

CORPORATE CONTROL: THE ROOT CAUSES OF REWORKS IN THE CONSTRUCTION OF PROJECTS

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Abstract

How to cite this paper: Maseko, C. M. (2017). Corporate control: The root causes of reworks in the construction of projects. *Corporate Ownership & Control*, 15(1-1), 213-223. <http://doi.org/10.22495/cocv15i1c1p5>

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ISSN Online: 1810-3057

ISSN Print: 1727-9232

Received: 29.05.2017

Accepted: 21.08.2017

JEL Classification: D24, R42, H41, H43, O22

DOI: 10.22495/cocv15i1c1p5

The root causes of reworks generally continue to be overlooked, despite the fact that reworks regularly cause corporate budgets to be exceeded by more than 12.4%. Reworks is a recurring problem which companies are gradually losing control of and as a result contributes to time and cost overruns, thereby bringing adverse effects on project performance. To improve corporate performance and control it is, therefore, necessary to identify the root causes of reworks in construction projects. This article explores the root causes of reworks on construction projects with reference to South Africa. The desktop methodological approach was adopted based on scholarly articles to ascertain root causes of reworks. Following a conceptual analysis on corporates, thirty-five causes of reworks were identified and categorized into five main categories namely client-related, design-related, site management-related, subcontractor-related and transporter-related. Client-related category had the most factors causing reworks. From this category, wrong communication was the factor identified to cause most of the reworks. Finding suggests the need for further empirical study. This finding contributes to the body of knowledge by identifying the root causes of reworks. This can eventually improve corporate control and performance by providing practitioners with an in-depth understanding of reworks.

Keywords: Projects, Causes Reworks, Corporate Control, Construction

1. INTRODUCTION

Rework has become a pervasive problem that has adverse impact (Wanberg, Harper, Hallowell & Rajendran, 2013; Love, Teo, Carey, Sing & Ackermann, 2015) on the performance and the control of construction of projects. Thus, rework is closely linked to corporate performance and control. Rework increases the total cost of the contract value by between 10% and 20% (Love, Davis, Ellis & Cheung 2010; Simpeh, Ndiokubwayo, Love, & Thwala, 2015; Ahmed & Naik, 2016) with design scope changes rework accounting for as much as 79% of the rework that occurs (Han, Love, Peña-Mora, 2013). According to Mahamid (2016), to 62% of construction companies have experienced reworks in the construction of projects. Most companies struggle to control the number of reworks occurring in the construction of projects and therefore, this leads to poor performance. It also negatively affects the resources and the quality of projects and is as well a major contributor to all schedule overruns. Reworks are, therefore, a chronic problem for corporates in construction. It is one of the many problems that such companies face and must control in the industry besides corruption, time and cost overruns, poor performance (Nketekete, Emuze & Smallwood,

2014; Lind & Brunes, 2014; Vaardini, Karthiyayini & Ezhilmathi, 2016). Therefore, reworks are a persistent issue for corporates and the industry at large and have attracted extensive interest from construction companies, both public and private as well as academia over the past decades. Despite a number of studies on reworks, the problem has not yet been resolved. This has resulted in project reworks being, accepted as a global pandemic of the construction industries by Love, Edwards, Watson & Davis (2010), Battersby (2014) and Sanchez, Hampson & Vaux (2016), among others. The reason for that is the fact that most companies struggle as well as fail to control reworks in the construction of projects.

Many companies encounter reworks in the construction of projects at different project phases for different reasons. According to Hwang & Yang (2014), 80.4% of construction companies experience client related rework and this causes an increase in project costs of about 7.1% and a delay of 3.3 weeks. However, as if this is not enough, reworks have ripple effects on the overall performance of both the organisation and the project. Considering that reworks constitute 20% of contract value companies need to take full control and manage reworks accordingly. There is therefore, an urgent need for

construction companies to reconsider their performance and eliminate reworks. Since corporates, work within tighter profit margins and their need for higher productivity levels they cannot afford to ignore rework as this would endanger their effectiveness and image. However, the problem is that parties involved in delivering construction projects tend to have differing goals which ultimately affects performance (Love *et al.*, 2016).

Research efforts have attempted to identify the causes of reworks for construction companies namely, lack of management control and supervision (Wasfy, 2010), lack of design experience (Raghuram & Nagavinothini, 2016), design errors (Hwang, Shan & Tan, 2016) omissions and inadequate coordination and collaboration between stakeholders (Forcada, Gangolells, Casals & Macarulla, 2017) poor communication or wrong information (Mahamid, 2017) amongst other causes. Other studies went further and categorised these causes of reworks into related factors such as client-related; design-related; site management-related; subcontractor-related; and transporter-related (Davis, Ledbetter & Burati, 1989; Burati, Farrington & Ledbetter, 1992; Fayek, Dissanayake, & Campero, 2003; Love & Edwards, 2004a; and Josephson, Larsson & Li 2002). Despite the considerable amount of research that has been undertaken, (Jingmond & Agren, 2015; Taggart, Koskeal & O'Rourke, 2014; Kakitahi, Alinaitwe, Landin & Rodrigues, 2014) reworks remains an inherent problem for construction companies and is has become uncontrollable. Corporate control literature has failed to provide a vigorous answer on how to control reworks in construction because causes of reworks have not been appropriately identified.

Therefore, some of the reasons for reworks remain largely unknown and, therefore, difficult to control and manage effectively for most construction companies. Notably, very little has been, encapsulated on the root causes of reworks in the South African construction industry. Thus, the objective of this article is to explore the root causes of reworks in construction companies with reference to South African projects so that effective ways can be, established to deal with reworks. The remaining sections of the article have been presented in the following order: literature on reworks in the construction of projects, and this includes the impact, the causes and the classification of reworks. This is, followed by the research methodology, the results and findings, the discussions and lastly the conclusion.

2. LITERATURE REVIEW

2.1. Reworks in Construction Projects

This section of the article explores the concept of reworks in construction projects. The section defines construction, projects, and reworks. It also discusses the causes of reworks and categorises the causes of reworks into five different categories.

There are many definitions of construction, however, this article adopts Merriam-Webster (2016)'s definition, which defined construction as "*The process of constructing a building or infrastructure*". This definition was, adopted for this article because it is simple, clear and easy to

understand. A project is defined as "*A temporary endeavour undertaken to create a unique product or service (outcome or result)*" (The Project Management Institute, (PMI, 2010). A construction project incorporates numerous mini-projects, and it is not a single activity and each type of construction project requires a unique team to design, plan, construct and maintain the construction endeavour. The management and control of these construction project activities involve numerous parties, various processes, different phases, stages of work and a great deal of input from both the public and private sectors, with the major aim of bringing the project to a successful conclusion (Nyenku, 2014).

However, the level of success in carrying out construction projects will depend heavily on the quality of managerial, financial, technical and organisational performance of perspective parties (Takim & Akintoye, 2002). Therefore, the companies' failure to successfully manage and control construction projects is mainly, due to a number of related problems such as failure in performance, for example, the existence of reworks. Reworks have been associated with quality failures and non-conformance (Hegazy, Said & Kassab, 2011) amongst other failures that are identified by different corporates. In this article, the term reworks is, defined as the unnecessary effort of redoing an activity that was inaccurately done the first time.

There are multitudes of problems that can ultimately create rework for any construction project that a construction company undertakes; each individual working on the job can contribute to the increase of rework. Regardless of who made the mistakes, which resulted in reworks, a solution has to be, found to resolve this issue as smoothly and cost effectively as possible in order to stop rapidly escalating the construction company's bill. The following section discusses corporate control and reworks and some studies that were carried out in relation to reworks and the suggested solutions in dealing with reworks in construction projects.

2.2. Corporate Control and Reworks

Control is a process used by managers continuously to establish if the business is on a proper course towards the accomplishment of its goals (Du Toit, Erasmus & Styrdom, 2010). According to Hwang, Thomas, Haas & Caldas (2009) there is generally an absence of systems within projects to control rework. A growing number of reworks experienced in the construction of projects evidence this. Therefore, corporates need to be in full control of projects activities in order to ensure that projects timely completion, within agreed budgets, quality specifications as well as to evade project reworks. According to Love & Sing (2011), in order to manage and control the risk of rework, successfully, it is necessary to determine its probability of occurrence in projects. Therefore, effective control of construction projects is obligatory in order to determine, identify and control causes of reworks in projects and improve performance.

The bottom line is that the immense impact of reworks in the construction industry is forcing corporate executives for continuous improvement and accuracy in performance. However, most of these corporates focus solely on financial measures

to measure and evaluate their performance (Ali, Al-Sulaihi & Al-Gahtani, 2013). The major challenge in undertaking this lies in the fact that financial statistics is a trailing indicator since they reveal answers of managerial actions already taken. However, corporate executives need existing, recent, and frequently nonfinancial data to be able to take better decisions concerning reworks. This nonfinancial information is critical and therefore, needed to encourage performance excellence and improve in attractiveness through a framework of seven groupings which are used to evaluate corporate leadership, strategic planning, customer focus, measurement, analysis and knowledge management, workforce focus, operations focus, and results (National Institute of Standards and Technology (NIST), 2011). This nonfinancial information includes knowledge and understanding of reworks in the construction of projects in order to identify relevant control measures to deal with reworks. However, current specific mechanisms through which corporates manage and govern reworks and their effects on performance have engendered big controversial debates (Erbeta *et al.*, 2013; Wagner, Block, Miller, Schwens & Xi, 2015). This is because these mechanisms do not fully address the problem of reworks since the causes are correctly identified. Therefore, it is a wrong prescription. Thus, rework continues to impact on corporates' control of resources and for many construction companies, there seems to be no way to avoid rework. With over 30% of the work performed by construction companies being invested in rework (Oyewobi, Oke, Ganiyu, Shittu, Isa & Nwokobia, 2011) this illustrates the kind of resources companies are losing concerning this phenomenon because of the wrong mechanisms being used to manage reworks. Another example of corporate losing the battle on reworks is from a study carried out by Ali, Al-Sulaihi & Al-Gahtani (2013) on indicators for measuring the performance of building construction companies in Kingdom of Saudi Arabia. In their study, quality of service and work was ranked second on the ranking of performance indicators out of 47 performance indicators. This signifies the importance of to reduce or eliminate rework on construction projects.

2.3. Construction Projects and Reworks

The growing rates of rework adversely affect the construction of projects and corrective measures need to be, taken urgently in order for companies to be in control of this problem. This is because a number of studies have suggested that reworks are the most significant contributor to cost and schedule overruns in construction and engineering projects (Mills, Williams & Yu, 2010; Kazaz, Ulubeyli & Tuncbilekli, 2012; Mahamid, 2013; Smallwood, 2016). However, this problem can be resolved only when the root causes of reworks are well known and understood by the project's practitioners and participants in construction.

Rework continues to affect the performance of projects throughout different construction companies because the root causes of rework have been found to be considerable (Love *et al.*, 2014). This has given rise to many different suggestions on how best to deal with reworks. For example, Simpeh,

Ndihokubwayo, Love & Thwala (2015) recommended the establishment of in-depth knowledge and greater awareness on how to reduce rework occurrences before construction projects even get under way. Love & Sing (2013) suggested that in order to manage and control the risk of rework, there is a need to determine the probability of its occurrence in construction. The unfortunate part of Love & Sing's suggestion is that it is difficult to predict reworks. This is because rework is mostly discovered only after some form of quality check has been done, after which a conclusion can be drawn about what kind of rework needs to be done (Anil & Danielraj, 2016). However, rework can also be, identified immediately, as soon as a mistake has occurred. Nevertheless, the most important issue is, firstly, to establish properly the root cause of reworks. Carey (2010) stressed the need to solve the problem of rework in projects, thus solving the requirements problem (the cause) and the rework problem (the effect). If this can be achieved, it can solve many problems that arise in construction projects. Therefore, there is a need to have definite answers to the root causes of reworks in order to permanently solve this problem once.

Both developing and developed countries have reported reworks in various construction projects. Although their percentages of occurrence and impact may differ from country to country, company-to-company or project-to-project, and generally agreed that reworks lower performance. For example, among developed countries, reworks have been reported by corporates in Australia, Turkey, and Saudi Arabia, among others. In Australia, for instance, Love *et al.* (2010) found that reworks were a significant factor that contributed to cost overruns in 115 civil engineering infrastructure projects. According to these authors, reworks amounted to a total cost of 10% of the contract value; this entails large amounts of money being, wasted on reworks. In Turkey, Kazaz *et al.* (2012) applied 34 factors that affect project duration to 71 construction companies. They found that design and material changes were the major factors that caused delays and - ultimately, rework - in construction projects. In Saudi Arabia, Mahamid (2013) found reworks to be within the top ten contributors to delays in public construction projects.

Construction companies in developing countries that reported on reworks were in Uganda, Nigeria, India, Malaysia and South Africa, among others. In Uganda, Alinaitwe *et al.* (2013) carried out a case study on the Civil Aviation Authority (CAA) and found that changes to the scope of work caused the most of both cost overruns and reworks. In Nigeria, Adewuyi, Idoro & Ikpo (2014) conducted a study that investigated the level of construction material waste generated on building sites. They found that material waste was between 10.45% and 12.07%. Material waste can be, attributed to many factors, including reworks after wrong materials have been utilised (the materials will have to be removed or replaced with the correct material). This causes not only material wastage, but rework as well. In India, Shanmugapriya & Subramanian (2013) ranked reworks as the fifth cause of cost overruns in construction projects. In Malaysia, Nagapan, Rahman, Asmi, Memon & Zin (2012) carried out a study on factors causing construction waste and

found that mistakes during construction were highly correlated with rework. In South Africa, a study by Smallwood (2016) concluded that rework constituted an average of not more than 4% of project value. The studies undertaken in South Africa, although not specifically investigating the root causes of reworks, provide circumstantial evidence that reworks are problematic in the South African construction industry.

The literature shows that most studies focused on the general causes of cost and time overruns in construction projects which ultimately linked to reworks in both developed and developing countries. However, the root cause of rework has not been properly investigated, therefore, this paper aims to identify the root causes of reworks in various construction projects within construction companies operating in South Africa. According to the best of the researcher's knowledge, no comprehensive research within the South African context has been carried out to identify the root causes of reworks in various construction projects. The importance of the South African construction industry has grown significantly over the past years and this trend is, expected to continue in the years ahead. Considering that the annual turnover of the South African construction industry was R117.4 billion in 2016, the cost of reworks may be about R14.5 billion (12.4 X R117.4 billion) per annum. Therefore, this loss prompted the researcher to perform an in-depth study of reworks.

2.4. The Impact of Rework on Construction Companies

The necessity for rework can have a negative impact and consequences for all project stakeholders. It may range from reduced profit, damages reputation, increased turnover of management and workforce, lower productivity, higher costs and costs associated with litigation between participants, over responsibility for overruns (Ahmed and Naik, 2016).

Different studies have placed the costs of reworks to be between 5% and 20% of contract value (Simpeh *et al.*, 2015; Ahmed & Naik, 2016), and 25% for poorly managed projects (Barber, Graves, Hall, Sheath & Tomkins, 2000). According to Ahmed & Naik (2016), in the long term, rework can affect construction companies' reputation and their ability to attract new business. Therefore, if rework can be reduced or eliminated, many problems can be resolved, for example by saving money and preserving the reputation of the business. Since it is extremely difficult to achieve a project's objectives where reworks are involved as a result the industry has been heavily criticised for poor performance because reworks significantly undermine project success. However, for many construction firms, there is simply no way to avoid rework because it has become such a regular and common part of the construction. This is because projects are immense undertakings, with scores of workers involved, specification books as thick as bricks, and aspects of the job that can take months to complete (Duane, 2016). Regardless of this, the root causes of reworks must be unearthed.

2.5. Causes of Reworks in Construction Projects

Rework, is defined as the unnecessary effort of redoing an activity that was inaccurately done the first time. Despite the advances in management and in computing tools and techniques, the accuracy of forecasts to prevent and eliminate reworks remains problematic and reworks persist to this day. The question is: Why is rework not eliminated? Olaniran, Love, Edwards & Matthews (2015) suggested that complex interactions between project characteristics, people, technology and structure and culture contribute to the occurrence and persistence of reworks. For example, large and or complex construction projects present exceptional challenges (Ruuska, Ahola, Arto, Locatelli & Mancini, 2013) as well as features, such as, cost increases, delay in the delivery of the project, to which rework has a high contributing factor, stemming from imperfection.

Another reason could be that construction projects are unique and perceived to be inherently risky because of the participation of multiple parties with their own interests. Oyewobi, Ibrinke, Ganiyu, & Ola-Awo (2011) reported that rework occurs as a result, of many factors. For example, some of these factors include but are not limited to client not being involved, design errors and substandard services by professional (Oyewobi & Ogunsemi, 2010; Oyewobi *et al.* 2011), poor communication (Mahamid, 2017) and the use of poor quality materials (Raghuram & Nagavinothini, 2016). Several researchers, among them, Love (2002) and Josephson, Larsson & Li (2002), categorised these factors according to the causes of rework as explained in the following section.

2.5. Classification of the Causes of Reworks

The main categorisation of reworks in construction projects came from Davis, Ledbetter & Burati (1989), Burati, Farrington & Ledbetter (1992), Love, Mohamed & Wyatt (1997) Fayek, Dissanayake, & Campero (2003) Josephson *et al.* (2002) and Love & Edwards (2004a; 2004b). These categorisations exist across different construction projects and briefly, discussed in the next sections.

Davis *et al.* (1989), reported that there are five origins of rework namely owner, designer, vendor, transporter and constructor. Davis *et al.*'s. (1989) category is the only one, which involves the vendor in its grouping and it is the oldest one of the five categories. Burati, *et al.* (1992), also identified five major areas of rework namely; design, construction, fabrication, transportation, and operability. Though old, this is the only one that takes transportation as a category on its own. However, the main problem with this view is that the categorisation associated reworks with quality deviations, failures and non-conformance instead of a specific process.

Love, Mohamed & Wyatt (1997) established a rework classification system based on the study of two constructions, projects namely residential and industrial development. The causes of reworks were, sorted into three principle groups identified as people, design and construction. This classification is similar to that of Fayek *et al.* (2003) in that it gave focus to humans as in people, which the previous classification did not focus on. However, one of its weaknesses is that, it is more than a decade old and

does not include materials and transportation as the previous one.

Fayek *et al.* (2003) reported five main broad areas of reworks namely; human resources capability, leadership and communications, engineering and reviews, construction planning and scheduling and material and equipment supply and four possible causes in each of these areas and are presented in the form of fishbone (Figure 1). The other classifications also consist of between five or three main broad areas and have thirty to thirty-five different possible causes. This category covers most aspects of construction and reworks, however, it does not cover subcontractor and design on their own. Love & Edwards (2004a; 2004b) categorised the

causes of reworks into design-related, client-related, contractor-related, site management and subcontractor. This classification also covers most aspects of construction and reworks, as it is deeper.

All of these classifications systems differ in perspective but the causes and the main areas do overlap. Construction companies experience most of these causes of reworks regardless of the categorisation. However, the most important thing is the recognition of these main broad areas and their possible causes in order to manage reworks effectively and efficiently. The following sections discuss the two classifications starting with the fishbone classification system developed by Construction Owners Association of Alberta (COAA).

Figure 1. Cause and effect diagram –Model of the Root Causes of Rework (Fayek *et al.* 2003)

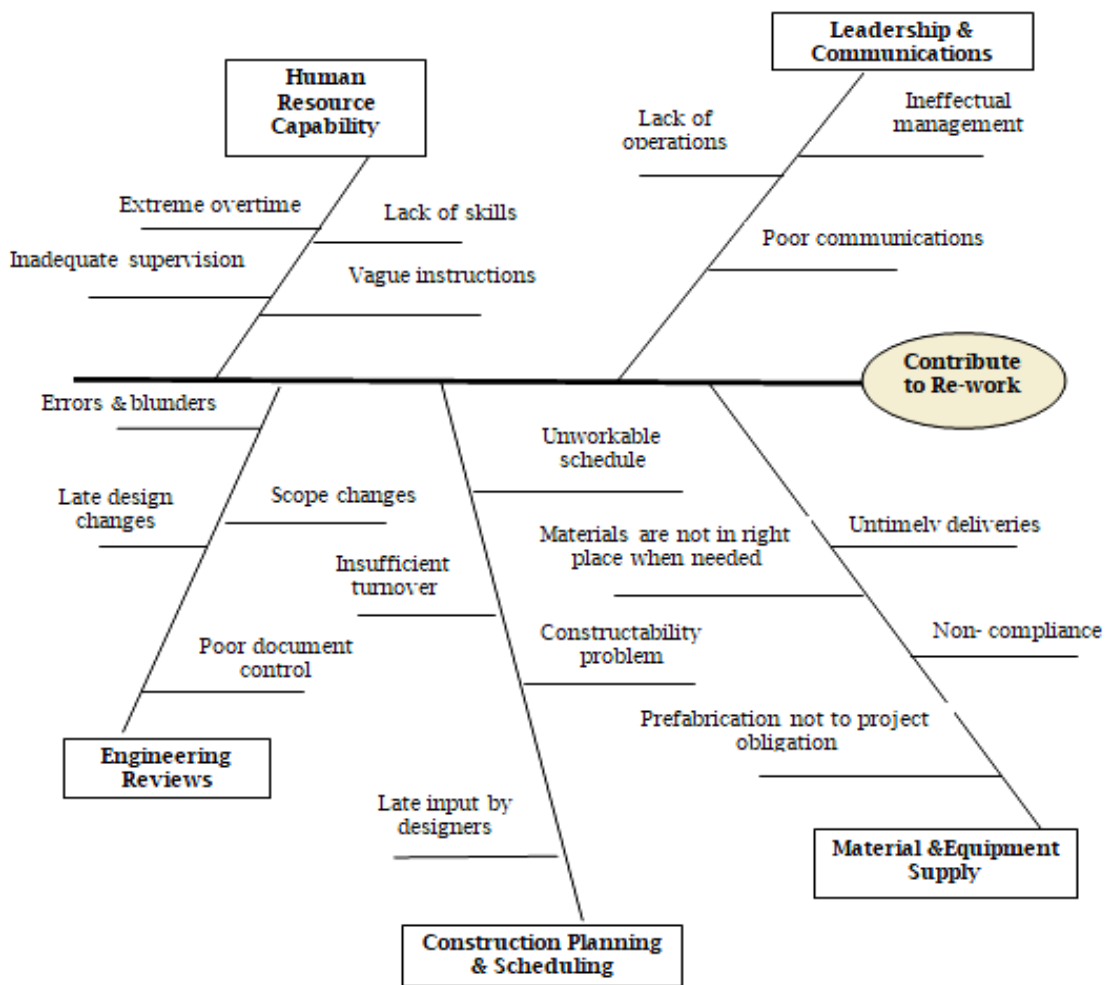
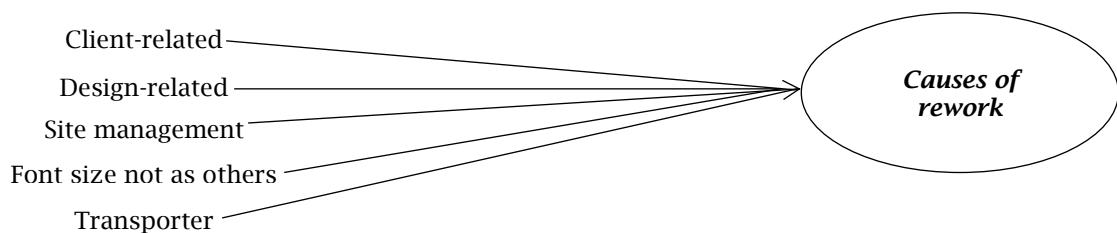


Figure 2. Causes of reworks - Love & Edwards (2004a; 2004a)



The categorisation system used in this article for classifying the cause of rework is based on a combination of the studies undertaken by Love & Edwards (2004a; 2004b) and Fayek *et al.*, (2003) and is presented in Table 2. Therefore, a combination of two different categories was, adopted in this article because the combination of these two models allows for more conclusive of many factors and for complete analysis on the root causes of reworks in construction. Table 1 below presents another form of categorisation system, which has five main broad classifications and thirty-five different possible causes. However, it must be noted that the Table is not exhaustive and most of the possible causes overlap with the cause and effect diagram in Figure 1.

3. RESEARCH METHODOLOGY

A comprehensive literature review was, conducted to identify the causes of reworks in construction projects for all types of construction companies. Google Scholar was employed to search for relevant literature, which was restricted to peer-reviewed articles. A total, of 85 published articles from 20 different journals related to reworks in the construction industry was, sorted from Google. From these 85 articles, only 20 articles reported directly on the causes of reworks. These 20 articles from the year 2010 to 2017 formed the basis of this article.

Keywords for the search included the following: construction projects, causes of reworks, root causes, construction reworks, corporate control,

construction delays, construction cost overruns, South Africa, Africa, reworks in construction, as well as combinations of some of these concepts. In addition, articles on reworks were, identified through the reference lists of the available articles and these were, used to contribute to this article. Five main groups of the related factors that causes reworks were, identified from literature and thirty-five factors grouped under the five main factors. Therefore, this article reports exclusively on the findings of the root causes of reworks in the construction industry. Following the discussion of the research method employed, the next section of the article presents a conceptual review of reworks in construction projects.

4. RESULTS AND FINDINGS

This section of the article presents the findings from the literature review, and these are, tabled in Tables 1, 2 and Figure 3 respectively. Table 1 summarises the causes of reworks in construction projects according to categories. Table 2 summarises some of the challenges and trends found in reworks. Figure 3 is a graphical presentation from a bird's eye view to demonstrate the causes of reworks form a distance. The next segment of this article presents and discusses these presentations of the findings.

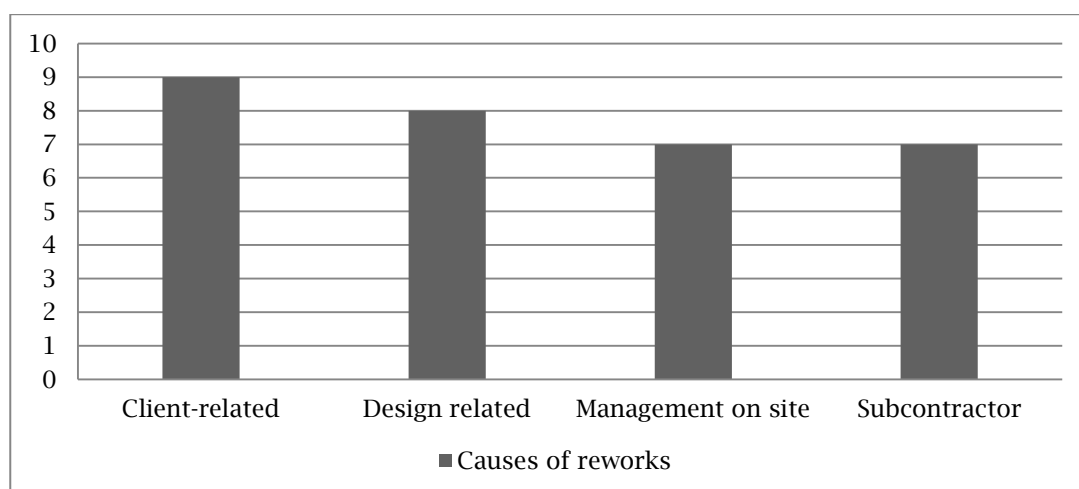
Table 1. Causes of reworks between periods of 2013 to 2016

Category of reworks	Description and Source
Client related	Inadequate briefing (Adeoye, 2014; Ahmed & Naik, 2016) Inadequacies in contract documentation (Adeoye, 2014; Ahmed & Naik, 2016) Summary of works as inadequate (Adeoye, 2014) Lack of design knowledge & experience (Alzanati, 2014 Raghuram & Nagavinothini, 2016; Ahmed & Naik, 2016) Lack of funding (Alzanati, 2014; Ahmed & Naik, 2016) Poor communication/ wrong information (Aiyetan, 2013; Alzanati, 2014; Gui, Zhigang, Bo & Skitmore, 2014; Adeoye, 2014; McDonald, 2015; Ahmed & Naik, 2016; Hwang, Shan & Tan, 2016; Raghuram & Nagavinothini, 2016) Client not involved (Oyewobi & Ogunsemi, 2010; Ahmed & Naik, 2016; Raghuram & Nagavinothini, 2016) Changes in expectations (Gui, Zhigang, Bo & Skitmore, 2014; Adeoye, 2014; Hwang, Shan & Tan, 2016)
Design related	Ineffective use of technology (Mahamid, 2017) Shortage of labour (Mastenbroek, 2010; Raghuram & Nagavinothini, 2016; Mahamid, 2017) Type of construction (Mills, Williams & Yu, 2010) Design errors/ changes incomplete (Mastenbroek, 2010; Oyewobi, Ibrionke, Ganiyu & Ola-Awo, 2011; Adeoye, 2014; McDonald, 2015; Hwang, Shan & Tan, 2016; Raghuram & Nagavinothini, 2016; Mahamid, 2017) Late design changes - Fayek <i>et al.</i> (2003) McDonald (2015) Lack of design coordination and integration (Oyewobi <i>et al.</i> , 2011) Poor document control (McDonald, 2015; Mahamid, 2017) Lack of professionalism by design professionals (Love, Davis, Ellis & Cheung, 2010)
Management on site	Conflicting information (Aiyetan, 2013) Substandard services by professionals (Oyewobi & Ogunsemi, 2010) Unrealistic schedules- Fayek <i>et al.</i> (2003) None compliance with specification- Fayek <i>et al.</i> (2003) McDonald (2015) Omissions- Fayek <i>et al.</i> (2003) Lack of management and supervision (Wasfy, 2010; Aiyetan, 2013; Alzanati, 2014; Gui, Zhigang, Bo & Skitmore, 2014) Poor coordination of resources (Wasfy, 2010; Aiyetan, 2013; Raghuram & Nagavinothini, 2016) Excessive overtime (McDonald, 2015; Raghuram & Nagavinothini, 2016) Unclear instructions to workers (McDonald, 2015; Raghuram & Nagavinothini, 2016)
Subcontractor factors	Weak labour (Mastenbroek, 2010) Carelessness (McDonald, 2015) Inadequate skills (Aiyetan, 2013) Use of poor-quality materials (Mills, Williams & Yu, 2010; Aiyetan, 2013; Alzanati, 2014; Gui, Zhigang, Bo & Skitmore, 2014; Mahamid, 2017) Materials not in right place when needed- Fayek <i>et al.</i> (2003) Constructability problems (Mastenbroek, 2010; McDonald, 2015; Raghuram & Nagavinothini, 2016) Restrictions (Alzanati, 2014)
Transporter	Lack of safety (Wasfy, 2010; McDonald, 2015; Raghuram & Nagavinothini, 2016) Machinery breakdown (Tsehayae, Tsehayae, Fayek & Fayek, 2016; Mahamid, 2017) Untimely deliveries- Fayek <i>et al.</i> (2003), McDonald (2015) McDonald (2015), Wasf (2010), Meshksar (2012)

Figure 3 depicts an overall picture of the causes of reworks in construction companies from 2003 to 2017. Client related factors contribute to the most

causes on reworks, followed by design related while management on site and subcontractor factors have an equal number of causes.

Figure 3. Causes of reworks in construction companies



As mentioned earlier, reworks in the construction of projects is a major challenge for both developing and developed countries.

Construction companies Table 2 below illustrates some of these challenges and the percentage that reworks accounts to in relation to the contract value.

Table 2. Rework challenges in construction project

Country and Source	Rework % to contract value	Challenges
Love et al. (1999)	-	Rework has become an accepted part of the construction process. The challenge here is to ensure that it does not remain this way.
Country: Australia, Love et al. (2010)	5%	Reworks contribute to schedule overruns. The challenge is attempting to predict reworks from a civil infrastructure project perspective to avoid and eliminate cost overruns.
Country: Australia, Mills et al. (2010)	12.4%	Sub-standard services rendered by professionals and lack of commitment to quality.
Country: Nigeria, Oyewobi et al. (2010)	5.06%	Reworks are in the top 5 in the list of causes of cost overruns.
Country: UK/IRISH Spillane et al. (2011)	-	Difficulties in management of materials required.
Country: Singapore, Hwang & Yang (2014)	25%	Rework is the leading factor affecting schedule performance and its occurrence is very high.
Country: Spain Forcada et al. (2014)	16.5%	Limited systematic knowledge available about the dynamics of rework in highway projects.
Country: South Africa Simpeh et al. (2015)	5.12%	Reworks make a significant contribution to a project's cost overruns, its likelihood of cost overruns is 76%.
Country: Iran Miri & Khaksefidi (2015)	30%	Reworks is in the top 5 list causes of cost overruns
Country: Sri Lanka Dahanayake et al. (2016)	3.7%	Generates controversies among parties involved.

The construction of projects all over the world involves many challenges, particularly for large public projects. This can be illustrated by, the percentage of reworks to the contract value of construction projects that have increased over the past years. For example, the reworks percentage on the contract value has moved from between 5.9% - 22% (Love *et al.*, 1999; Love, 2002; Love & Edwards, 2005, etc.) to 5% and 30% (Love *et al.*, 2010; Miri & Khaksefidi, 2015, etc.). Reworks has constantly, been identified as one of the five major causes of cost overruns by many authors (Oyewobi *et al.*, 2010; Miri & Khaksefidi, 2015, etc.) over the past years. The trend of the causes of reworks is moving from non-conformance (Abdul-Rahman, 1993; Davis *et al.*, 1989; Mills *et al.*, 2009 Mahamid, 2017, etc.) to poor

communication (Aiyetan, 2013; Raghuram & Nagavinothini, 2016, etc.) and this trend seems to be increasingly growing. Nawaz *et al.* (2013) suggested that this can only be eliminated through open and effective communications, while Doloi *et al.* (2012) recommended that the construction industry should improve practices and Love & Sing (2011) suggested a more proactive attitude from construction professionals. However, some challenges in the construction of projects may not effortlessly, be dealt with using conventional techniques and may result in lack of performance and in some situations project failure (Ruuska *et al.*, 2011). According to Asim, Zaman & Zarif (2013) resistance to change is the biggest challenge because contractors reflect a lack of interest in adapting to new technologies, as

they do not want to break away from the established norms. Construction participants need to take advantage of relevant technology in order to deal with reworks instead of resisting changes. However, some construction projects are incorporating systems of digital sensors, intelligent machines, mobile devices and new software applications – increasingly integrated with a central platform of building information modelling (BIM).

5. DISCUSSION

As found from the literature review, the construction industry suffers from reworks and companies have little control on some of the reworks that occur. Table 2 reflects information distilled from literature between the periods of 1999 and 2017. The overview of past findings as indicated in Table 1 and Table 2 shows not only similarities of results but also illustrate just how widespread reworks are. From the 20 articles that were, used to look at the causes of reworks in the construction in Table 1, only one article focused on the South African industry. From the observation of Table 2, much has not been, done in South Africa to investigate reworks because only a limited number of studies focused on the South African construction industry.

The table presents a summary of the five main categories of the causes of reworks and their respective sources as derived from the literature review. The review of literature acknowledged client related factors and management on site as the critical group factors that caused the most reworks. These categories are discussed below.

Client-related. This group of causes of reworks had a total of 8 factors from 10 different studies and from these, the most significant cause of reworks identified by 8 studies from 2013 to 2016 was poor communication or wrong information. Other causes of reworks grouped in this category are an inadequate briefing, inadequacies in contract documentation, a summary of works as inadequate, lack of design knowledge and experience, lack of funding, client not involved and changes in expectations. This finding suggests that if clients provide construction companies with correct information at the right time, place and to the right people, reworks could be avoided. Therefore, it becomes an issue that both construction companies and their clients need to manage efficiently and effectively in order to eliminate reworks.

Design-related. This collection of factors comprise of 8 factors that cause reworks. The top three factors in this group are design errors or changes incomplete, shortage of labour, lack of professionalism by design professionals and poor document control.

This finding indicates that companies should employ experienced and qualified designers to provide good quality designs. This finding implies that construction companies and project managers have control over those reworks that are design related since they have control over this particular factor.

Site management-related. The following collection of factors covers 9 factors gathered below it that cause reworks. However, from the 9 the most influential factors are lack of management and

supervision, poor coordination of resources, excessive overtime and unclear instructions to workers. Lack of management and supervision tops this list and this implies that if there is proper control and effective management companies could better control reworks.

Subcontractor-related. This group of rework factors contains 6 factors grouped under it that cause reworks. The most influential factor in this group is the use of poor-quality materials followed by constructability problems. This finding suggests that materials have an important role to play in causing reworks therefore; this is a matter that can be resolved through procurement of good quality material. However, the problem could be high prices and availability of such good quality materials. Good quality materials is a matter that is within the control of construction companies, therefore, can be planned and managed in ways that could avoid reworks.

Transporter-related. This faction of factors that cause reworks inhibits 4 factors. Transporter related factors include lack of safety, machinery breakdown, and untimely deliveries. This finding implies that preventative measures are better than cure. Most of the causes under this group can be prevented by ensuring that equipment's are in good working order before construction begins.

In summary, as illustrated in Table 1, out of the 20 studies on reworks, 10 highlighted that client related factors are the main causes of reworks in the construction industry. This was, followed by management on site related factors, design related factors, sub-contractor related factors and transporter related factors respectively.

While the least number of studies acknowledged transporter related factors as the least cause of reworks. However, poor communication was the most dominating cause from the client related factors followed by design errors/ changes incomplete from the design related group of factors. Therefore, the results indicate that client related group factors specifically communication must be taken, into serious consideration by project managers and decision makers in order to minimise reworks. Nevertheless, this does not mean that the rest of the causes must be, ignored because each has its own negative impact on the performance of the project. This is because understanding the causes of reworks can lead to behaviour adjustment that can be extremely beneficial to the project.

The findings of this article are mostly consistent with the earlier study by Josephson *et al.* (2002), McDonald (2015), Hwang, Shan & Tan (2016) and Mahamid (2017), who conclude that design error is the most critical cause of rework in construction projects. However, the findings of this article are also in conflict with the findings of Oyewobi & Ogunsemi (2010), Mills, Williams & Yu (2010) and Alzanati (2014). These issues prompted this researcher to ask the questions below.

Limitations and implications for further research. The limitations of this article are that it was, based purely on a literature review. However, it provides a starting point and a foundation for further empirical investigations and validation within the context of the South African construction industry. Although the research objectives were,

accomplished in this paper additional research direction was, identified in the process. This includes a detailed study that can be conducted in order to evaluate the effects of reworks on a specific type of construction projects, such as a highway, a dam or a building.

6. CONCLUSION

The main aim of this article was to identify the root causes of reworks in construction projects since, rework is one of the major problems that affect the control and performance of projects for corporates. However, there is limited knowledge available about the root causes of reworks in the South African construction industry. This article identified five major group related factors that cause reworks for corporates in construction projects and thirty-five possible causes. The group factor that was most influential in the causes of reworks was the client related group followed by management on site factors. Literature revealed that most companies fail to control, avoid and manage reworks and the trend is growing fast and therefore, affecting project performance.

The major issue found was that reworks continue to take between 5% and 30% of the contract value of construction projects. It was, also revealed that from the client related group of factors, poor communication was the major cause of reworks and that the impact of these reworks is enormous. It is, hoped that the identification of the root causes of reworks will improve corporate control and performance and lead to solutions in managing reworks in construction projects. The challenges that are associated with reworks were, identified as increasing competition, cost and time overruns. Literature revealed rework as uncontrollable and a major challenge for all construction corporate. There is also the challenge among construction professionals to adapt to new technologies as some still resist change.

A review of current literature further shows that fully autonomous construction equipment is not yet common on the vast majority of construction sites. This is a challenge in two ways; firstly, it is an advantage for corporates, as it will assist in reducing reworks, fewer paper documents, and reduction in unanticipated problems. However, besides such equipment is costly to acquire, it will cause job losses and will not receive full support from unions and governments. Finally, the possibility to predict the likelihood of rework would go a long way but unfortunately, it is not always predictable.

Therefore, a comprehensive understanding of the causes of reworks is mandatory in order to overcome reworks in construction projects. It was, also noted that most of the corporates do acknowledge that reworks are unpredictable, unavoidable and problematic in the construction of projects. To this effect, some construction companies have taken some measures to find out the causes as well as to solutions in managing reworks in the best way they can. However, most of the steps taken have not assisted in eradicating and controlling reworks. This is because there is no general management policy for companies to manage and control reworks. Therefore, it is important to identify suitable endorsements and

strategies to address some challenges for different construction projects and different companies. Hence, a conceptual model that manages reworks is necessary for the South African construction industry.

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