The common causes of rework in construction contracts: a diagnostic approach

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Abstract

Purpose – The high rate of rework that occurs in construction projects has a negative effect on the performance of the construction projects. Although several mechanisms have been implemented to control reworking, a comprehensive list of rework causes is yet to be provided to present the common causes that contribute to rework in construction contracts. This paper aims to investigate the most common rework causes that need to be addressed in construction contracts.

Design/methodology/approach – A mixed-method using both the qualitative and quantitative approach is used in this paper. First of all, the study adopted a four-step literature review to introduce the rework research trends and provide statistical reports using descriptive analysis. Next, a comprehensive review has been completed using content analysis to identify the common causes of rework in construction projects. Finally, the common causes in construction contracts are further investigated through a quantitative questionnaire survey to validate the initial results.

Findings – The results of the review showed an increasing trend of publications on rework over the last three decades. Most of the studies were conducted in Australia, the UK, Nigeria and Hong Kong. Based on further investigation in the study area of sources of rework, 37 causes of rework causes were identified and classified in five groups. Then, the most significant causes of rework in construction contracts were compiled in the list of 22 items.

Research limitations/implications – The paper's reported result, contributes to the contract management body of knowledge by proposing a list of common rework causes that can be used by practitioners during the contract negotiation to prevent contractual issues. The result of the review can also be used for further investigation of the relationship between rework and contract conditions.

Originality/value – The proposed list of common causes of rework in construction contracts allows project parties to improve the terms of the contract in addressing rework, this could result in fewer contractual claims and disputes. The findings of this study will also guide the investigations into the contract conditions, thus the approach used is constructive.

Keywords Causes, Construction management, Construction contracts, Rework

Paper type Technical paper

Introduction

The construction industry is always under investigation in terms of performance and, generally, there are many criticisms around the poor performance of the construction projects (Isnaini *et al.*, 2015). The primary factors influencing the projects' performance are mainly regarding cost and time (Han *et al.*, 2013). Consequently, numerous researchers have studied the effects of these two leading factors (Hwang and Yang, 2014). The literature has recognised that while there are several reasons for the cost and time overruns, rework has been identified as one of the most significant sources (Hwang *et al.*, 2009; Love *et al.*, 2010).

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"An effort for redoing an activity or a process that was implemented incorrectly the first time" is referred to as rework (Love *et al.*, 2002), that is, an activity that is defined as waste in the process and has an adverse effect on the project. Several rework definitions can be found in the literature as described in Table 1. Rework in construction projects continues to exist as a chronic problem and because the problem has existed for a long time, it affects the industry's reputation (Love and Curtin, 2019). Thus, announcing the occurrence of rework is not willingly reported by the construction firms and the impacts of the rework are ignored (Love *et al.*, 2016; Ahmed and Naik, 2016). Rework also impacts the psychological well-being, project measures, organisational factors (Aiyetan, 2013; Eze and Idiake, 2018a) and the progress of the contractual management (Kim and Miroslaw, 2020).

Despite the various assumptions in the literature, it is confirmed that the rework occurrence is due to the nonconformance in the project specifications or contract obligations (Hwang *et al.*, 2009; Oyewobi *et al.*, 2011). The nonconformance activities in different settings have been recorded with different terms, such as changes, faults, errors, defects, deviations, failures and more (Forcada *et al.*, 2017), while none of them add any value to the process (Bhatl *et al.*, 2016). Using the practitioners' and researchers' interchangeable words has had a negative effect on the success of the rework reduction process (Kakitahi *et al.*, 2014; Taggart *et al.*, 2014). Furthermore, rework occurs due to the number of causes that originated from various project stages or different contract sides. Thus, previous results are not comparable to generate a unique measure to reduce the impacts of rework (Forcada *et al.*, 2017). The common factors that lead project activities to require rework include yet are not limited to: process performance, such as errors and changes, human resources attributes, such as expertise and skills, lack of quality management, poor IT use and some other technical issues, material replacement, contract documents and lack of constructability.

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Table 1.
Definitions of rework identified in the literature

Year	Description	Literature Source
1999	Involves unnecessary effort of correcting construction errors and occurs when a product or service does not meet the requirement of the customer	Love *et al.*
2001	An activity that must be carried out more than once or activities that involves the removal of previously completed work	(CII) Construction Industry Institute
2002	Unnecessary output caused by mistakes undertaken during the construction process	Josephson *et al.*
2002	The unnecessary effort of redoing a process or activity that was incorrectly implemented the first time	Love *et al.*
2004	Activities in the field that have to be done more than once in the field, or activities that remove work previously installed as part of the project regardless of source, where no change order has been issued and no change of scope has been identified by the owner	Robinson *et al.*
2009	Having to redo work due to non-conformance with requirements	Hwang *et al.*
2011	A waste that involves doing a certain task more than once	Oyewobi *et al.*
2014	Work discovered to require change (either through errors, omissions, or regulation changes)	Li and Taylor
2019	Any change that veers from the agreed upon and signed contract	Safapour *et al.*
2019	The waste or redundant part of a project that has become part of the construction process	Hwang *et al.*
2019	The total direct cost of re-doing work in the field regardless of the initiating cause excluding variations and off-site errors	Love and Curtin
2020	The tasks of rectifying errors and dealing with changes in scope, quality deviations, and non-conformance, which is wasteful and non-value-adding activity	Liu *et al.*

In recent years the topic of rework management has become a focus of attention in construction research studies (Ji and AbouRizk, 2018; Safapour and Kermanshachi, 2019; Mahamid, 2020), mostly on the affecting factors, causes and impacts and rework management models (Zhang *et al.*, 2012). Several approaches have been implemented in construction projects for rework reduction or prevention, such as design scope freezing, information technology use, integration process, change management, quality management and other methods. However, even though the literature on rework topics shows an adequate number of studies in the last few years, there are very few studies that research the evidence of project performance improvement by rework reduction (Jingmond and Agren, 2015). Understanding the underlying rework causes and their effects on the construction contracts' project performance is critical for the sustainability of the construction industry (Simpeh *et al.*, 2015). Therefore, future work for adopting and implementing more effective strategies on rework management is required.

This paper aims to identify the most common causes of rework in construction contracts. To provide a list of common rework causes in the construction projects, an adequate sample of the relevant literature was reviewed. The final review of the documents suggests that the causes of rework can be classified in five categories: process, human resources, materials and equipment, technical and general/external. The clustered rework helps construction practitioners understand the underlying causes of rework in contracts and select better strategies to deal with the associated problems.

Rework conceptualization

Despite the considerable number of research studies that have been undertaken to date, based on a review of the literature, there is not a unique definition of rework. In most studies, researchers have described their research scope based on a specific given definition of rework. The rework concept that was presented by the Construction Industry Development Agency in 1995 evolved through the years considering the two main aspects of quality and change (Love and Smith, 2018). However, even though there are plenty of available definitions they do not cover snagging and defects in the construction of building projects (Taggart *et al.*, 2014). The lack of a standard definition resulted in a range of methods to determine rework cost and various measures to quantify the impacts of rework on project performance (Love and Smith, 2018). Thus, generating an acceptable worldwide definition of rework is still an issue. Table 1 shows the trend of the conceptualisation of rework and its definitions based on a review of the literature.

Methodology

This paper utilises a systematic literature review followed by a questionnaire survey to meet the qualitative and quantitative parts of the research and to achieve the study's goals. The research methodology stages have been demonstrated in Figure 1. These two approaches need to be used together in data collection and analysis as doing so improves the reliability and validity of the results (Kisi *et al.*, 2020).

F1

Stage 1: systematic literature review

This stage of the research is used to report the research trend of rework publications and to identify rework causes in construction projects. The method of systematic review is widely used in various disciplines including construction management (Ayodele *et al.*, 2020). Systematic review is a suitable method for evaluating previous studies to extract and analyse the data from the literature. The implemented approach in stage one provides a better understanding of the rework trends in the literature for construction projects. This approach extracts data from relevant sources in the literature, analyses the data to generate

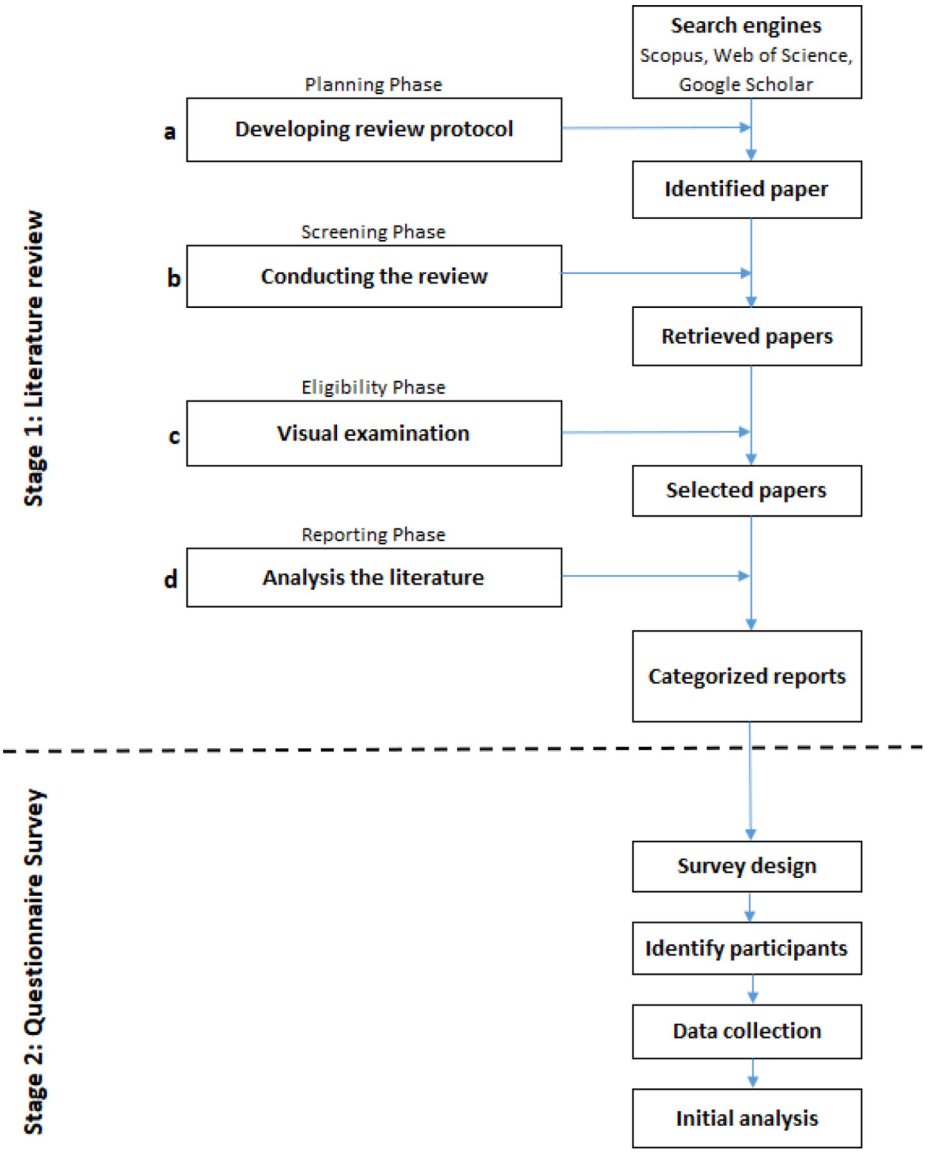

Figure 1.
Flowchart of adopted methodology "Research framework", Search date: 27.06.2021

various categories and explores new visions for further investigation. Thus, this method was adopted at the initial stage to gain an insight into the rework research trends and to enable identification of the common causes of rework. Following the various definitions that were found for rework, a search of the literature was conducted following the same steps that previous studies used (Schon *et al.*, 2017; Xia *et al.*, 2018; Kasperiuniene and Zydziunaite, 2019; Dallaseg *et al.*, 2020). The steps are very clear and easy to follow as described in four steps shown below.

Step a: developing a review protocol. The first step, known as the planning phase, involved selecting the required criteria to conduct the search. The review process comprised keyword searches in three databases, defining inclusions and exclusions, removing duplicated documents, selecting final papers, categorising and data analysis. The search planned to use three databases, namely, Scopus, Web of Science (WoS) and Google Scholar. The selected databases contain the highest quantity of peer-reviewed literature (Wang *et al.*, 2020). A lack of coverage in some search engines is the primary reason for planning to search within three academic databases (Malek and Desai, 2020). The search was carried out then, using the keywords, as described in the following process. Keywords are the critical part of the review and the selected keywords in this paper to meet the research objectives were "rework" and "construction." The language was then restricted only to English within the time from 1990 to 2020. The inclusion condition was defined to cover the peer-reviewed papers only in journals and leading conferences at the final approved level in the field of construction management. The other types of documents were excluded to maintain the quality of the research. Further refinement was also employed by focusing only on the construction projects and removing irrelevant papers from other sectors.

Step b: conducting the review. The second step, also called the screening phase, aims to identify the relevant research papers. The study started reviewing published papers from 1990 to 2020 in April 2020 and then was updated in June 2021. This period included a sufficient number of articles and conference papers. After the initial search of the keywords without restriction and papers retrieval, 5,482 were collected, in which 1,023 were from Scopus, 2,115 from WoS and 2,344 from Google Scholar. Refinement was then required because most of the collected papers were irrelevant to the construction industry. Thus, two criteria were set to screen the collected papers and select the most relevant documents:

- published work in the construction industry; and
- papers that include only rework in their reports, not the other similar terminologies.

In other words, papers should be directly linked to rework management in construction projects. According to the study's aim, the keywords were limited to two, rework and construction terms that would lead to more precise results. Except for Google Scholar, the other two search engines had more options for advanced search in filtering the publications in line with the defined criteria. The second round of search by applying the inclusion and exclusion criteria, resulted in 139 screened papers in Scopus, 104 in WoS and 121 in Google Scholar. In total, 364 documents were included for visual examination in the next step.

Step c: visual examination. This step, also called the eligibility phase, is used to assess the quality of the research by reviewing the details of papers in compliance with the study's objective. In this step, an in-depth visual examination was performed to select the right papers for further analysis. The final retrieved papers' information was controlled through a validated review of the sequences in title, abstract and the main text. The abstract of retrieved papers was initially checked to find if the paper's content was according to the criteria or not. Accordingly, unsatisfactory papers and publications beyond the research scope were excluded. The duplicated papers among the three databases were also identified; documents with the exact same titles were removed to avoid duplication. Eliminating the duplicated papers resulted in 157 published works out of 364 retrieved documents.

Step d: analysis and categorizations. A total of 157 publications were included in this review to establish rework research trends. The comprehensive method of literature review is used for providing reports on the existing evidence in a specific area of knowledge. The results of such a review generally identify gaps in the knowledge and can be used as a starting point for further research on a specific topic. The conceptual boundary of the

current review is to involve rework concepts that apply to the construction industry. The papers that were selected from the previous steps were then analysed to provide reports in different categories. In this step, the basic information of each paper was initially transferred to a Microsoft Excel file. The codebook list was then prepared based on each paper's extracted relevant data from the Excel file, as presented in Table 2. The list of items in the codebook table is for interpreting the papers, providing statistical reports and assessing how many categories can be adjusted. T2

The codebook items were then investigated further to make a list of categories for further analysis. The reports around each category were based on the bibliography features of the papers using a descriptive analysis. The generated categories for further descriptive analysis are based on the publication year, countries' status, research methodologies, relevant journals and causes of rework as presented in Table 3. Once the extraction of the data was completed, all the rework topics, classified causes and other patterns around it was reviewed in considerable details. A full review of the selected papers resulted in the revealing of 35 publications on the sources of rework. The reports on the sources of rework are based on the content analysis of the extracted data from the Excel file. Content analysis is an inductive method to unfold, outline and organize the extracted data into groups (Ayodele *et al.*, 2020). Content analysis of the last 35 papers falls into five groups consisting of 37 rework causes that are reported in the result section. The five groups of rework causes are based on the classification methods used in the previous studies (Josephson *et al.*, 2002; Oyewobi and Ogunsemi, 2010; Zhang *et al.*, 2012; Enshassi *et al.*, 2017). T3 AQ: 4

Table 2.
Codebook list for data extraction and descriptive analysis

Code		Description
A	Basic information	
	A.1. Date	Year of publication
	A.2. Authors	List of the authors' name
	A.3. Title	Title of the article or conference paper
B	Publication information	
	B.1. Journal details	Journal title that published the article including detail address of paper such as Vol., Issue, and pages
	B.2. Conference details	Conference name and proceedings details such as date, location, and paper pages
C	Geographical region	Affiliations including universities and research centers name or industry conducting research
D	Citations	Number of papers that cited the study
E	Research details	Research aim, main results and contributions, perspective, the methodology used and project types

Table 3.
List of categories for statistical report

No.	Categories of review	Description
1	Yearly base	Evaluating the development of rework management through a trend line
2	Country status	Assessing the score of each country contributing to published papers
3	Journal	Identification of the journals that have published rework research
4	Research methodologies	Dividing into subcategories of case study, survey, interview, literature review and others
5	Rework causes	Exploring the causes of rework in the studies on the sources of rework

Stage 2: questionnaire survey

This stage of research comprises four steps to conduct the qualitative part of the used methodology. In step one, a questionnaire was designed based on the result of the systematic literature review on the causes of rework. The questionnaire was then confirmed with industrial and academic professionals. Step two involved identification of the participants and the distribution of the questionnaire to conduct a pilot study via an online system. In step three, the initial data was collected through online software called Qualtrics, and step four involved analysing the data to investigate the significance of each cause of rework in relation to construction contracts used in New Zealand. The questionnaire included two sections; section one for collecting participants information such as years of experience in construction and contracting, their job positions, their organization and project type. Section two involved collecting the opinion of the participants on the effects of the rework causes on the contractual issues. The Likert scale from 1 to 5 was used to rate the respondent's opinion on each rework cause. The questionnaire was distributed using networks and communication tools such as mailing lists.

The first round of data collection for the pilot survey was performed 15 September 2020 using a networking system. Thus, a request to participate in the pilot survey was sent to three associations, the NZ Certified Builders, Civil and Construction New Zealand and NZ Architects and Consultants. Once the number of recorded files on the Qualtrics software showed adequate responses to start the initial analysis of the pilot survey, the second round of data collection was performed 22 October 2020 using a mailing system. In the first round, there were 63 responses from the members of the prementioned associations. Further investigation into the collected data showed that part of the recorded files is incomplete. After refining all records, a total number of 42 responses remained in order to rank the causes of rework that affect contracts in New Zealand construction projects.

Results

Category 1 – rework papers on biannual bases

According to the search engines' result, the total number of rework-related papers biannually shows an increasing trend from seven papers in 1999–2000 to 31 papers in 2019–2020. The rework publication status has been presented in Table 4. This category of data shows the frequency distribution of 157 papers. The table indicates zero publications between 1990 and 1997; thus, 1998 is a commencement year for using the terminology of rework in construction studies. However, based on a review in the literature there are some studies that were conducted before 1998 in which other interchangeable words have been used.

Noticeably, the figures in Table 4 indicate that studies on rework topics have been initiated between 1998 and 2010 with a total number of 40 papers and within the next ten years this more than doubled to a total number of 117 publications. Figure 2 also shows that rework research interests have been increasing within the last 20 years. As the search of

Table 4. Rework related papers published between 1990 and 2021

Search Engines	1990 1997	1998	1999 2000	2001 2002	2003 2004	2005 2006	2007 2008	2009 2010	2011 2012	2013 2014	2015 2016	2017 2018	2019 2020	2021	Total
Scopus	0	1	5	3	5	3	4	4	7	15	12	10	18	6	*93*
Web of Science	0	0	0	1	0	0	0	0	0	0	2	6	3	0	*12*
Google Scholar	0	0	2	0	2	4	3	3	5	4	10	9	10	0	*52*
Total	*0*	*1*	*7*	*4*	*7*	*7*	*7*	*7*	*12*	*19*	*24*	*25*	*31*	*6*	*157*

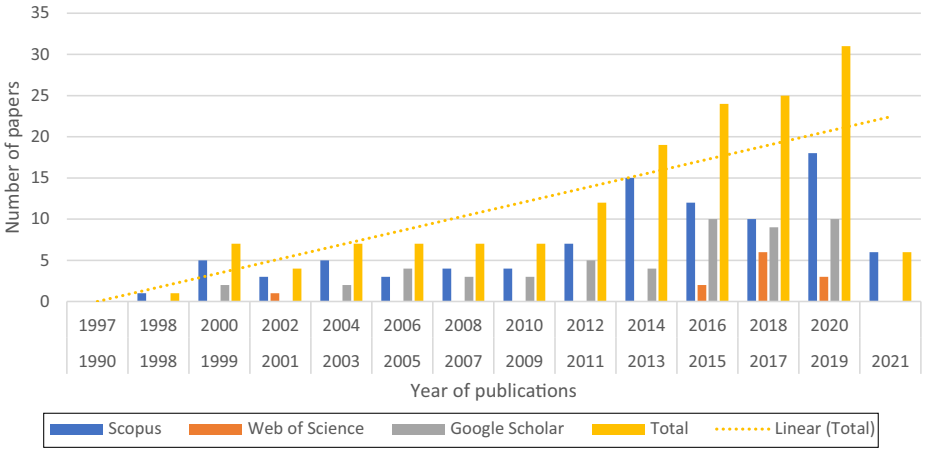

Figure 2.
Number of published papers biannually within the selected period

databases was performed in June 2021, the number of published papers in the last column shows fewer papers than the previous biannual terms.

Category 2 – contributions of countries to rework research

In reference to the previous studies' method of scoring, each country's contribution to the rework literature was analysed. Therefore, this paper shows the country's contribution rank quantitatively. The same formula used by previous researchers to calculate each country's score was used in which the credit of the author is split between all participants (Ke *et al.*, 2009; Hong *et al.*, 2012; Yi and Chan, 2014; Wang *et al.*, 2020; Chan *et al.*, 2020). The scores for each author, using the pre-mentioned technique within a multi-author paper matrix, is described in Table 5. T5

The papers with six authors or more have been considered the same as the five authors' scores with zero point for the sixth and above authors. The author's score is calculated in each paper, and the total score of each university is calculated by accumulating the score of the relevant authors. The total sum of regional universities' scores is considered the final score of the country that shows the contribution of that region to rework studies. The summary of all calculations on each country's score has been presented in Table 6, along with the total number of universities, researchers and published papers. The top ten countries, Australia, the UK, Nigeria, India, Hong Kong, the USA, China, Singapore, Iran and Canada, have the highest number of published papers with a range of scores from 40.04 to 5.42. T6

Table 6 also shows that the top four countries' contribution to the rework research in construction projects is higher than for the other regions. The first four countries account for

Table 5.
Multi-authored papers matrix for scoring

No. of authors	Order of specific author				
	1	2	3	4	5
1	1.00				
2	0.60	0.40			
3	0.47	0.32	0. 21		
4	0.42	0.28	0.18	0.12	
5	0.38	0.26	0.17	0.11	0.08

Country	Institute/University	Researchers involved	Total no. of papers	Scores
Australia	19	35	62	40.04
UK	17	27	33	16.34
Nigeria	7	25	15	15
India	9	20	9	9
Hong Kong	3	8	18	8.53
United States	11	19	11	8.28
China	10	20	11	7.38
Singapore	6	10	11	6.57
Iran	9	16	6	5.55
Canada	5	14	8	5.42
South Africa	5	7	6	5.4
Saudi Arabia	2	1	4	5.4
Malaysia	2	6	4	3.01
Korea	7	11	4	3
Uganda	1	5	4	2.99
Spain	1	6	4	2.7
Indonesia	4	6	3	2.47
Brazil	2	7	2	2
Sweden	3	4	5	1.68
Germany	2	3	2	1
New Zealand	1	3	1	1
Egypt	1	2	1	1
Poland	1	3	1	1
Portugal	1	3	1	1
Lithuania	1	3	1	1
Sri Lanka	1	2	1	0.79
Palestine	1	2	1	0.68
Bangladesh	1	1	1	0.6
Mozambique	1	1	1	0.12

Table 6.
Research origin of rework related papers published in construction

more than 50% of the total publications within the studied period (80.38 scores out of 157). The table also shows that different nations worldwide have participated in rework research – "29 countries". Table 6 also presents the number of selected papers according to the 29 countries of origin. Publications from Australia are at the summit in supporting rework research, and it clearly displays a considerable number of publications compared with other countries such as UK, Nigeria and Hong Kong.

Category 3 – employed methodologies

A comprehensive review of rework published papers indicated some similarities in the implemented research methodologies. The research methodology tends to follow four steps: a comprehensive "literature review" for identifying the topic, "data collection" via recognized techniques including review papers, case studies, interviews and questionnaire, then "knowledge processing" via techniques such as statistical, scenario analysis, simulation and theoretical analysis on the collected data to provide the initial findings of the study, and lastly "validation process" to deliver the conclusions via focus group meetings, pilot studies or further interviews (Ke *et al.*, 2009). The preliminary review on the implemented methodologies in the selected papers showed that while there are some techniques, such as dataset simulation, theoretical and mathematical models have been used in only a few papers; most of the studies have collected their data through one of the

conventional methods of case study, literature review, questionnaire survey and interviews. An overview of the methodologies used for data collection among the selected documents in this paper is shown in Table 7. T7

The presented information in Table 7 illustrates that case studies were used more than other methods solely. Collecting data only through case studies has been used by 53 researchers; however, using it concurrently with other methods can be seen in some of the studies. Various case studies have been used across the publication, including Exploratory, Interpretative, Longitudinal, Single and Multiple case studies. In summary, 53 papers (33.75%) used case studies and 48 studies (30.57%) were carried out using a questionnaire survey. Based on the literature review regarding the other type of methodologies, they have been used by 20 papers (12.73%). Nineteen studies (12.10%) have been conducted through interviews using unstructured and semi-structured questions, and in the last 17 papers (10.82%), the other methods of retrieving data from the database, simulation, experiment and running theoretical and mathematical models have been used. The low number of applied miscellaneous methods will encourage researchers to use other tools rather than the conventional methods to depict the rework predictors in different situations. As rework is often explored in real projects, it can be concluded that the obtained result in a series of selected papers which mostly relies on the case study, questionnaire survey and interview are very practical, and sometimes it would be difficult for the purpose of generalization, as the majority of studies have been undertaken in various cultural settings (Palaneeswaran *et al.*, 2014; Love and Smith, 2018).

Category 4 – list of journals

This category aims to create awareness about the journals that have published the most rework articles. The list of highlighted publishers may help researchers in their future studies. Concerning the type of publications, 126 of the reviewed studies were published in journals (80%), and only 31 papers appeared in conference proceedings (20%). The search results among the journal papers reviewed indicated that the *Journal of Construction Engineering and Management* (JCEM) has published the most rework related articles compared with other journals. The *Journal of Management in Engineering* (*JME*) was ranked in the second level. In Table 8, there is a list of Journals that have published more frequent rework papers. This table shows the name of 14 journals that have published more than three papers. These 14 journals have published 66 out of 126 selected journal articles under the scope of this study. T8

To bring the main research outputs of rework to light from the well-known academic journals with a prominent position and higher impacts in the research community of construction management, the list of top journals in the construction industry from previous researchers has been used. Accordingly, the total number of 40 papers among the selected 126 journal papers in this study are listed as high impact rework papers as follows: 17 papers from the *JCEM*, five papers from the *JME*, four papers from *Construction*

Table 7. Overview of research methodologies on data collection

Research method	Paper	(%)
Case study	53	33.75
Questionnaire survey	48	30.57
Literature review	20	12.73
Interview	19	12.10
Other methods	17	10.82

Journal title	No. of papers	SJR (Q1-Q4)	H index
Journal of Construction Engineering and Management (JCEM)	17	Q1	105
Journal of Management in Engineering (JME)	5	Q1	62
International Journal of Construction Management (IJCM)	5	Q2	19
Construction Management and Economics (CME)	4	Q1	88
International Journal of Sustainable Construction Engineering and Technology (IJSCET)	4	Q4	2
Engineering, Construction and Architectural Management (ECAM)	4	Q1	54
Journal of Civil Engineering and Management	4	Q2	47
International Journal of Quality and Reliability Management (IJQRM)	4	Q2	82
Sustainability	4	Q1	85
International Journal of Project Management (IJPM)	3	Q1	134
Project Management Journal (PMJ)	3	Q1	37
Civil Engineering and Environmental Systems (CEES)	3	Q2	28
International Journal of Innovative Research in Science, Engineering and Technology	3	–	–
Journal of Engineering, Design and Technology (JEDT)	3	Q2	19
Other Journals*	60	–	–

Note: *Other journals are those published one or two articles

Table 8. Overview of the journals and the number of published rework related papers

Management and Economics, four papers from *Engineering, Construction and Architectural Management*, three papers from *International Journal of Project Management*, three papers from *Project Management Journal*, two papers from *Automation in Construction*, one paper from *Building Research and Information* and one paper from *Canadian Journal of Civil and Engineering* (Ke *et al.*, 2009; Xue *et al.*, 2010; Hong *et al.*, 2012; Yi and Chan, 2014; Bao *et al.*, 2018). Statistical analysis of the journal papers demonstrates that the rate of published rework papers in a well-known academic journal is about 32%.

Category 5 – common causes of rework in construction contracts

This category includes publications with the report on the sources of rework in construction projects. A full review of the selected documents to identify the causes of rework in the construction sector revealed that a total of 35 papers are placed under this study area. The trend of studies on identifying the sources of rework throughout the literature indicated that this area of study has been a focus of attention for several years and remained an exciting topic in current research studies. This group of papers has mainly introduced rework sources and identified a cluster of rework causes from different perspectives. The identified causes contributing to rework have been reviewed using a qualitative approach to the 35 relevant publications. Table A1 shows the list of studies that were included to identify the causes of rework in this research. The reviewed papers identified 37 causes that contribute to rework based on a qualitative interpretation. The causes of rework derived from the literature were grouped on the basis of the main process of work, human resources attribute, procurement of materials and equipment, supporting technical activities and general/external items as described in the following sections. Each group in this review consisted of the causes leading to rework in construction projects. The associated causes also provide insight into how they are related to the incidence of rework. The framework used for grouping all of the identified causes was based on the presented results, discussion and the conclusion of the selected papers. Grouping the causes is critical for developing future effective rework management and strategies. The list of rework causes within each group can be used to measure the impacts of rework in various ways.

Causes related to work process

This group of rework causes consists of six items that generally are part of the main process of work. The repeat number of evaluated causes of this group among different articles is presented in Figure 3. The number of papers in Figures 3–7 only shows the high frequency of using the same item within 35 of the selected publications from the literature and does not have any significance related to the causes. The list of rework causes under the group of process are as follows: F3-F7

- (P1) Changes, modification and revisions in design/construction changes.
- (P2) Error in design, drawings and specifications/error in construction.

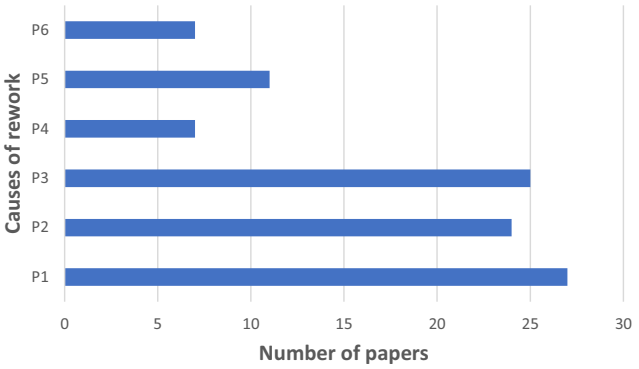

Figure 3.
Rework causes related to work process

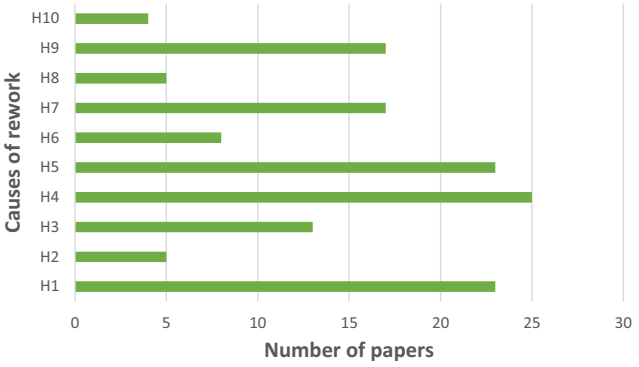

Figure 4.
Rework causes related to human factors

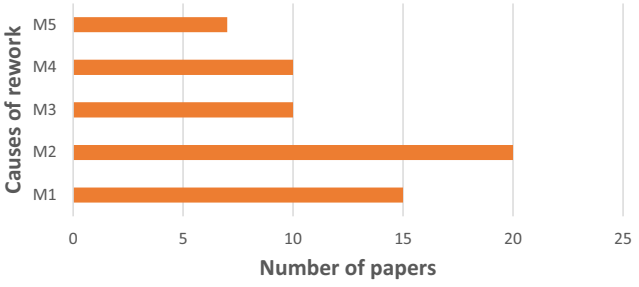

Figure 5.
Rework causes related to materials and equipment

- (P3) Incomplete design, any omission in the design or construction process.
- (P4) Inadequate procurement methods/poor contract execution.
- (P5) Improper contractor and subcontractor selection.
- (P6) Lack of document control.

Causes related human factors

This group of rework causes consists of 10 items that generally are linked to the human attributes. The repeating number of evaluated causes of this group among the different articles is presented in Figure 4. The list of rework causes under the group of human related factors are as follows:

- (H1) Lack of experience and personal expertise in design and construction.
- (H2) Inadequate supervision staff.
- (H3) Inadequate manpower to complete the task.
- (H4) Insufficient skilled level manpower.
- (H5) Poor knowledge of team member, lack of education and training.
- (H6) Lack of employee motivation and rewards, Carelessness.
- (H7) Poor workmanship approach and inappropriate personal attitude.
- (H8) The absence of job security and other safety rules.
- (H9) Labor reallocation, alteration and staff turnover.
- (H10) Conflict of interests.

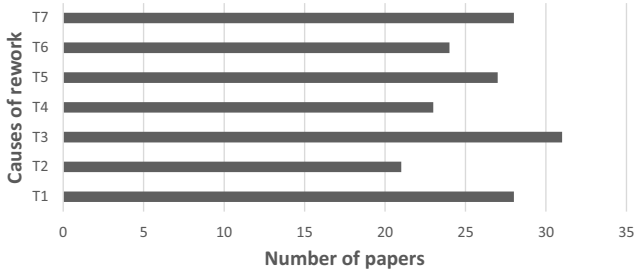

Figure 6.
Rework causes related to technical factors

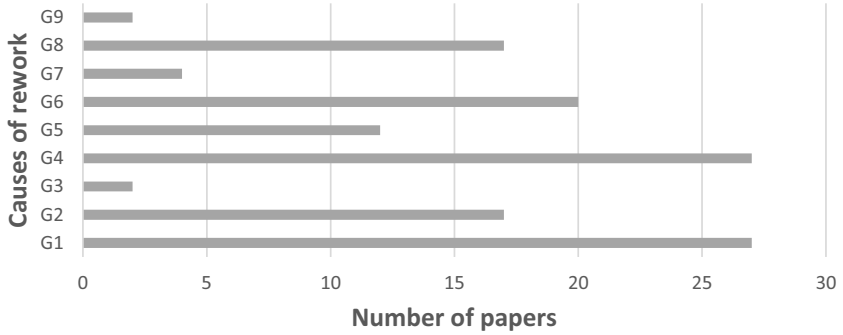

Figure 7.
Rework causes related to general/ external factors

Causes related to materials and equipment

This group of rework causes consists of five items that generally are relevant to the procurement of the project's requirements. The repeating number of evaluated causes in this group among the different articles is presented in Figure 5. The list of rework causes under the group of materials and equipment related factors are as follows:

- (M1) Defective materials, Non-adherence to material specifications.
- (M2) Poor-quality material or substandard products/Prefabrication errors.
- (M3) Replacement or misplacement of material and equipment.
- (M4) Inefficient equipment use or altered material.
- (M5) Untimely deliveries of materials and equipment.

Causes related to technical factors

This group of rework causes consists of seven items that generally are used to perform better project management. The repeating number of evaluated causes in this group among the different articles is presented in Figure 6. The list of rework causes under the group of technical are as follows:

- (T1) Ineffective use of quality management practices/deviation due to poor monitoring.
- (T2) Poor technology application and lack of information technology use.
- (T3) Poor communication system for coordinating between members.
- (T4) Inefficient management process, poor site management practice.
- (T5) Poor project documents, unclear instructions, poor contract documents.
- (T6) Conflicting and incomplete information.
- (T7) Inadequate planning and poor scheduling of workload.

Causes related to general/external factors

This group of rework causes consists of nine items that are listed in no order and generally are imposed from outside of the project. The repeating number of evaluated causes in this group among the different articles is presented in Figure 7. The list of rework causes under the group of general/external are as follows:

- (G1) Financial issues such as lack of funding, low contract or payment fee, delay in payment and cost pressure.
- (G2) Lack of client involvement.
- (G3) Unclear line of authority.
- (G4) Time pressure, schedule acceleration to finish the task, insufficient time to prepare contract documentation.
- (G5) Lack of constructability.
- (G6) Damage/defects/Deviations in the product due to poor handling and safety considerations.
- (G7) Governmental regulations/changes and policies.
- (G8) Environmental conditions, poor site condition.
- (G9) Unpredictable factors from different sources.

Survey respondent's characteristics

T9 The detail of background information about the participants has been provided in Table 9. This part describes and analyses the demographic of the respondents in the survey. While the majority of the participants comprise consultants and client organizations (57.1%), the remainder (42.9%) comprise contractors and subcontractors. Therefore, different views can be captured from different perspectives according to the respondent roles. The minimum average working experiences of the participants is more than 19 years in the construction industry and more than 8 years in contracting activities. This rate of experience justifies the theoretical and practical knowledge of the respondents (Evans *et al.*, 2020). Moreover, almost 60% have managerial positions which sounds appropriate for judgment on the questionnaire (Yap and Tan, 2021).

Rework causes in construction contracts

Cronbach's alpha test was used in this study to check the consistency of the items in the questionnaire. SPSS statistics Version 26 was implemented to analyse this set of data and the computed alpha was 0.910, which is greater than 0.7 as the criteria for reliable data. Cronbach's value toward one indicates the higher degree of internal consistency (Eze and Idiake, 2018b). The significant score of each cause in the questionnaire was evaluated using Mean and Standard Deviation extracted from the frequency report of the analysis. Accordingly, the causes of rework in generating contractual issues were ranked in

T10 descending order as shown in Table 10. In the cases where the mean score of items is the same, the cause with the smaller standard deviation is considered as more significant (Yap and Tan, 2021). The Relative Importance Index also has been calculated for each cause to ensure that the ranking of the causes is accurate. If two or more causes show the same mean score and standard deviation, the priority is given to the one with the higher RII. In the questionnaire with the Likert scale 1 to 5, the mean scores higher than 4.20 are regarded as very significant as it shows strongly agree responses from the majority of participants. Furthermore, the mean scores between 3.40 and 4.20 also are significant, as agree and lower

Parameter descriptions	Responses	Frequency (%)
Profession/job roles of participants		
Project Director/Project Manager	21	50
Commercial/Contract Manager	5	11.9
Quantity Surveyor	7	16.6
Others	9	21.5
Year of experience in construction		
Less than 10 years	6	14.3
Between 10 and 20	9	21.4
More than 20	27	64.3
Contract experience		
Less than 5 years	6	14.3
Between 5 and 10	4	9.5
More than 10	32	76.2
Type of organisation		
Subcontractor	3	7.1
Contractor	15	35.8
Consultant	21	50
Client	3	7.1

Table 9. Participants profile

Rework causes	Mean	SD	RII %	Rank
Error in design, drawings and specifications/error in construction	4.52	0.594	90.48	1
Incomplete design, any omission in the design or construction process	4.36	0.656	87.14	2
Poor project documents, unclear instructions, poor contract documents	4.24	0.617	84.87	3
Conflicting and incomplete information	4.24	0.617	84.76	4
Changes, modification and revisions in design/construction changes	4.17	0.908	83.33	5
Lack of experience and personal expertise in design and construction	4.00	0.937	79.52	6
Inadequate supervision staff	3.90	1.055	77.14	7
Time pressure, schedule acceleration to finish the task, insufficient time to prepare contract documentation	3.86	0.814	77.14	8
Inadequate planning and poor scheduling of workload	3.86	0.872	77.14	9
Lack of document control	3.81	0.994	76.19	10
Ineffective use of quality management practices/deviation due to poor monitoring	3.81	0.917	75.71	11
Inadequate procurement methods/poor contract execution	3.76	0.932	75.24	12
Inefficient management process, poor site management practice	3.76	0.932	74.76	13
Insufficient skilled level manpower	3.76	1.122	74.76	14
Inadequate manpower to complete the task	3.74	0.989	74.76	15
Improper contractor and subcontractor selection	3.71	1.066	73.81	16
Lack of constructability	3.69	0.749	73.81	17
Defective materials, Non-adherence to material specifications	3.55	0.993	70.48	18
Poor knowledge of team member, lack of education and training	3.55	1.041	70.48	19
Poor communication system for coordinating between members	3.52	0.917	70.00	20
Poor-quality material or substandard products/Prefabrication errors	3.48	0.943	69.05	21
Poor workmanship approach and inappropriate personal attitude	3.48	1.065	68.57	22

Table 10. Ranking of rework causes that affect construction contracts

than 3.4, are neutral or disagree (Beale and Smallwood, 2019). As such, four rework causes are listed as very significant and 18 items are considered as significant in the rating scale that generate contractual issues. The other causes with the mean score less than 3.4 have been excluded in Table 10, to present only the significant causes of rework as the final result of this paper.

Discussion

Rework research dominates a wide range of processes and activities among the different industries. However, the construction industry has been taken into consideration in this paper. The initial observations from the collected literature revealed that more than 80% of the publications belongs to the most recent decade. The increasing trend of publications in recent years, in overall, indicates the importance of rework to the construction industry. Rework studies also are covering different types of projects in a number of regions around the world. Rework studies have been developed mainly by only a few countries, such as Australia and the UK. These two countries alone have contributed about 40% of the research papers. The analysis of the study indicated the other main regions as Nigeria, India, Hong Kong and the United States. While rework articles have been published by over 60 publishers, the journal of Construction Engineering and Management has the most articles compared to the others. In addition, it can be stated that the research results are very practical as many of the studies have been conducted within real projects through case studies.

While Figures 3–7 show the trend of rework causes under various groups over time, Figure 8 compares the categories of rework causes based on biannual periods. This comparison illustrates that research interest in rework causes was the highest between 2015 and 2016, followed by the period between 2017 and 2018. While the causes under the group

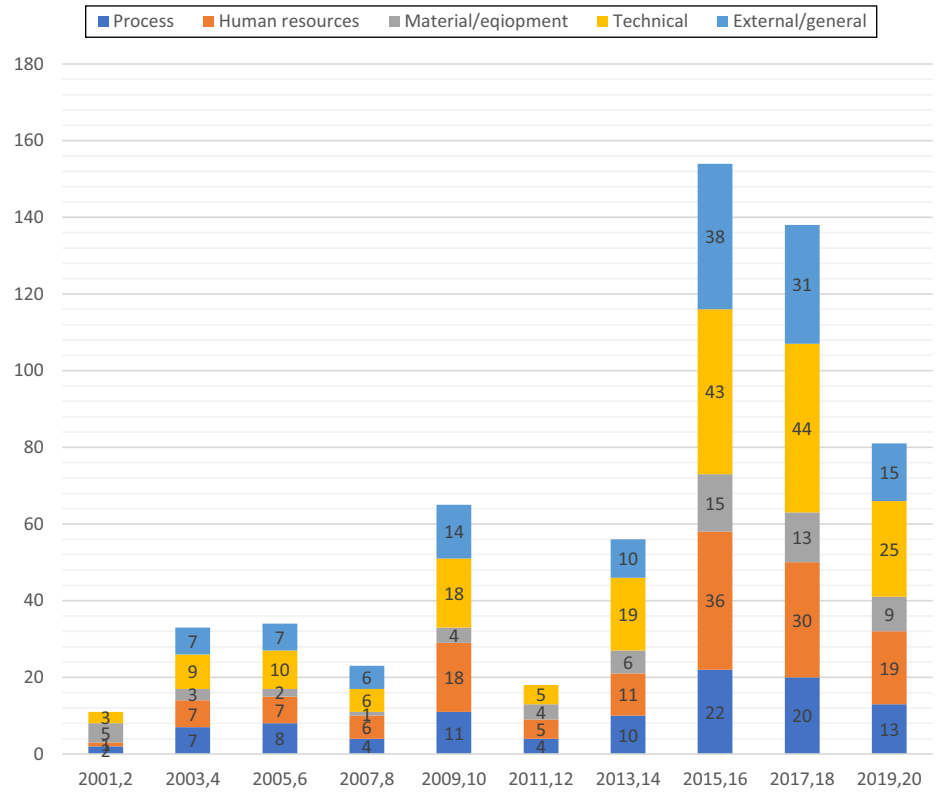

Figure 8.
Distribution of five rework groups over time

of materials and equipment seemed to be less considered compared to the other four groups, two groups of human resources and technical were highlighted more often. Exploring the logic behind the ongoing interest to study rework causes in recent years is an area that requires further investigation. In terms of the increased interest to study this area of rework, it requires attention to find out whether it is due to the applicability of rework causes or if it is a result of more research activities in that period. The most frequently reviewed causes of rework based on the literature review under each group will be discussed in the following sections.

Under the group of rework causes related to the process, it seems that changes, modifications and revisions in the project's design and construction stage have steadily been reviewed more than the other contributing causes. Various research results pointed out that design and construction changes are the most significant causes of rework (Ye *et al.*, 2015; Ajayi and Oyeyipo, 2015; Trach *et al.*, 2019). When considering how rework causes under the group of human resources have evolved over the last two decades, inefficient skilled level of manpower, lack of experience and poor knowledge are highlighted more frequently. It is not surprising as low skill level (Forcada *et al.*, 2014) and lack of experience (Ajayi, 2017) have been identified as highly ranked causes of rework in previous studies. Therefore, training is generally recommended to reduce rework through improving labour competencies (Yap *et al.*, 2017). Technology also has influenced human development in recent years. Such trends on rework causes cannot be drawn from the information provided

in Figure 4, so further research to evaluate the role of technology on the human performance that results in rework reduction is required to be performed. Figure 8 also illustrates the high interest rate of studying the causes of rework under the group of technical. There were a number of studies from the beginning that considered six causes of this group with a relatively high index of occurrence. Findings from previous studies confirm that "poor communication system for coordination between members" was ranked first under the clusters of client/owner causes of rework in Australia (Love and Smith, 2003), Ukraine, Nigeria and Palestine (Aiyetan, 2013; Mahamid, 2016; Trach *et al.*, 2019). Table A1 shows that a few studies are concerned with causes relevant to materials and equipment. Among the five causes in this group, only poor-quality material and defective materials due to substandard products or prefabrication errors seemed to be mostly assessed, and the other causes received attention infrequently. The replacement of material by the client is one of the causes of rework with the highest frequency of occurrence (Hwang *et al.*, 2014). Moreover, poor quality of material was ranked second in building projects (Ajayi, 2017), and third in the overall ranking of 43 identified causes in residential buildings (Mahamid, 2016). The other nine causes of rework under the general/external group also show various views ranging from financial issues, environmental conditions, external events and other similar terms. Time and cost pressure, such as schedule acceleration to finish the task, lack of funding and/or late payments have attracted the most attention from studies over the years. In the study conducted by Aiyetan and Das (2015), time pressure was identified as the third main parameter influencing rework and it was used for conceptual model development.

On the other hand, the results of the survey revealed the most significant causes of rework in the construction contracts in New Zealand. The first leading cause is related to error in design and error during the construction (mean 4.52). Error and its primary role in rework circumstances has been acknowledged in many rework studies, and accordingly solutions for reducing or preventing errors have been proposed. Error in design and construction also contributes to the contract change orders (Hansen *et al.*, 2020) and leads to conflicts and claims in the construction contracts (Jelodar *et al.*, 2016). Love and Smith (2018), have argued the current approaches of errors handling and advised error management to the organisations with a new vision of looking at error as a system behavior. Incomplete design and omission during the process of work is the second leading cause of rework in this study (mean 4.36). Similarly, incomplete design at the time of tender has been ranked under various situations in previous studies; as the most significant cause under design related group in the study of construction projects in Ukraine (Trach *et al.*, 2019), third in the study for the benchmarking of rework mitigation in Australia (Love and Smith, 2003), fifth in the study of building components in Nigeria (Ajayi, 2017) and 11 in the study of residential buildings in Palestine (Mahamid, 2016). The third leading causes of rework in this study is poor project documents including contracts (mean 4.24). The majority of the respondents in New Zealand agreed that poor project documentation such as deficiencies in the contract documents is a very significant cause of rework in generating contractual issues. Project documents are an important part of the construction contracts. Poor documentation in the contracts leads to individuals' interpretations that finally result in miscommunications and conflicts (Jalai and Moharreri, 2020). Lastly, conflict and incomplete information is the fourth significant cause of rework in this study (mean 4.24). Incomplete information at the design stage was ranked as the second cause of rework in the study of rework impacts on the performance of construction projects (Enshassi *et al.*, 2017). Furthermore, Conflict and inaccuracy of information ranked fifth in rework causes in the study of building construction projects in Nigeria (Aiyetan, 2013). The main reason behind such conflicts is due to the early releasing of preliminary information to speed up the

project's progress (Arundachawat *et al.*, 2009). Even though the result of this study is comparable to the most significant causes of rework in other countries, further investigation in the context of New Zealand construction projects is required to understand how rework is addressed in the conditions of the contract.

Implications of the study

In practice, this study highlights the following implications for contract parties. Insights into the rework circumstances in construction projects will allow practitioners to look for solutions to mitigate the effects of rework and provide adequate measures to manage them. The main implication of this research is to enhance the awareness of the practitioners about how rework occurs. By ranking the various causes of rework, this paper has generated a list of significant causes that can be used for addressing rework at the contractual level. The findings of this study have provided evidence on the significant causes of rework in New Zealand construction contracts. Studies to explore the clauses of the contract that need to be addressed in terms of rework will provide a framework that reduces contractual claims and disputes. Thus, it requires the contract parties to be more conscious in the contract negotiation period. Contract professionals may need to pay attention to the causes of rework while contract documents are prepared. Implementing such an approach improves the effectiveness of contracting management, affecting the quality of work and performance of the project. Nonetheless, addressing rework causes in the contract conditions will bring more clarity that may help to interpret claims originating from rework. The higher the accuracy of the contract conditions will help to avoid further contractual claims and disputes during the construction stage (Chen *et al.*, 2018). One way of exploration could be the development of a relationship between rework and contractual claims. Moreover, designers need to understand rework causes to improve their design process to prevent rework in the other stages of a project. Overall, an integrated system between the various disciplines of the client and contractor is required at the early stages of the project to manage the rework efficiently.

Conclusion

This paper's key objective was to identify the common causes of rework in a classified system used for further investigations in construction contracts. Thus, the paper has summarised the evolution of rework research trends by reviewing the literature from the published papers between 1990 and 2021. Over the past 30 years, there have been many research studies on rework issues in construction projects. Adequate sample cases using different strategies have been reported for reducing or preventing the impacts of rework globally. The literature review depicted the quantum of reported work in rework management, including opportunities for future research. In total, 157 academic papers were identified and selected for descriptive analysis to report publication numbers, research regions, journals, employed methodologies and common causes of rework. The result showed that studies addressing sources of rework are mainly focused on the causes of rework. Hence, 35 deducted papers from the literature on this study area were extensively reviewed to provide a comprehensive list of common rework causes. Accordingly, a list of 37 rework causes has been clustered into five categories of process, human resources, materials and equipment, technical and general/external.

The construction practitioner's opinions related to the effects of identified rework causes associated with the contracts were then attained through a questionnaire survey. Initially, a pilot survey was conducted to achieve the preliminary results from the New Zealand construction industry. The significant causes of rework in construction contracts were

identified through an analysis of the collected data. They were listed as the top four most significant rework causes. The final list of significant causes of rework for further investigation into the contract conditions were then completed by adding 18 more causes. The potential of generating contractual claims and disputes from rework would be better understood if the causes of rework were addressed in the contract documents. The possibility and capability of projects to overcome contractual issues under rework circumstances is an area worth addressing for further investigation. Thus, future research into the contract clauses to suggest an improved decision support system is recommended. The list of 22 common causes of rework provided in this paper will serve as a basis for improving construction contracts. Factor analysis on the list of 22 identified causes, after collecting an adequate number of responses from the survey, will reduce the number of causes to achieve more authentic results. The findings of this study could help contract professionals to obtain insights about the probability of rework before the commencement of the contract. The recognition of the causes to address rework in the contract conditions during the negotiation of the parties is a proactive approach that may help to prevent rework occurrences.

While the paper contributes to the contract management body of knowledge through identifying the significant causes of rework, it also has some limitations. Firstly, this paper is limited only to identifying the causes of rework, and the other study areas of rework such as the proposed models and solutions for rework reduction, the impacts of rework and the implanted theories and underpinned rework methods, necessitate further exploration. Therefore, identification of the knowledge gaps in the other study areas of rework will require a further review with the focus on construction contracts. Secondly, it has to be noted that five more papers on the sources of rework have been published after conducting this survey in September 2020. Even though the recently identified papers have been included in the rework research trend results, the survey result does not reflect their contributions. Lastly, even though the result of the paper is limited to the initial analysis of the pilot survey, and it cannot be used for generalization purposes; nevertheless, it supports the next stage of the research, to start the interviews and to conduct the qualitative part of the study. AQ: 5

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Table A1.
Included studies in the review and identified rework causes under each rework group

References	Country	Process						Human resources										Material & equipment					Technical						General/external factor								
		P1	P2	P3	P4	P5	P6	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	M1	M2	M3	M4	M5	T1	T2	T3	T4	T5	T6	T7	G1	G2	G3	G4	G5	G6	G7	G8	G9
Josephson *et al.* (2002)	Sweden	√	–	√	–	–	–	–	–	–	–	–	–	√	–	–	–	√	√	√	√	√	–	–	√	–	–	√	√	–	–	–	–	–	–	–	–
Love and Smith (2003)	Australia	√	√	√	–	–	–	√	√	√	√	√	–	–	–	√	–	–	√	–	–	–	√	√	√	–	√	–	√	√	√	–	√	–	√	–	–	–
Robinson *et al.* (2004)	Canada	√	√	√	–	–	√	–	–	–	√	–	–	–	–	–	–	√	–	–	–	√	√	–	–	√	–	√	√	√	–	–	√	√	–	–	–	–
Palaneeswaran *et al.* (2005)	Hong Kong	√	√	√	–	√	–	–	–	–	–	–	–	–	–	√	–	–	√	–	–	–	√	√	–	–	√	–	√	–	–	–	–	–	√	–	–	–
Palaneeswaran (2006)	Hong Kong	√	√	√	–	√	–	√	–	√	√	√	–	√	–	√	–	–	√	–	–	–	√	√	√	–	√	√	√	√	√	–	√	√	√	–	√	–
Palaneeswaran *et al.* (2008)	Hong Kong	√	√	√	–	√	–	√	–	√	√	√	–	√	–	√	–	–	√	–	–	–	√	√	√	–	√	√	√	√	√	–	√	√	√	–	√	–
Love *et al.* (2009)	Australia	√	√	√	–	–	–	√	–	√	–	√	–	–	–	√	–	–	–	–	–	–	√	√	√	–	√	–	√	√	√	–	√	–	√	–	–	–
Oyewobi and Ogunsemi (2010)	Nigeria	√	√	√	√	√	–	√	–	√	√	√	√	√	√	√	–	√	√	–	–	√	√	√	√	√	√	√	√	√	–	√	–	√	–	√	√
Love *et al.* (2010)	Australia	√	√	√	–	–	–	√	√	√	√	√	–	–	–	√	–	–	√	–	–	–	√	√	√	–	√	√	√	√	√	–	√	–	√	–	–	–
Zhang *et al.* (2012)	Canada	√	√	√	–	–	√	√	–	–	√	√	√	√	–	–	–	√	–	√	√	√	√	–	√	√	√	–	√	–	–	–	–	–	–	–	–
Aiyetan (2013)	Nigeria	√	√	√	√	√	–	√	–	–	–	–	–	–	–	–	√	√	√	–	–	–	√	√	√	√	√	√	√	√	√	–	√	–	√	–	–	–
Palaneeswaran *et al.* (2014)	Hong Kong	–	√	√	–	√	–	√	–	√	√	√	–	–	–	√	–	–	√	–	–	–	√	√	√	√	√	–	√	√	√	–	√	–	√	–	–	–
Hwang *et al.* (2014)	Singapore	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	√	–	–	–	–	–	–	–	√	–	–	–	√	–	–	–	–	–	–	–	–
Forcada *et al.* (2014)	Spain	–	–	–	–	–	√	√	√	–	√	√	–	–	–	–	–	√	–	√	–	–	√	–	√	√	–	√	√	–	–	–	√	–	–	–	–	–
Ye *et al.* (2015)	China	√	√	√	√	–	–	–	–	–	–	–	–	–	–	–	–	√	√	√	√	–	√	√	√	√	√	√	–	√	–	–	√	√	√	√	√	√
Miri and Khaksefidi (2015)	Iran	√	√	–	–	–	–	√	–	√	√	√	–	√	–	√	–	–	√	–	–	–	√	√	√	√	√	√	√	√	–	√	–	√	–	–	–	–
Ajayi and Oyeyipo (2015)	Nigeria	–	–	√	–	–	–	√	–	√	√	√	–	√	–	√	–	–	√	–	–	–	–	√	√	√	√	√	√	√	√	–	√	√	√	–	√	–
Aiyetan and Das (2015)	Nigeria	√	√	–	–	–	√	√	–	–	–	–	–	√	–	–	–	√	√	–	–	–	√	√	√	√	√	√	√	√	–	–	√	–	√	–	–	–
Mahamid (2016)	Palestine	√	√	√	–	√	–	√	√	–	√	√	√	√	–	√	–	–	√	–	√	–	√	–	√	√	√	√	√	√	√	–	√	–	√	–	√	–
Shah *et al.* (2016)	India	√	–	–	–	–	–	–	–	–	√	√	√	√	√	–	√	√	√	√	√	√	√	–	–	–	√	√	√	√	–	√	√	√	–	√	√	–
Ahmed and Naik (2016)	India	–	–	–	–	√	–	√	–	–	√	√	–	–	–	–	–	–	–	–	–	–	–	–	√	–	–	–	√	√	√	–	√	–	–	–	–	–
Oyewobi *et al.* (2016)	Nigeria	√	√	√	√	√	√	√	–	–	√	√	√	–	√	√	–	–	–	–	–	–	√	–	√	√	√	√	√	√	–	–	√	–	√	–	√	–
	Nigeria	√	√	√	√	–	√	√	–	–	√	√	–	–	–	–	–	–	–	–	–	–	√	√	√	–	√	√	√	–	–	–	√	√	–	–	–	–

(*continued*)

Table A1.

		Process						Human resources										Material & equipment					Technical							General/external factor								
References	Country	P 1	P 2	P 3	P 4	P 5	P 6	H 1	H 2	H 3	H 4	H 5	H 6	H 7	H 8	H 9	H 10	M 1	M 2	M 3	M 4	M 5	T 1	T 2	T 3	T 4	T 5	T 6	T 7	G 1	G 2	G 3	G 4	G 5	G 6	G 7	G 8	G 9
Wilson and Odesola (2017)																																						
Enshassi *et al.* (2017)	Palestine	√	√	√	√	–	–	–	–	–	√	√	√	√	√	–	√	√	–	√	√	√	√	√	√	√	√	√	√	√	–	√	√	√	–	√	√	–
Ndwandwa *et al.* (2017)	South Africa	√	√	√	–	√	–	√	–	√	√	–	–	–	–	–	–	√	√	–	√	√	√	–	√	√	√	√	√	√	√	–	√	–	–	–	–	–
Ajayi (2017)	Nigeria	–	–	√	–	–	–	√	–	√	√	√	–	√	–	√	–	√	–	–	√	–	–	–	–	√	√	√	√	√	√	√	√	–	√	√	√	–
Yap *et al.* (2017)	Malaysia	–	–	–	–	–	–	–	√	–	√	–	–	–	–	–	–	√	–	–	√	–	√	√	√	√	√	–	–	–	–	–	√	–	–	–	√	–
Eze *et al.* (2018a)	Nigeria	√	√	√	–	–	–	√	–	–	√	√	–	√	–	√	–	–	–	√	–	–	√	√	√	√	√	√	√	√	√	–	√	√	√	–	√	–
Eze *et al.* (2018b)	Nigeria	√	√	√	–	–	–	√	–	–	√	√	–	√	–	√	–	–	–	√	–	–	√	√	√	√	√	√	√	√	√	–	√	√	√	–	√	–
Trach *et al.* (2019)	Ukraine	√	√	√	–	–	–	√	–	–	√	√	–	√	–	–	–	–	–	√	–	–	–	√	√	–	√	√	√	√	√	–	√	–	–	–	–	–
Hwang *et al.* (2019)	Singapore	√	√	√	√	–	–	–	–	√	–	√	–	√	–	–	√	√	√	√	–	–	√	–	√	√	√	–	–	√	–	–	–	√	√	√	√	–
Safapour *et al.* (2019)	USA	–	–	–	–	–	√	√	–	√	√	√	√	–	√	–	–	√	√	–	–	–	√	–	√	√	–	–	–	√	–	–	–	–	–	–	√	–
Liu *et al.* (2020)	China	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	√	–	√	–	√	–	√	√	√	√	√	√	–	–	–	–	–	–	√	–
Mahamid (2020)	Saudi Arabia	√	√	√	–	√	–	–	–	–	√	–	√	√	–	√	–	–	–	–	√	–	–	–	√	√	–	–	–	–	–	–	–	–	√	–	√	–
Salihu and Babarinde (2020)	Nigeria	–	–	–	–	–	–	–	–	–	–	–	–	–	–	√	–	–	–	–	–	–	√	√	√	–	–	√	√	–	–	–	√	–	–	–	–	–