispute factors in an overseas construction project in Korea revealed 30 claim risk factors, of which failure to examine contract conditions at the time of tender was ranked highest (Choi and Kim 2016). Other causes that were identified in common as contributors to rework were acceleration, unrealistic contract, site management, improper planning, inadequate contractor experience, mistakes during construction, improper construction methods, quality assurance and control, material quality and shortage, change orders, mistakes and discrepancies in the contract document, lack of communication, weather conditions, site conditions, and coordination problems (Kim and Skibniewski 2020).

Rework root causes are variables that facilitate the occurrence of claims. These variables may appear as an event, a chain of factors, or triggers resulting in rework in the project. The emergence of rework root causes at all project stages is a possibility that cannot be ignored. Previous researchers have identified various root causes of rework. The study carried out by Liu et al. (2020) revealed that most rework costs are generated by three factors: contractor field management, design management, and client management. It also categorized 37 contributing subcauses of rework under 11 significant factors in China. Ranking of the subcauses of rework in this study showed that lack of communication between client and project parties has the highest impact on rework cost followed by design mistakes, contradictory instructions, ineligible techniques, and poor site conditions. Factors identified by Hwang et al. (2019) included client changes, design errors and omissions, design changes, contractor error and omissions, contractor changes, vendor errors and omissions, vendor changes, and transportation errors. These factors as the sources of rework were examined to measure the impacts of building information modeling (BIM) implementation in construction projects in Singapore. The omission and planning, change issues, funding and communication issues, poor workers, and resource control are the principal rework risk triggers in Nigerian construction projects that cause rework (Eze et al. 2018a).

Mahamid (2016a), in a survey conducted among residential buildings in Palestine, found that poor communication of client with contractors and consultant, poor-quality material use, and poor site management are the most severe rework causes that need attention. Other studies also confirmed that the client significantly

contributes to most rework projects (Hwang et al. 2014). The study of the client rework–related factors in Singapore revealed that the client usually replaces material, changes project plans and scope, and is involved in low-level decision-making processes. Using substandard services, defects under the grouping of related technical factors, lack of support for site management, lack of commitment in the quality management–related group, disturbance of personal planning, carelessness, lack of skill, and inexperienced staff under the human resources–related factors are known as the highest contributors to rework occurrence in the study done by Oyewobi and Ogunsemi (2010). According to Enshassi et al. (2017), attempts to defraud, competitive pressure, ineffective management, and schedule pressure are the main causes of rework in the Gaza Strip that influence the productivity of construction projects. The most commonly used rework factors and their root causes can be found in the studies done by Palaneeswaran et al. (2008) and Love et al. (2009) categorized under four headings: client, contractor, site management, and subcontractor groups. They include changes, errors, omissions, lack of allocating funds, low contract fee, ineffective use of quality management, poor technology use, and incomplete design at tender time, leading to poor contract documentation. Some other factors and causes of rework related to external sources or environmental aspects have also been identified, including political issues, economic situations, and weather conditions (Mahamid 2016b; Enshassi et al. 2017).

The characteristics of the project are altered by activation of rework root causes. Thus, the project results do not meet the contract or the client's requirements. According to Al-Janabi et al. (2020), poor contract management could result in ambiguity in the contract documentation. Initially, such ambiguity is due to the poorly defined scope of the project by the client. Mistakes in the contract documentation create errors during the construction process that will ultimately end with change orders, claims, and rework. Thus, the procurement stage of the project needs more investigation to minimize such problems. Further studying of the effects of procurement on rework in construction projects has also been recommended (Anjum and Azam 2019). This research aims to identify the root causes of rework through a comprehensive review of the literature and examine their influence on contractual claims by conducting a questionnaire survey. The identified root causes provide a basis to understand the potential problems in rework occurrence that lead to claims and other contractual issues. Thus, it would help project organizations to control rework's adverse effects such as disputes by addressing identified causes in the contract documents.

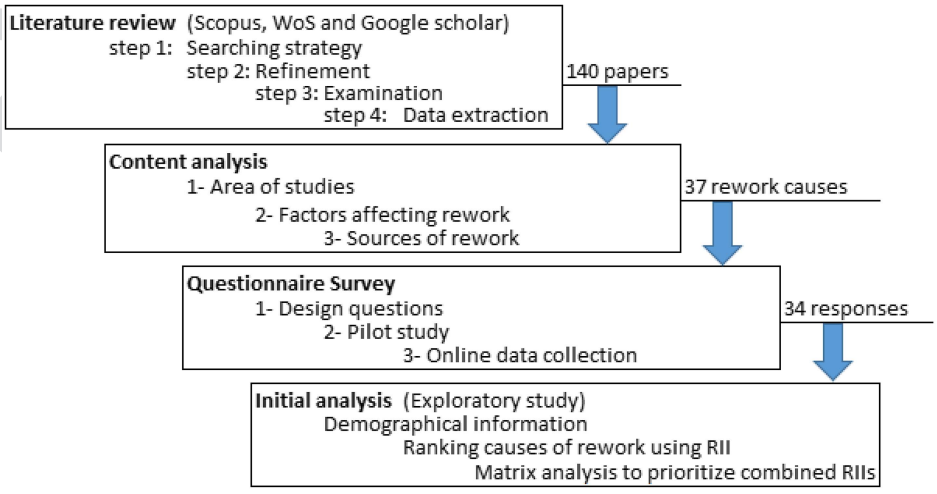
Methodology

For this study, a mixed method of literature and survey was used to cluster and rank rework causes that generate claims using relative importance index (RII) analysis. The study followed a comprehensive literature review to identify the causes of rework, and then a questionnaire approach to collect data was carried out. The initial strategy was based on the analysis of implemented theories for meeting the sources of rework through the literature. The survey then comprised structured questions, including 37 identified rework causes collected from previous studies for further investigation. The employed strategy was completed by gathering professionals' opinions to evaluate the contractual claims during rework circumstances. The second phase was designed to assess contract documents in the presence of ework causes among practitioners in New Zealand construction companies. Before sending questions out to collect data, a pilot study was conducted to verify that questions are reliable, answerable, and designed appropriately to align with the research objectives.

The adopted framework of 4-level methodology to gain insight into the relationship between rework causes and contractual claims in New Zealand construction contracts is presented in Fig. 1. After preanalysis of identified rework causes and categorizing them into five groups of factors, the questionnaire survey using a 5-point Likert scale was distributed to the targeted participants. Finally, descriptive statistics were adopted for participants' demographic information, and a relative importance index was performed for ranking the causes of rework. The methodology's outline simply follows the sequences as described hereafter.

Literature Review and Content Analysis of the Literature

A 4-step systematic literature review was carried out. In this stage, rework-related articles were identified to determine the possible causes and their classification models. The comprehensive literature review followed four main steps: (1) defining a strategy search by choosing the keyword of *rework* in the title of papers in the field of construction between 1990 and 2020, (2) refining the identified papers by applying some exclusion and inclusions to find more precise articles according to the scope of the study, (3) quality assessment of the remaining papers by scanning the titles and reviewing the abstracts, and (4) extraction data from the final shortlisted papers using a Microsoft Excel file. Similarity checking to prevent



F1:1 **Fig. 1.** Applied methodology.

duplications in published papers and identified rework causes was also carried out. Three search engines were employed for retrieving relevant journals and conference papers. The shortlist of relevant articles was prepared after screening the full text of the selected papers. This stage finally concluded with a list of rework root causes disseminated throughout the project's life cycle.

Questionnaire Design and Pilot Study

In reference to Table 1, a total of 37 retrieved root causes of rework from the literature were selected to be used in the preliminary questionnaire. Following the literature's concept, similar causes of rework were grouped to construct rework factors under five broad headings: process, human resources, material and equipment, technical, and general/external-related factors. Because one purpose of this paper is to explore the significant causes to be included in the next research step, it was decided to use an exploratory survey research design. A well-structured questionnaire to collect data from the causes leading to contractual claims was designed. The questionnaire was based on the 5-point Likert scale from strongly disagree (1) to strongly agree (5) to measure the influence of each cause on claims. The survey involving the use of these structured questions covers the quantitative part of the research. A pilot study verified the questionnaire and ensured that the questions are appropriate for research purposes. The questionnaire was tested with four experts, two from the academic field and two from industry. The academic experts reviewed the fluency and clarity of the questions in line with the study's objectives and confirmed the simplicity and precise language (Gunduz and Elsherbeny 2020). Also, questions were controlled because they need to be easy to answer (Eze et al. 2018a). Two industry experts were interviewed, and a draft copy with a cover letter was emailed to obtain their comments about the content validity. They gave comments to modify questions based on the industry's expectations. The selection criteria of pilot study participants were mainly based on their expertise and years of experience related to the research subject. Each interviewee had more than 30 years of experience in contracting and construction management. According to their advice, the questionnaire was slightly modified to improve the quality by merging the same items from different project stages, because the general conditions of the contract cover the entire life cycle of a project. The pilot study ensured that all questions were sufficiently defined without the possibility of misunderstanding arising (Ye et al. 2015). The survey included two lead questions as follows, with 37 causes of rework listed under each question. Question 1 determined which causes create claims and Question 2 established which causes have not been addressed in the general conditions of the standard from of contract in New Zealand:

1. To what extent do you agree that the following rework root causes lead to claims and other contractual issues?
2. To what extent do you agree that the conditions of contract NZS 3910:2013 adequately address the following rework root causes?

Conducting Survey

The finalized questionnaire was developed as an instrument for data collection in two separate parts. The survey was started with general questions to collect demographic information of participants such as experience, project value, type of organization, and position. Before moving to the next part of the survey, participants needed to advise whether they are from the client or contractor side of the contract. Then they were given the developed list from the literature that contains 37 rework root causes. This part asks to what extent participants agree that rework causes lead to claims and other contractual issues. It explores the relationship between claims and rework causes. Respondents were then asked to answer to what extent they agree that the contract conditions adequately addressed each of the causes listed in the questionnaire. A 5-point Likert scale was used to measure and quantify each cause's importance. The questionnaire was agreed to be used online, and the survey questions were placed on Qualtrics software and distributed electronically to draw the professionals' views on the construction industry. The target population for the main research was a combination of clients and contractors working on civil and infrastructure projects, certified builders, architectural consultant firms, and other organizations that generally use the standard form of contract in their projects.

A list of 173 firms was provided for the first round of questionnaire distribution by checking the Infrastructure New Zealand and Association of Consulting and Engineering in New Zealand (ACENZ) authorities. The list comprised 133 architects and consultant firms and 40 civil and construction contractors. The questionnaire link was emailed to the targeted firms with a cover letter explaining the research aims. All invited firms participating in the survey were asked to complete the questionnaire if they had experience of contracting management. The invitation emails introduced the survey and requested participants to answer the survey question only if they have experience using the standard form NZS 3910 contract conditions. As a result, all respondents had enough understanding of the claims process under construction contracts. This point brings more validity and reliability to the collected data (Kisi et al. 2020).

Because the research process was completed later by conducting an interview, it was necessary to analyze the primarily collected data for designing the interview questions. The Qualtrics software showed the completed survey with 46 participants through 1.5 months, a response rate of about 26.58%. The achieved rate was suitable for starting the initial analysis on ranking rework causes to design the interview questions. According to Yap et al. (2017), a sample size between 30 and 500 is adequate for initial analysis in most conducted research. Therefore, the collected data from the completed questionnaire by 46 respondents were extracted to SPSS to perform the required analysis. A more detailed review of the completed survey revealed that only 34 responses were properly filled in with all the required questions. The remaining 12 responses with incomplete answers were considered invalid and discarded from the list. Fig. 2 illustrates the respondents' distribution based on the type of organization and their response rate. The participants' cumulative response rate was about 20% based on 173 distributed and 34 submitted/returned questionnaires. This rate is close to the acceptable normal range for conducting research analysis in construction management (Hwang and Yang 2014; Hwang et al. 2016). Conducting research analysis on the basis of the same number of responses and less can also be seen in the literature (Banwo et al. 2015; Oyewobi et al. 2016; Lessing et al. 2017). The responses comprised 21 on the client side of the contract and 13 on the contractor side, showing relatively sufficient coverage of both contract sides for an acceptable result.

Data Analysis and Results

This paper presents a statistical analysis using an RII to evaluate collected data and rank the causes of rework for both study's objectives. A 5-point Likert scale was used to measure the frequency of each rework cause and then provide the priority list of causes. According to Zaneldin (2020), collected data from a construction research survey using a Likert scale are frequently analyzed through the RII method. Therefore, the RII method was employed in this

Table 1. Root causes of rework identified from the literature

Group	Rework root causes	Covered by references	∑
		Process	
1	Changes, modification, and revisions in design/construction changes	Josephson et al. (2002), Love and Smith (2003), Robinson et al. (2004), Palaneeswarane et al. (2005), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Zhang et al. (2012), Aiyetan (2013), Hwang et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Aiyetan and Das (2015), Mahamid (2016a), Shah et al. (2016), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ndwandwa et al. (2017), Eze et al. (2018a, b), Trach et al. (2019), Hwang et al. (2019), Liu et al. (2020), Mahamid (2020)	27
2	Incomplete design, any omission in the design or construction process	Josephson et al. (2002), Love and Smith (2003), Robinson et al. (2004), Palaneeswarane et al. (2005), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Zhang et al. (2012), Aiyetan (2013), Palaneeswaran et al. (2014), Ye et al. (2015), Ajayi and Oyeyipo (2015), Mahamid (2016a), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ndwandwa et al. (2017), Ajayi (2017), Eze et al. (2018a, b), Trach et al. (2019), Hwang et al. (2019), Mahamid (2020)	25
3	Error in design, drawings, and specifications/error in construction	Josephson et al. (2002), Love and Smith (2003), Robinson et al. (2004), Palaneeswarane et al. (2005), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Zhang et al. (2012), Aiyetan (2013), Palaneeswaran et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016a), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ndwandwa et al. (2017), Eze et al. (2018a, b), Trach et al. (2019), Hwang et al. (2019), Mahamid (2020)	24
4	Improper contractor and subcontractor selection	Palaneeswarane et al. (2005), Palaneeswaran (2006), Palaneeswaran et al. (2008), Aiyetan (2013), Palaneeswaran et al. (2014), Mahamid (2016a), Ahmed and Naik (2016), Oyewobi et al. (2016), Ndwandwa et al. (2017), Mahamid (2020)	11
5	Inadequate procurement methods/poor contract execution	Oyewobi and Ogunsemi (2010), Aiyetan (2013), Ye et al. (2015), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Hwang et al. (2019)	7
6	Lack of document control	Robinson et al. (2004), Zhang et al. (2012), Forcada et al. (2014), Aiyetan and Das (2015), Oyewobi et al. (2016), Wilson and Odesola (2017), Safapour et al. (2019)	7
		Human resources	
7	Insufficient skilled level manpower	Love and Smith (2003), Robinson et al. (2004), Palaneeswaran (2006), Palaneeswaran et al. (2008), Oyewobi and Ogunsemi (2010), Love et al. (2010), Zhang et al. (2012), Palaneeswaran et al. (2014), Forcada et al. (2014), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Mahamid (2016a), Shah et al. (2016), Ahmed and Naik (2016), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ndwandwa et al. (2017), Ajayi (2017), Yap et al. (2017), Eze et al. (2018a, b), Trach et al. (2019), Safapour et al. (2019), Mahamid (2020)	25
8	Lack of experience and personal expertise in design and construction	Love and Smith (2003), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Zhang et al. (2012), Aiyetan (2013), Palaneeswaran et al. (2014), Forcada et al. (2014), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016), Ahmed and Naik (2016), Oyewobi et al. (2016), Wilson and Odesola (2017), Ndwandwa et al. (2017), Ajayi (2017), Eze et al. (2018a, b), Trach et al. (2019), Safapour et al. (2019)	23
9	Poor knowledge of team member, lack of education and training	Love and Smith (2003), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Zhang et al. (2012), Palaneeswaran et al. (2014), Forcada et al. (2014), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Mahamid (2016a), Shah et al. (2016), Ahmed and Naik (2016), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ajayi (2017), Eze et al. (2018a, b), Trach et al. (2019), Hwang et al. (2019), Safapour et al. (2019)	23
10	Poor workmanship approach and inappropriate personal attitude	Josephson et al. (2002), Palaneeswaran (2006), Palaneeswaran et al. (2008), Oyewobi and Ogunsemi (2010), Zhang et al. (2012), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016), Shah et al. (2016), Enshassi et al. (2017), Ajayi (2017), Eze et al. (2018a, b), Trach et al. (2019), Hwang et al. (2019), Mahamid (2020)	17
11	Labor reallocation, alteration, and staff turnover	Love and Smith (2003), Palaneeswarane et al. (2005), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Palaneeswaran et al. (2014), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Mahamid (2016), Oyewobi et al. (2016), Ajayi (2017), Eze et al. (2018a, b), Mahamid (2020), Salihu and Babarinde (2020)	17
12	Inadequate manpower to complete the task	Love and Smith (2003), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Palaneeswaran et al. (2014), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Ndwandwa et al. (2017), Ajayi (2017), Hwang et al. (2019), Safapour et al. (2019)	13
13	Lack of employee motivation and rewards, carelessness	Oyewobi and Ogunsemi (2010), Zhang et al. (2012), Mahamid (2016), Shah et al. (2016), Oyewobi et al. (2016), Enshassi et al. (2017), Safapour et al. (2019), Mahamid (2020)	8
14	Absence of job security and other safety rules	Oyewobi and Ogunsemi (2010), Shah et al. (2016), Oyewobi et al. (2016), Enshassi et al. (2017), Safapour et al. (2019)	5
15	Inadequate supervision staff	Robinson et al. (2004), Love et al. (2010), Forcada et al. (2014), Mahamid (2016), Yap et al. (2017)	5
16	Conflict of interest	Aiyetan (2013), Shah et al. (2016), Enshassi et al. (2017), Hwang et al. (2019)	4

Table 1. (*Continued*.)

Group	Rework root causes	Covered by references	∑
		Material and equipment	
17	Poor-quality material or substandard products/prefabrication errors	Josephson et al. (2002), Love and Smith (2003), Palaneeswarane et al. (2005), Palaneeswaran (2006), Palaneeswaran et al. (2008), Oyewobi and Ogunsemi (2010), Love et al. (2010), Aiyetan (2013), Palaneeswaran et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016), Shah et al. (2016), Ndwandwa et al. (2017), Ajayi (2017), Hwang et al. (2019), Safapour et al. (2019), Liu et al. (2020)	20
18	Defective materials, nonadherence to material specifications	Josephson et al. (2002), Robinson et al. (2004), Oyewobi and Ogunsemi (2010), Zhang et al. (2012), Aiyetan (2013), Hwang et al. (2014), Forcada et al. (2014), Ye et al. (2015), Aiyetan and Das (2015), Shah et al. (2016), Enshassi et al. (2017), Ndwandwa et al. (2017), Yap et al. (2017), Hwang et al. (2019), Safapour et al. (2019)	15
19	Inefficient equipment uses or altered material	Josephson et al. (2002), Oyewobi and Ogunsemi (2010), Ye et al. (2015), Mahamid (2016), Shah et al. (2016), Enshassi et al. (2017), Ndwandwa et al. (2017), Yap et al. (2017), Liu et al. (2020), Mahamid (2020)	10
20	Replacement or misplacement of material and equipment	Josephson et al. (2002), Oyewobi and Ogunsemi (2010), Forcada et al. (2014), Ye et al. (2015), Shah et al. (2016), Enshassi et al. (2017), Eze et al. (2018a, b), Trach et al. (2019), Hwang et al. (2019)	10
21	Untimely deliveries of material and equipment	Josephson et al. (2002), Robinson et al. (2004), Oyewobi and Ogunsemi (2010), Zhang et al. (2012), Shah et al. (2016), Enshassi et al. (2017), Ndwandwa et al. (2017)	7
		Technical	
22	Poor communication system for coordinating between members	Josephson et al. (2002), Love and Smith (2003), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Zhang et al. (2012), Aiyetan (2013), Palaneeswaran et al. (2014), Forcada et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016), Ahmed and Naik (2016), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ndwandwa et al. (2017), Ajayi (2017), Yap et al. (2017), Eze et al. (2018a, b), Trach et al. (2019), Hwang et al. (2019), Safapour et al. (2019), Liu et al. (2020), Mahamid (2020), Salihu and Babarinde (2020)	31
23	Ineffective use of quality management practices/deviation due to poor monitoring	Love and Smith (2003), Robinson et al. (2004), Palaneeswarane et al. (2005), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Zhang et al. (2012), Aiyetan (2013), Palaneeswaran et al. (2014), Forcada et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Aiyetan and Das (2015), Mahamid (2016a), Shah et al. (2016), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ndwandwa et al. (2017), Yap et al. (2017), Eze et al. (2018a, b), Hwang et al. (2019), Safapour et al. (2019), Liu et al. (2020), Salihu and Babarinde (2020)	28
24	Inadequate planning and poor scheduling of workload	Josephson et al. (2002), Love and Smith (2003), Robinson et al. (2004), Palaneeswarane et al. (2005), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Zhang et al. (2012), Aiyetan (2013), Palaneeswaran et al. (2014), Forcada et al. (2014), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016a), Shah et al. (2016), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ndwandwa et al. (2017), Ajayi (2017), Eze et al. (2018a, b), Trach et al. (2019), Liu et al. (2020), Salihu and Babarinde (2020)	28
25	Poor project documents, unclear instructions, poor contract documents	Love and Smith (2003), Palaneeswarane et al. (2005), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Zhang et al. (2012), Aiyetan (2013), Palaneeswaran et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016a), Shah et al. (2016), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ndwandwa et al. (2017), Ajayi (2017), Yap et al. (2017), Eze et al. (2018a, b), Trach et al. (2019), Hwang et al. (2019), Liu et al. (2020)	27
26	Conflicting and incomplete information	Josephson et al. (2002), Robinson et al. (2004), Palaneeswaran (2006), Palaneeswaran et al. (2008), Oyewobi and Ogunsemi (2010), Love et al. (2010), Aiyetan (2013), Forcada et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016a), Shah et al. (2016), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ndwandwa et al. (2017), Ajayi (2017), Eze et al. (2018a, b), Trach et al. (2019), Liu et al. (2020), Salihu and Babarinde (2020)	24
27	Inefficient management process, poor site management practice	Robinson et al. (2004), Oyewobi and Ogunsemi (2010), Zhang et al. (2012), Aiyetan (2013), Palaneeswaran et al. (2014), Hwang et al. (2014), Forcada et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016), Oyewobi et al. (2016), Enshassi et al. (2017), Ndwandwa et al. (2017), Ajayi (2017), Yap et al. (2017), Eze et al. (2018a, b), Hwang et al. (2019), Safapour et al. (2019), Liu et al. (2020), Mahamid (2020)	23
28	Poor technology application and lack of information technology use	Love and Smith (2003), Palaneeswarane et al. (2005), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Aiyetan (2013), Palaneeswaran et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Wilson and Odesola (2017), Enshassi et al. (2017), Ajayi (2017), Yap et al. (2017), Eze et al. (2018a, b), Trach et al. (2019), Salihu and Babarinde (2020)	21

Table 1. (*Continued.*)

Group		Rework root causes	Covered by references	∑
			General/external	
T1:37	29	Financial issues such as lack of funding, low contract or payment fee, delay in payment, and cost pressure	Love and Smith (2003), Robinson et al. (2004), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Aiyetan (2013), Palaneeswaran et al. (2014), Hwang et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016a), Shah et al. (2016), Ahmed and Naik (2016), Oyewobi et al. (2016), Enshassi et al. (2017), Ndwandwa et al. (2017), Ajayi (2017), Eze et al. (2018a, b), Trach et al. (2019), Hwang et al. (2019), Safapour et al. (2019), Liu et al. (2020)	27
T1:38	30	Time pressure, schedule acceleration to finish the task, insufficient time to prepare contract documentation	Love and Smith (2003), Robinson et al. (2004), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Aiyetan (2013), Palaneeswaran et al. (2014), Forcada et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016a), Shah et al. (2016), Ahmed and Naik (2016), Oyewobi et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ndwandwa et al. (2017), Ajayi (2017), Yap et al. (2017), Eze et al. (2018a, b), Trach et al. (2019), Salihu and Babarinde (2020)	27
T1:39	31	Damage/defects/deviations in the product due to poor handling and safety	Love and Smith (2003), Palaneeswarane et al. (2005), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Aiyetan (2013), Palaneeswaran et al. (2014), Ye et al. (2015), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Aiyetan and Das (2015), Mahamid (2016), Oyewobi et al. (2016), Ajayi (2017), Eze et al. (2018a, b), Hwang et al. (2019), Mahamid (2020)	20
T1:40	32	Environmental conditions, poor site conditions	Palaneeswaran (2006), Palaneeswaran et al. (2008), Oyewobi and Ogunsemi (2010), Ye et al. (2015), Ajayi and Oyeyipo (2015), Mahamid (2016a), Shah et al. (2016), Oyewobi et al. (2016), Enshassi et al. (2017), Ajayi (2017), Yap et al. (2017), Eze et al. (2018a, b), Hwang et al. (2019), Safapour et al. (2019), Liu et al. (2020), Mahamid (2020)	17
T1:41	33	Lack of client involvement	Love and Smith (2003), Palaneeswaran (2006), Palaneeswaran et al. (2008), Love et al. (2009), Oyewobi and Ogunsemi (2010), Love et al. (2010), Aiyetan (2013), Palaneeswaran et al. (2014), Miri and Khaksefidi (2015), Ajayi and Oyeyipo (2015), Mahamid (2016), Ahmed and Naik (2016), Ndwandwa et al. (2017), Ajayi (2017), Eze et al. (2018a, b), Trach et al. (2019)	17
T1:42	34	Lack of constructability	Robinson et al. (2004), Palaneeswaran (2006), Palaneeswaran et al. (2008), Ye et al. (2015), Ajayi and Oyeyipo (2015), Shah et al. (2016), Wilson and Odesola (2017), Enshassi et al. (2017), Ajayi (2017), Eze et al. (2018a, b), Hwang et al. (2019)	12
T1:43	35	Governmental regulations/changes and policies	Ye et al. (2015), Shah et al. (2016), Enshassi et al. (2017), Hwang et al. (2019)	4
T1:44	36	Unclear line of authority	Shah et al. (2016), Enshassi et al. (2017)	2
T1:45	37	Unpredictable factors from different sources	Oyewobi and Ogunsemi (2010), Ye et al. (2015)	2

F2:1 **Fig. 2.** Distribution of respondents and organizations.

paper to measure the importance of rework causes. The RII technique facilitates comparative analysis, depicts the most contributing elements of management, and helps planners allocate resources better (Alaghbari et al. 2018). This method determines the importance level of each cause listed in the questionnaire and then ranks all causes. The RII result identifies the most significant rework causes that lead to contractual claims and gives the severity indication for each cause. The list of 37 identified rework root causes are the variables of this research that affect claim and other contractual issues in construction contracts. The ranked causes of rework then were transferred into a matrix through a combination of the relative importance index of each cause in relation to both objectives of the study. The matrix prioritizes rework causes at different levels of importance for further study.

Results of the Systematic Literature Review

To identify the cause of rework, 35 articles out of the initial 140 documents were relevant to the research scope. Content analysis of the relevant papers resulted in the identifying rework causes as listed in Table 1, which are classified into five groups as the most common rework causes. Table 1 also shows the total number of citations within the reviewed papers in this study's scope. These causes can result from either the nature of construction or the other imposed determinants such as human attributes, procurement approaches, external factors, and supporting activities. In line with the previous research studies on the classification of rework causes, the 37 identified items are clustered into the generic sources for interpretation and further discussion concerning the contract. Some of the causes are process based and ignoring them stops the progression of work. This group included the causes of rework that mostly occur during the project's main activities (Zhang et al. 2012). Changes, errors, omissions, and incomplete or faulty processes can be categorized under process-related factors. Knowledge, skills, experiences, motivations, and other similar characteristics are human attributes and can be clustered in one group of causes. Some causes are related to the provided material or used equipment directly affecting the construction project's outcomes. The causes linked to supplying the required material and equipment for the project are categorized under material/equipment-related factors (Robinson et al. 2004). Other causes are related to the activities that provide support services to the main process, such as quality control for monitoring, employing technology, communication means, planning, and scheduling for controlling projects. All these causes are clustered under technical-related factors (Oyewobi and Ogunsemi 2010). The last group of causes consisting of nine items is generally linked to the external sources and are listed in no particular order.

Analysis and Survey Result

The detailed demographics of respondents are given in Table 2. As summarized in Table 2, demographic data analysis revealed that the consultants' companies contributed the most to the survey with the frequency of 19 out of 34 responses, equal to 55.88%. About 61.76% of the participants were from the client side, and the remaining 38.23% filled their survey questions from the contractor side. Therefore, the importance index of rework causes comprises enough responses from both sides of the contract. In terms of the role of participants, the highest percentage is project directors with 32%. The respondents' other positions that show 23% include two CEOs, three project advisors, one regional manager, one contract engineer, and one building surveyor. Most respondents had more than 25 years of experience in the construction field, with a rate of 58.82%. This rate verifies that the analysis result is authentic based on the given information from an experienced sample. Regarding the years of experience in contracting management, all participants were from the construction sector, and the highest percentage belonged to the group having more than 10 years' experience, at 76%, compared to the other groups. The high percentage of this group with more than 10 years of experience in contracting management strengthens the collected data's reliability and results.

Table 2. Demographic characteristics of respondents

Profile	Classification	Frequency	Percent
Organizational type	Client	2	5.88
	Consultant	19	55.88
	Contractor	11	32.35
	Subcontractor	2	5.88
Role of participants	Project director	11	32.35
	Project manager	6	17.64
	Contract manager	1	2.94
	Commercial manager	3	8.82
	Quantity surveyor	5	14.70
	Others	8	23.52
Years of experience	Less than 5 years	0	0
	6–10 years	5	14.70
	11–15 years	2	5.88
	16–20 years	3	8.82
	21–25 years	4	11.76
	Over 25 years	20	58.82
Contract side	Client	21	61.76
	Contractor	13	38.23

Internal Reliability of the Questionnaire

The *T*-test technique was used to ensure that the sample size, including two categories of 21 clients and 13 contractors, is adequate to deliver a trustworthy finding. This test is used to find discrepancies between different groups of respondents in answering the questions. The results confirmed that the *p*-values of only three causes out of 37 regarding Objective 1 were less than 0.05 as can be seen in Table 3. In other words, there are no significant differences between the two groups of client and contractor for the majority of variables, and consequently, the result of the initial analysis is meaningful due to minimal inconsistencies (Lee et al. 2020). The SPSS result also showed a *p*-value for all 37 causes in Objective 2 is more than 0.05. Thus, the initial analysis result is satisfactory for conducting the next research step.

The validity of the responses was also verified through a reliability test. Before data analysis, the reliability of the questions needs to be examined. For this purpose, the internal consistency of the variables among two different respondent groups, client and contractor, was measured using the Cronbach alpha test. Because a Likert scale was used to measure the study variables, the questionnaire's reliability can be checked through the Cronbach alpha test. The result of this test with the figure greater than 0.7 shows higher internal consistency based on the participants' responses and proves the reliability of the questions (Gamil and Rahman 2020; Gunduz and Elsherbeny 2020). The Cronbach alpha test results among all 37 rework causes were in a range of 0.949 to 0.953 in Objective 1 and equal to 0.968 in Objective 2. This result proves the reliability of the questions. Thus, the data's internal consistency received high appraisal, and the collected data were reliable for performing further analysis. IBM SPSS version 26 software was used for all analysis in this paper.

The relative importance index of each rework cause is presented in Table 4 and the result of implementing RII for each group of factors is presented in Table 5. It shows that process-related factors

Table 3. Result of *T*-test for the causes of rework

Rework cause variable	Group	*N*	Mean	*p*-value (significance)
Inadequate supervision staff	Client side	21	3.76	0.003
	Contractor side	13	4.00	—
Insufficient skilled level manpower	Client side	21	3.62	0.011
	Contractor side	13	4.31	—
Time pressure, schedule acceleration to finish the task, insufficient time to prepare contract documentation	Client side	21	3.90	0.006
	Contractor side	13	3.54	—

Table 4. Relative importance index of rework root causes for objectives of the study on general conditions of NZS 3910

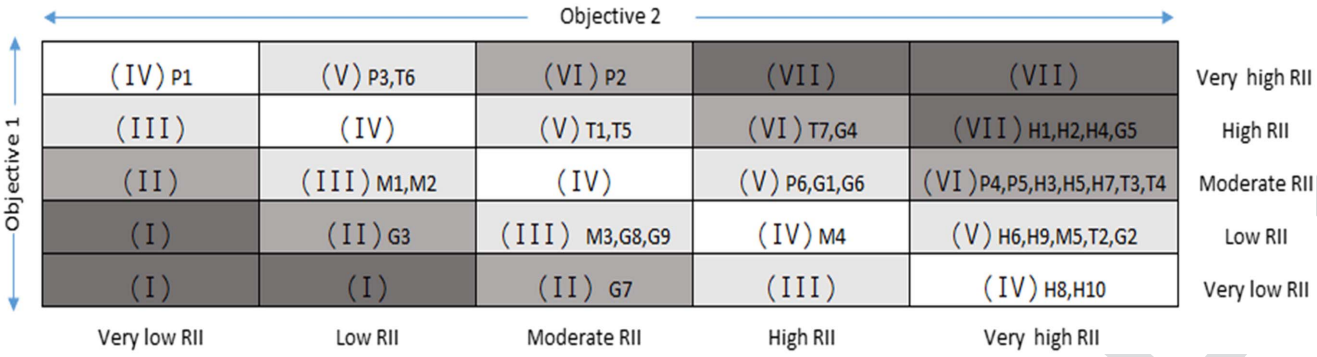
Group	Rework root cause	Objective 1 RII	Objective 1 *A*	Objective 1 *B*	Objective 2 RII	Objective 2 *A*	Objective 2 *B*
Process-related factors							
P1	Changes, modification, and revisions in design/construction changes	0.841	3	4	0.747	1	1
P2	Error in design, drawings, and specifications/error in construction	0.923	1	1	0.652	3	5
P3	Incomplete design, any omission in the design or construction process	0.894	2	2	0.658	2	4
P4	Inadequate procurement methods/poor contract execution	0.7	6	15	0.552	5	17
P5	Improper contractor and subcontractor selection	0.705	5	14	0.529	6	20
P6	Lack of document control	0.717	4	12	0.582	4	13
Human resources–related factors							
H1	Lack of experience and personal expertise in design and construction	0.77	1	6	0.511	6	23
H2	Inadequate supervision staff	0.764	2	7	0.517	5	22
H3	Inadequate manpower to complete the task	0.729	4	11	0.541	2	19
H4	Insufficient skilled level manpower	0.77	1	6	0.511	6	23
H5	Poor knowledge of team member, lack of education and training	0.741	3	9	0.517	5	22
H6	Lack of employee motivation and rewards, carelessness	0.647	6	20	0.523	4	21
H7	Poor workmanship approach and inappropriate personal attitude	0.711	5	13	0.517	5	22
H8	Absence of job security and other safety rules	0.482	9	29	0.511	6	23
H9	Labor reallocation, alteration, and staff turnover	0.6	7	25	0.529	3	20
H10	Conflict of interests	0.505	8	28	0.558	1	16
Material and equipment-related factors							
M1	Defective materials, nonadherence to material specifications	0.735	1	10	0.688	1	2
M2	Poor-quality material or substandard products/prefabrication errors	0.717	2	12	0.670	2	3
M3	Replacement or misplacement of material and equipment	0.623	3	22	0.611	3	11
M4	Inefficient equipment use or altered material	0.611	4	23	0.582	4	13
M5	Untimely deliveries of material and equipment	0.605	5	24	0.558	5	16
Technical-related factors							
T1	Ineffective use of quality management practices/deviation due to poor monitoring	0.752	3	8	0.623	3	9
T2	Poor technology application and lack of information technology use	0.6	6	25	0.523	6	21
T3	Poor communication system for coordinating between members	0.688	5	16	0.517	7	22
T4	Inefficient management process, poor site management practice	0.729	4	11	0.547	5	18
T5	Poor project documents, unclear instructions, poor contract documents	0.817	2	5	0.635	2	7
T6	Conflicting and incomplete information	0.847	1	3	0.670	1	3
T7	Inadequate planning and poor scheduling of workload	0.752	3	8	0.564	4	15
General/external factors							
G1	Financial issues such as lack of funding, low contract or payment fee, delay in payment and cost pressure	0.670	3	18	0.576	6	14
G2	Lack of client involvement	0.635	5	21	0.558	7	16
G3	Unclear line of authority	0.594	6	26	0.670	1	3
G4	Time pressure, schedule acceleration to finish the task, insufficient time to prepare contract documentation	0.752	1	8	0.594	5	12
G5	Lack of constructability	0.752	1	8	0.541	8	19
G6	Damage/defects/deviations in the product due to poor handling and safety considerations	0.682	2	17	0.594	5	12
G7	Governmental regulations/changes and policies	0.535	7	27	0.641	2	6
G8	Environmental conditions, poor site condition	0.652	4	19	0.629	3	8
G9	Unpredictable factors from different sources	0.652	4	19	0.617	4	10

Note: *A* shows ranking of causes under each group and *B* shows ranking of causes among all groups.

Table 5. Relative importance index of rework group factors

Rework factor	Objective 1 RII	Objective 1 Rank	Objective 2 RII	Objective 2 Rank
Process-related factors	0.797	1	0.620	2
Human resources–related factors	0.672	3	0.524	4
Material and equipment-related factors	0.658	4	0.622	1
Technical-related factors	0.741	2	0.583	3
General/external factors	0.658	4	0.620	2

are generating contractual claims more than the other groups of factors, followed by technical-related factors and human resources factors. Therefore, these three groups have greater priority for further investigation because they result in higher numbers of claims in projects. In terms of being addressed by contract conditions, the group factors of material and equipment stand higher than the other groups, meaning that the conditions of contract have adequately addressed the causes of rework under this category and more investigation may not be required. The group of human resources–related factors with lower RII has more priority for further investigation because they seemed to be less addressed in the conditions of the contract. Table 4 lists the relative importance index for each of the causes of rework to meet the study's objectives. The result showed that the rework leads to contractual claims under various situations. The causes of rework illustrate the causal relationship between rework and claims. The other side of the result showed that contract conditions do not adequately address the causes of rework, making the assessment of claims even more difficult. When the contract conditions do not provide enough legal evidence for processing claims, they are more likely to lead to conflict and disputes. Based on this result, further investigation on contract conditions is required.



F3:1 **Fig. 3.** Matrix of relative importance index of rework causes.

Table 6. Ranking criterion for dividing relative importance index into five levels

T6:1 Scale	Level of importance	Objective 1 Range of RII	Objective 2 Range of RII	Level
T6:3 $0 \le x \le 20\%$	Very high	0.923–0.835	0.511–0.558	1
T6:4 $20\% < x \le 40\%$	High	0.834–0.747	0.559–0.605	2
T6:5 $40\% < x \le 60\%$	Moderate	0.746–0.658	0.606–0.652	3
T6:6 $60\% < x \le 80\%$	Low	0.657–0.570	0.653–0.700	4
T6:7 $80\% < x \le 100\%$	Very low	0.569–0.482	0.701–0.747	5

A combination of these two importance indexes would facilitate further discussion on the causes of rework in relation to the contractual claims and contract conditions. The listed causes of rework in Table 4 can take two indicators from each objective of the study and make a matrix with two dimensions. Fig. 3 shows the matrix that has been made by RII of the study's objectives. Each objective's RII is divided into five equal parts from top to bottom to show the importance level of causes according to the industry's feedback (Kassem et al. 2020). The level of importance is indicated by very important, important, moderate, less important, much less important. The assessment is based on the matrix scale of the RII value, where the lowest and highest are 0.482 to 0.923 for Objective 1, and 0.747 to 0.511 for Objective 2 (Husin et al. 2019). The matrix then shows seven different areas that have been colored for identifying the priority of combinations between importance indexes (Luo et al. 2018). Area (VII) that encompasses very high RII in both objectives has the highest priority for further investigation, followed by the areas (VI) and (V). The other areas including (IV), (III), (II), and (I) consist of rework causes that have moderate or lower RII on both sides of the matrix and therefore have less priority for further investigations. A two-dimensional matrix was then used for covering the result and placing each rework cause distributed in the defined zones (Kassem et al. 2019). The result of this combination is presented in Fig. 3.

Table 6 lists the criteria and boundaries for dividing the range of RII in both objectives of the study. Data analysis on Objective 2 showed a range of 0.511 to 0.747 as the relative importance index of each evaluated cause. A higher score shows that respondents are more likely to agree that the condition of the contract adequately addresses the root causes of rework, and a lower score means the causes of rework have not been addressed adequately in the contract conditions. Therefore, the lowest RII in Objective 2 has the highest probability of leading to conflict or dispute because no reference has been placed in the contract conditions. Since the provided list of causes in the survey was not against or aligned with contract parties' interests, it is worth mentioning that the RII result is most likely unbiased; however, the number of participants from the client side was higher than from the contractor side.

Discussion

Main Source of Claim under Rework Circumstances

Rework shares a variety of common causes with claims and can be used as a trigger for claim management. Lack of claim management triggers dispute situations that usually lead to a deterioration in the quality of the party's relationship. Contract parties use the identified sources of the claim as evidence for reasoning based on the contract provisions. Nonetheless, identification of the sources of a claim needs to be performed before proposing a solution. Different singular or multiple causes may originate claims and it is critical to understand which combination of causes has made a claim (Jelodar et al. 2016). The relevant importance index of each cause listed under Objective 1 ranks them in terms of their influence in generating contractual claims. Therefore, a higher RII shows more probability of generating a claim from that particular source. The following section first discusses the most influential causes of rework under five categories and then provides a priority list of top causes for future investigations.

Among the six causes under the group of process-related factors, error in design and construction stands as the first rank of causes that highly trigger the generation of claims. Review of the completed design to identify design errors by an expert team has been suggested to be included in standard contract agreements (Mendis et al. 2015). Design error has been also ranked at the top of claim, dispute, and conflict causes in previous studies (Kisi et al. 2020; Saseendran et al. 2020), while Zaneldin (2020) ranked this cause at ninth of 45 reviewed items in the UAE. A large proportion of construction errors are raised due to mistakes in contract documentation (Dosumu 2018) and this cause has been ranked second in the study of dispute causes in Sri Lanka (Illankoon et al. 2019). The RII of the 10 rework causes under the human resources group showed that lack of experienced staff and insufficient skilled level manpower highly generate claims. A study in Egypt also ranked interpersonal skills and construction law experience together in the second level of factors causing construction claims (Mohamed et al. 2014). With a relative importance index of 0.735, defective materials are ranked as the highest cause compared with the other four causes under the group of material/equipment-related factors. Failure to disclose the used material specification by a contractor was among 13 severe factors influencing construction contract disputes in Nigeria (Aiyewalehinmi and Nkumah 2019).

The technical-related factor that comprises seven different causes revealed that conflicting and incomplete information can be the most influential causes in generating a contractual claim. According to Ekhator (2016), a lack of information and conflicting data leads to misunderstanding, and Enshassi et al. (2009) stated that design errors arise from conflicting information; both end with claims. It has also been ascertained that rework is managed well when information is adequate with no conflictions (Oyewobi and Ogunsemi 2010). In the last group of causes, which have been clustered under the name of general/external-related factors, two underlying causes—lack of constructability and time pressures—stand at the top of the list between nine causes. In the list of conflict causes presented by Gajaman et al. (2019), a reluctance to check for constructability is categorized under consultant-related factors. On the other side, time pressure is a common practice for the construction industry; however, it is almost always underestimated by construction practitioners (Palaneeswaran et al. 2007). In the study done in Nigeria (Aiyetan 2013) time pressure ranked sixth under design-related factors related to the causes of rework. In addition, time pressure is one of the variables of organizational culture that influence rework occurrence (Oyewobi et al. 2016).

Contract Conditions in a Claim Incident from Rework

The relevant importance index of each cause listed under Objective 2 ranks them in terms of being addressed adequately within NZS 3910 contract conditions. The higher RII of each cause shows more contract conditions coverage that makes for a lower priority for further investigation. Therefore, items with lower relative importance indexes would have more priority for further investigation. The lower rate of RII means that specific rework causes have not been addressed adequately within the contract conditions, and it requires more study to find a solution or provide recommendations for improving relevant clauses of the contract. The initial results of this paper will be used for discussion on the clauses that can be linked to rework. Therefore, the next step of the study provides insight into contract conditions by conducting interviews with legal professionals and construction practitioners to understand how rework can be addressed in the contract to avoid conflicts.

Under the group of process-related factors, changes in design and construction (RII = 0.747) are ranked highest in terms of being addressed in the contract conditions. Change also ranked the highest among all investigated causes. Therefore, it is known as one of the causes that have been covered enough under the examined contract conditions. In the study of claim causes and types in India, eight types of claim were introduced, in which change claim was ranked at the third level after extra work and delay claims (Al-Qershi and Kishore 2017). Change claims also have been identified as the most common type of claim in construction projects (Atanda and Fabi 2015; Hansen 2016; Zaneldin 2020). In contrast, improper contractor and subcontractor selection with an RII of 0.529 ranked as the lowest cause. In other words, the condition of contract has, relatively speaking, addressed this cause less than other causes categorized under this group. Although selection of contractor and subcontractor has been studied adequately under rework circumstances, it seems to have received very limited studies under claim situations. A research study for reducing construction disputes through effective claim management ranked improper contractor selection at eighth among 31 identified factors causing construction claims (Mohamed et al. 2014).

Under human resources–related factors, conflicts of interest with a relative importance index of 0.558 are ranked the highest for referencing in contract conditions. Conflicts of interest as a root cause of rework may not be required to be assessed under claim events because most of the contract conditions cover it in their clauses (Raj et al. 2009). In contrast, lack of experience, insufficient skilled manpower, plus the absence of job security ranked the lowest among all causes, which means that the contract conditions have not covered these root causes of rework adequately compared to the others. Most probably, incorporating these items in the contract provisions is very difficult (Jelodar et al. 2016). Two causes—experienced staff and skilled manpower—are seen in the list of most significant dispute causes in construction projects (Illankoon et al. 2019) but the absence of job security has not been evaluated under claim causes yet. Defective material, one of the main triggers of the claims under the material/equipment group, has been addressed adequately in the contract conditions with the high RII of 0.688. Previous studies also claimed that defective material accounted for 20% of nonconformance cost of projects (Josephson et al. 2002; Oyewobi and Ogunsemi 2010). Conversely, untimely deliveries of material and equipment with an RII of 0.558 ranked as the lowest; therefore, it has priority for more investigation through the contract conditions. Late supply of material by client makes the contractor eligible for an extension of time claim (El-adaway et al. 2020). Late material delivery is very dependent on the terms and conditions of the contract when categorized under a construction change order (Hansen et al. 2020).

Under the technical-related factor group of causes, the highest and lowest identified causes are conflicting and incomplete information and poor communication system for coordinating between members with RIIs of 0.670 and 0.517, in which the lowest one needs more investigation within the contract conditions. Poor information generates project uncertainties (Eze et al. 2018a) and uncertainty has been identified as the third most common causes of claim (Jelodar et al. 2016). Previous studies also stressed that poor communication among project parties may lead to claims and conflict (Mahamid 2016a). Poor communication has also been identified as a critical item in rework occurrences by a number of studies (Eze et al. 2018a; Ye et al. 2015). The cause with RII of 0.670, namely, the unclear line of authority, is ranked as the first item, and lack of constructability with the relevant importance index of 0.541 is ranked as the last cause under the group of general/external causes that has more priority for exploring the contract conditions. The line of authority generally lies with the role of the engineer in most standard forms of contract worldwide in which clauses of the contract clearly make reference to them (El-adaway et al. 2016). Lack of constructability was not listed under causes of claim in the study done by Zaneldin (2020) but implementing constructability during various stages of a project is one of the author's suggested solutions for preventing claims.

The priority list of rework causes for further investigation as the main contribution of this paper is presented in Table 7. This list narrows down only to the causes that need to be focused on for the next research steps through interviews. The priority list was extracted based on the importance areas of the matrix and clustered causes with the same level of importance in three clusters.

Conclusion

This paper aims to provide basic information for further studying the relationship between rework and claims by investigating rework causes in construction contracts. Various practical works and theories were employed to reduce or manage claims through the years, but a general agreement has yet to be reached on the relationship between the causes of rework and contractual claims. The paper explores whether the general conditions of contract address the identified causes of rework from the literature or not. A foundation for

Table 7. Priority list of rework causes for further investigation in the general conditions of the contract NZS3910

Priority	Root causes of rework	Code	Group factor
	(1) Cluster of causes in "VII area of Fig. 3"		
1	Lack of experience and personal expertise in design and construction	H1	Human resources
1	Inadequate supervision staff	H2	Human resources
1	Insufficient skilled level manpower	H4	Human resources
1	Lack of constructability	G5	General/external
	(2) Cluster of causes "VI area of Fig. 3"		
2	Error in design, drawings and specifications/error in construction	P2	Process
2	Inadequate procurement methods/poor contract execution	P4	Process
2	Improper contractor and subcontractor selection	P5	Process
2	Inadequate manpower to complete the task	H3	Human resources
2	Poor knowledge of team member, lack of education and training	H5	Human resources
2	Poor workmanship approach and inappropriate personal attitude	H7	Human resources
2	Poor communication system for coordinating between members	T3	Technical
2	Inefficient management process, poor site management practice	T4	Technical
2	Inadequate planning and poor scheduling of workload	T7	Technical
2	Time pressure, schedule acceleration to finish the task, insufficient time to prepare contract documentation	G4	General/external
	(3) Cluster of causes in "V area of Fig. 3"		
3	Incomplete design, any omission in the design or construction process	P3	Process
3	Lack of document control	P6	Process
3	Lack of employee motivation and rewards, Carelessness	H6	Human resources
3	Labor reallocation, alteration and staff turnover	H9	Human resources
3	Untimely deliveries of material and equipment	M5	Material/equipment
3	Ineffective use of quality management practices/deviation due to poor monitoring	T1	Technical
3	Poor technology application and lack of information technology use	T2	Technical
3	Poor project documents, unclear instructions, poor contract documents	T5	Technical
3	Conflicting and incomplete information	T6	Technical
3	Financial issues such as lack of funding, low contract or payment fee, delay in payment and cost pressure	G1	General/external
3	Lack of client involvement	G2	General/external
3	Damage/defects/Deviations in the product due to poor handling and safety considerations	G6	General/external

this study was established by conducting a comprehensive literature review to identify the causes of rework in the first instance. Over the past 30 years, considerable literature has been directed to research rework issues in construction projects. Adequate sample cases using various strategies have been reported for reducing or preventing the impacts of rework globally. Content analysis of the papers revealed that a large proportion of rework studies have focused on rework root causes, explaining that a great effort has been made to understand the nature of rework. The comprehensive literature review identified 37 root causes of rework, classified into five distinct groups for further investigation. Based on the classified causes of rework, a survey questionnaire was designed and distributed to the industry to examine the relationship between identified rework causes and contractual claims, and to explore the adequacy of the general conditions of contract in addressing rework. The identification of rework causes that affect contractual claims can assist in reducing construction disputes.

The ultimate goal of the survey was to find the most important causes of rework that have not been addressed in the contract conditions. For this purpose, after collecting an adequate number of responses on the survey, the initial analysis using the method of RII was performed to prioritize the most significant causes of rework. The performed analysis ranked rework causes in terms of not being addressed by the contract conditions of the most commonly used standard form in New Zealand, NZS 3910. This initial result showed that the general conditions of NZS 3910 do not address the causes of rework adequately. As such, this exploratory study needs more empirical investigations with construction professionals to improve contract conditions. Further investigation into the clauses of the contract could be developed on the basis of feedback from the industry for addressing rework in contract conditions. A developed framework could enable contractual parties to manage their aspects during the handling of claims as a result of rework. Thus, the concluded result from the initial analysis of this paper will be used for the interview questions to find the solutions for improving contract conditions during rework circumstances.

The result of this paper is limited to the contract conditions contained in NZS 3910 and cannot be extended to other standard forms of contract. Also, the study may be limited by the higher number of responses from the client side compared to the contractor side. This may have the effect of skewing the results toward client perspectives. Future investigations could ensure a balanced proportion of study participants, if indeed this had any effect on study findings. Finally, the small sample size in the current study confines the generalization of the findings, but the study's contribution provided evidence that some causes of rework can quickly trigger the occurrence of a claim. Therefore, empirical testing with a larger sample accompanied with validation interviews could address these limitations.

Data Availability Statement

All data, models, and code generated or used during the study appear in the published article.

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Queries

1. Please check and confirm that all the corrections are incorporated correctly.