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# REVIEW OF RISK MANAGEMENT STUDIES: TOWARDS A FRAME OF REFERENCE FOR LARGE PROJECTS

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Construction is a high risk industry that operates a very complex and dynamic environment, which significantly contributes to the existence of high uncertainty and risk in construction projects. Journal articles on review of literature surrounding risk abounds in construction management studies. However, such considerations have assumed a silo approach to risk management, for instance, focus on processes, thereby neglecting the holistic perspective to risk management. The absence of this holistic perspective results in sub-optimality in knowledge within this domain. Therefore, this study aims to undergo a systematic literature review, with the purpose of bringing forth a holistic perspective of researches in this field. Findings shows that studies in this domain have largely focused on three main themes of risk management, namely: practices, maturity and processes, with particular emphasis on processes. While the overwhelming majority of these studies are replicative, they fail to advance the frontiers of risk management knowledge for large projects. Such advancement is recognised within risk systemicity. However, studies focused within risk systemicity have continued to follow the trend in generic risk management considerations i.e. the silo approach. Although, risk systemicity consideration is relatively new, the lack of research on interactions and interdependencies within and between sub-systems opens newer directions for risk management studies, particularly large projects. For instance, bringing out the components of a risk management system and studying the interactions within each component and those across them. Hence, the outcome of this paper, amongst others, contributed immensely as part of an on-going PhD research on modelling the dynamic interaction of risk in large construction projects.

Keywords: large projects, risk interdependences, risk management, risk systemicity

## INTRODUCTION

Construction is a high risk industry that operates a very complex and dynamic environment, which significantly contributes to the existence of high uncertainty and risk in construction projects (Siraj, & Fayek, 2019). Because of these

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complexities, the success of construction projects is usually highly dependent on the quality of preparation and planning prior to execution (Firmenich, 2017). However, despite the preparation and planning prior to execution, many complex projects have been adjudged unsuccessful (Williams, 2017). This largely results from poor understanding of the risk management, which is a major success factor in all types of projects especially in large projects, as it can help project managers to anticipate delays that cause projects not to be delivered on time among other benefits. Although, risks are not fully predictable but with effective risk management practice, potential damage can be mitigated.

Researches in this domain have largely attributed construction project failure to a number of problems such as: lack of systematic & formal approach to risk management, ineffective & inapplicable risk management models, lack of capacity to manage risk, among others (Nawaz, Waqar, Adnan, Shah, & Sajid, 2019; Abdulrahman, Ibrahim & Chindo, 2019; Khallaf, Naderpajouh, & Hastak, 2018; Salawu & Abdullah, 2015; Serpell, Ferrada, Rubio, & Arauzo, 2015). As a result, studies have proffered many replicative and fragmented solutions to these problems (Chileshe, & Kikwasi, 2014; Yirenkyi-fianko, et al., 2015; Gajewska & Ropel, 2011) through various forms of assessment, development of models and approaches that will enhance the effectiveness of risk management.

Literature on construction risk management is abound, therefore, it becomes very important to review and understand the development of studies in this domain, to enable the uncovering of new areas and closing of saturated ones. Attempts have been made to review risk management studies (Siraj & Fayek, 2019; Bahamid & Doh, 2017; Renault & Agumba, 2016; Tesfaye, Berhan & Kitaw, 2016), however, those attempts have yielded similar silo approach of focusing on specific aspect of risk management, rather than a holistic approach. The absence of this holistic perspective results in sub-optimality in knowledge within this domain. Therefore, this study aims to undergo a systematic literature review, with the purpose of bringing forth a holistic perspective of researches in this field.

This study is broken down into sections of which the first has just been discussed as the introduction. The rest of the paper is articulated as follows; in the second section, an overview of the research themes is provided. Also a summary of the previous literature reviews on risk management is provided. The third section is the methodology which talks about how the research was conducted. The fourth section is the reporting of result from the extensive reviews and lastly, conclusions and recommendations for future works.

## LITERATURE REVIEW

### Risk management process

Risk management is the process of conducting risk management planning, identification, analysis, response planning, response implementation and monitoring risk on a project (PMI, 2017). The whole essence of risk management is to decrease the probability and / or impact of negative risks and increase the probability and / or impact of positive risks, to increase the chances of project success. Risk Management (RM) is greatly influenced by the uniqueness of the

construction industry in a specific country; it is influenced by different project typologies as well as organisations 'risk management maturity.

Several researches have been conducted focusing on risk assessment and risk response stages of the risk management process. For instance; Ojo (2010) assessed the construction site related risk factors. His argument is that studies have concentrated on other aspects of project risks and have not looked at site risks; on the one hand this is highly questionable because, studies dealing with project risks would have included site risks as part of the overall project risks. On the other hand, he assumed that risk factors and risk are the same. According to PMI (2017) only risk can be assessed using the risk management process and not the risk factors that cause risks. Several studies are guilty of using risk factors and risks interchangeably, when in fact they are different.

Other studies (Ibronke, Famakin, Akingunola, 2011; Abd El-Karim, Naway & Abdel-Alim, 2017; Sanda, Anigbogu, Rugu & Babas, 2020) have also assessed either risk or risk factors using almost identical methods that include the use of questionnaires surveys and qualitative risk assessment techniques. According to Dziadosz & Rejment (2015) the most common risk assessment method is the product of the likelihood of occurrence and the magnitude of impact which results to risk criticality. Almost all studies on risk assessment either used this technique alone or in collaboration with other techniques. Bahamid & Doh (2018) identified brainstorming, expert judgment; cause and effect diagram; checklists; Delphi; Event Tree Analysis (ETA; Risk Breakdown Matrix (RBM); risk data quality assessment as the main qualitative risk analysis techniques while decision tree analysis; expected monetary value; Fault Tree Analysis (FTA); fuzzy logic; probability distributions; sensitivity analysis/tornado diagram as the main quantitative analysis techniques.

Generally, studies on risk management are largely replicative; in that the same or very similar tools and techniques are used for instance; questionnaire survey in collecting data, most studies used qualitative risk assessment approach, overwhelming majority of studies used risk factors and risks interchangeably and there doesn't seem to be a standard form of classifying risks. Bahamid & Doh (2018) reported in their study that various approaches have been used to classify risks in literature. Cakmak & Tezel (2019) reported the similar finding, a clear indication of the need to have a standard approach for risk classification.

## Risk management practices

Owing to the importance of risk management in project management, its efficiency is expected to significantly influence project performance but because of reasons such as; lack of systematic & formal approach to risk management, its influence has been questionable, leading to investigation on the impact of risk management on project performance. Strutt (1993) in his study found that risk management strategies lead to project success. However, reports from literature shows that construction practitioners rarely utilize the formal risk management process in their projects and that "direct judgment, personal skills and comparing analysis of similar projects with similar conditions" are the most frequently used risk analysis techniques (Yirenkyi-fianko, et al., 2015; Jin, Zhang, Liu, Feng, & Zuo, 2017). In Nigeria, studies have reported that not only is the adoption of risk management process low, they also lack the understanding of risk management process (Ojo,

2010; Augustine et al., 2013). Consequently, these practices by construction organisations have been reported to be ineffective particularly amongst the small and medium size organisations as they have been underperforming due to their inability to manage risk (Algahtany, Alhammadi, & Kashiwagi, 2016; Oduoza, Odimabo, & Tamparapoulos, 2017).

Furthermore, Oyewobi, Ibrahim & Ganiyu (2012) reported that identified risk are not rigorously examined and even when they have been assessed and remedial measures agreed upon, they are not generally communicated effectively. Thus, project participants do not have a shared understanding of the risks that threaten a project and, consequently, they are unable to implement effective early warning measures and mitigating strategies to adequately deal with problems resulting from decisions that were taken elsewhere in the chain. Hence, the industry continues to suffer poor performance with many projects failing to meet time and cost targets.

This facet of risk management studies has a direct relationship with organisations RMM level, since the maturity level of organisations is assessed based on certain parameters or attributes associated with organisations that have made some efforts towards implementing risk management. Majority of studies on risk management practices have reported the lack of implementation of the risk management process as the ultimate problem to studies in this area.

## Risk management maturity

The risk management maturity (RMM) reflects the sophistication of an organization's understanding of its risk portfolio and how to manage those risks (Zou, Chen & Chan, 2010). According to Mafakheri, Breton & Chauha (2012), if an organisation is highly matured in the management of identified risk events on projects, the consequence of the risk events on project performance objectives will be reduced. Several researchers have stressed the importance of assessing the RMM of construction organisations, as it is the commencing point in comprehending their risk management capabilities (Zou et al., 2010; Mu, et al., 2013; Salawu and Abdullah, 2015). Loosemore, Raftery, Reilly & Higgon (2006) indicated that many organizations operate at different levels of maturity for different types of risks. For example, an organization's risk management culture may be as low as level 1 but achieved level 3 in risk management processes. This means that while organizations may have developed sophisticated risk managmenet systems, they have not fully imbedded it within their organizational behaviour and practices. In addition, Hopkinson (2011) indicated that assessing RMM can help to identify the strengths and weaknesses of the organization and can also identify areas needing improvement.

Studies across different regions of the world have demonstrated different maturity levels for different project types. However, studies conducted in the developed countries have reported higher maturity levels relative to those in the developing countries (Abdulrahman et al., 2019; Salawu & Abdullah, 2015; Mu et al., 2013; Zou et al., 2010). The point here is that organisations must understand their RMM levels in other to stand the chance delivering projects successfully. Although, knowing and understanding their maturity may not be enough, as they may be lacking in one aspect or the other. Therefore, there is need for organisations to continuously

improve on the aspects that requires improvement through development of strategies that will promote progression.

### Previous state of the art reviews in construction risk management

Risk management is one of the most researched areas in the construction industry, however, only few studies have attempted to review existing literature to show development trends (Siraj & Fayek, 2019). Studies by Taroun (2013) reviewed articles on risk modelling and assessment over a twenty-nine (29) years (1983-2012). Studies (Bahamid & Doh, 2017; Renault & Agumba, 2016) have reviewed and brought forth the frequently used risk management techniques in construction industry. Islam, Nepal, Skitmore & Attarzadeh (2017) reviewed research trends and application areas of fuzzy and hybrid methods to the risk assessment of construction projects. Content analysis of eighty-two (82) research articles published between 2005-2017 was used in the study. Yu, Chan, Chen & Darko (2018) conducted a systematic review of the critical risk factors of transnational public-private partnership projects. In their study, a total of thirty-seven (37) articles published between 1991-2015 were used to study the trends as well as identifying the critical risk factors of transnational public private partnership (TPPP) projects. Similarly, Tesfaye, Kitaw & Berhan (2016) undertook systematic review and meta-analysis on risk assessment of construction project literature over the past twenty (20) years. They reported statistical analysis and fuzzy expert system as the dominant risk assessment tools used. Several attempts have been made to capture the development of studies in risk management, the most recent being that of Siraj & Fayek (2019) where risk identification tools and techniques, risk classification methods and the most common risks in construction projects were reported. In their study, a systematic review and content analysis of one hundred and thirty (130) research articles was selected over the previous thirty (30) years. Their findings revealed that majority of the articles identified risks mainly for infrastructure projects and either categorised the risks based on their nature or simply listed them out. Although, the above reported studies have reviewed almost all aspects of risk management, they have all being in silo approach, rather than a holistic approach which provides better insight to the risk management as a system. Looking at the risk management as a system, it is made up of three essential components of causation, risks and consequences. This can be Fitted into the input, process and output structure of a system. In this case, the causation (risk factors or sources of risk) is the input, the risks (risk management process) being the process and lastly, the consequences (effects) being the output. Of course equally important are the existing reviews which have adopted the silo approach and can be viewed as sub-systems or components within the larger system (risk management system). However, it is also very important to have a holistic view of the entire system.

## RESEARCH METHODOLOGY

A three (3) stage process adopted by Siraj & Fayek (2019) was modified into a two (2) stage process for this study. The modifications were on the initial stage of the process which involves journal selection. Figure 1 below shows details of the review process.

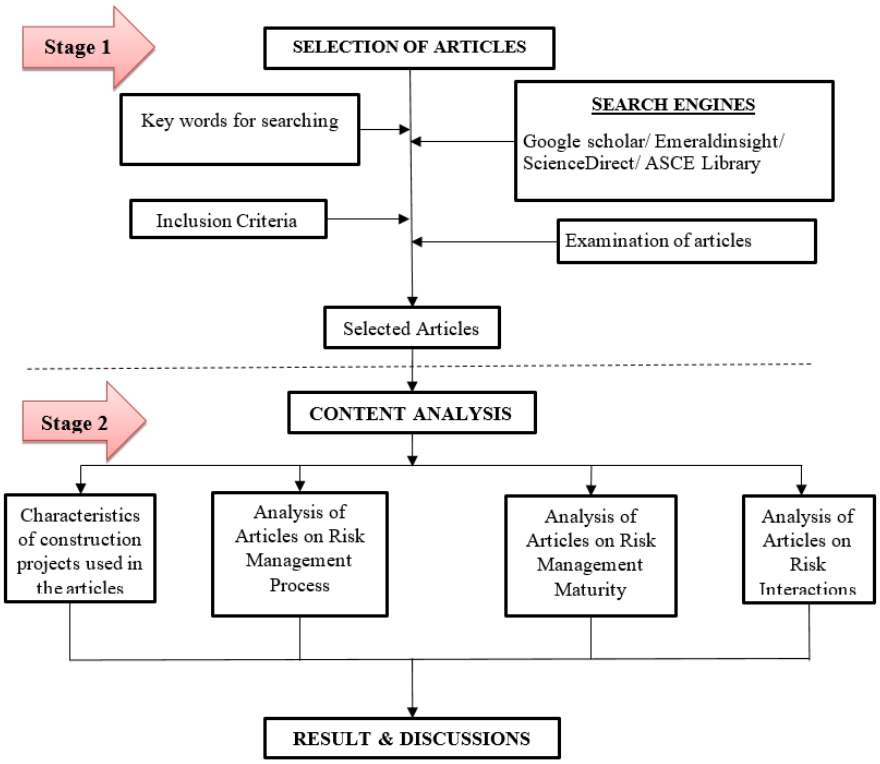



Figure 1: Research Methodology for Articles selection

## Article selection

At the first stage, articles were first identified using the keywords to search from these online databases; Science Direct, Emeraldinsight, Google Scholar and ASCE library. The keywords were selected from review articles (Nabawy & Khodeir, 2020; Siraj & Fayek, 2019; Tesfaye, Berhan & Kitaw, 2016) on risk related topics, based on the common keywords used by researchers. For the purpose of this study the search words include; "Construction risk management", "risk identification and assessment", "Risk modelling in construction", "risk interactions in construction projects" etc. A number of different variations of the search words were used to collate articles within this domain over a ten (10) year period (2010-2020). Consequently, a total of 135 articles were found and more importantly, reduced to 94 articles as a result of systematic refinement to collate articles that are more relevant to the study. Furthermore, these articles were then reviewed to capture details of existing information regarding risk management as well as project information used in the selected articles. The following were the inclusion criteria in the selection of articles:

1. Only accessible articles within the following databases; Science Direct, Emeraldinsight, Google Scholar and ASCE library were used
2. Articles selected must focus on risk management in construction industry
3. Articles must have been published between the year 2010 and 2020
4. Articles must be within risk management process, risk management practices, risk management maturity and/or risk interactions

### Content analysis

Content analysis can be used to determine the categories of a group of data, by counting the number of times an activity occurs (Fellow & Liu, 2015). It has also been defined as a powerful technique for gathering information and evaluating the trends and patterns in a document or documents (Siraj & Fayek, 2019). The first step in undertaking a content analysis is to identify the materials to be analysed, then determine the form of content analysis to be used. The type of content analysis could be qualitative, quantitative or structural depending on the nature of the research issues to be addressed.

However, for qualitative content analysis, the focus is on determining the meaning of data, while for quantitative content analysis the focus is on producing numerical data ratings, frequencies, rankings and so on and lastly, structural content analysis is focused on examining the relationships between groups of data.

This research will use qualitative content analysis in understanding the nature of researches in the field of construction risk management. Hence, the last stage of this methodology requires detailed content analysis to synthesize information regarding characteristics of the projects and the geographical regions used in the articles, analysis of articles that focused on risk management process, risk management maturity and risk interactions.

## RESULTS AND DISCUSSIONS

### Profile of the projects in the selected articles

The construction projects considered in the articles used for this review were profiled on the basis of their geographical region and project types. The selected articles encompassed the entire risk management process; risk management practices, risk management maturity, risk management process, and risk interactions in various project types. The projects were widely grouped into three (3) categories based on the nature of construction works and they are listed as follows; building construction works (residential, office, commercial, etc.), Infrastructural works (Highway, Tunnel, Railway and pile works) and large projects (mega projects and complex projects).

Having reviewed 94 risk management articles over a ten (10) year period, result shows that the most common project type used in literature is building construction works with 66%, Infrastructural works 15% and large projects 19% as shown in Table 1 below.

Building construction works has the highest percentage (65.96%) in terms of the number of published articles in that category, probably because it has a wider range of projects subsumed in that category and also the fact that there is more number of projects under construction in this category particularly in the African region. Another reason could be the willingness of key stakeholders to participate in researches focusing on this type of projects. Infrastructural works and large projects have 14.89% and 19.15% in terms of the number of published articles in these categories respectively. Although, infrastructural development plays a vital role in the economic and social development of both developed and developing countries (Siraj & Fayek, 2019), reasons such as; lack of participation of key

stakeholders in researches focusing on infrastructural projects could deter researchers from conducting studies in this facet. Also, these projects are complex and as a result the uncertainties are likely to be more interdependent, interconnected, subject to change or there will be socio-political risks whose effects are unknown (Williams, 2017).

**Table 1: Categories of projects in published articles**

| FEATURE | CATEGORY | NUMBER OF ARTICLES | PERCENTAGE OF ARTICLES |
|---|---|---|---|
| Project Type | Building Construction Projects | 62 | 65.96 |
| | Infrastructural Projects | 14 | 14.89 |
| | Large Projects | 18 | 19.15 |
| | TOTAL | 94 | 100.00 |
| Geographical Region of Projects | Africa | 26 | 27.66 |
| | America | 6 | 6.38 |
| | Asia | 33 | 35.11 |
| | Europe | 29 | 30.85 |
| | TOTAL | 94 | 100.00 |

Furthermore, risk management is a wide area of research with varieties of research categories, this study has therefore, categorised studies in this domain based on the nature of researches published. The categories are as follows; review papers, risk management practices, risk management maturity, risk management process and risk interactions. It was observed that review articles focused on individual component within the risk management process, for instance; review article (Siraj and Fayek 2019) on risk identification tools and techniques, others are on risk assessment and response techniques (Islam, Nepal, Skitmore & Attarzadeh, 2017; Renault & Agumba, 2016). Table 2 shows categories and number of articles within risk management studies over the period considered.

**Table 2: Categories of published articles on risk management**

| FEATURE | CATEGORY | NUMBER OF ARTICLES | PERCENTAGE OF ARTICLES |
|---|---|---|---|
| RISK MANAGEMENT | Review Papers | 11 | 11.70 |
| | Risk management practices | 5 | 5.32 |
| | Risk management maturity | 8 | 8.51 |
| | Risk management process | 46 | 48.94 |
| | Risk interactions | 24 | 25.53 |
| | TOTAL | 94 | 100.00 |

Result shows that 11.7% of the total articles reviewed are on review papers, 5.32%, 8.51%, 48.94% and 25.53% are on risk management practices, risk management maturity, risk management process and risk interactions respectively.

11.70% for the review papers denotes the efforts that has been made by researchers (Siraj and Fayek 2019; Islam, et al., 2017; Renault & Agumba, 2016; Taroun, 2013) towards reviewing studies to report what has been done and also to capture future directions. Articles on review of literature surrounding risk abounds in construction management studies. However, such considerations have assumed a silo approach to risk management, for instance, focus on processes, thereby neglecting the holistic perspective to risk management.

Similarly, articles focusing on risk management practices and maturity have 5.32% and 8.51% respectively of the total number of articles reviewed. This could be an indication that these areas are saturated, due to the relatively low amount of publications in the area and also being that the most recent publication on risk management practices was in 2017 and that of risk management maturity (RMM) was in 2019. Cakmak & Tezel (2019) also opined that risk management literature may have reached saturation. However, there are renewed efforts on RMM towards developing strategies on how to move from a lower maturity level to a higher level. This is very important because, reports show that organisations in developed countries apply systematic risk management and have superior maturity levels relative to organisations in the developing countries. Furthermore, the risk management practices of organizations in developing countries have been found generally to be inadequate due to it not being structured.

Most importantly, majority of the articles reviewed focused on risk management process largely because it encompasses more subdivisions (risk identification, assessment, response, monitoring and controlling). Although, even within the risk management process, studies have paid more attention to the risk assessment stage. Perhaps researchers believe it is the most important stage within the entire process. This is highly questionable, in fact the plan risk management and risk identification that have seemingly been relegated are the two (2) most important stages of risk management, because they are inputs in all other stages of the process. This means other stages cannot be carried out without these two stages. It is important to note that the overwhelming majority of articles in this facet are replicative and therefore, will not advance the frontiers of knowledge in this domain.

Lastly, articles on risk interactions could form part of the risk assessment within the risk management process category, but it was extracted to enable a more indebt review and discussion. For this category, there were 24 articles amounting to 25.53% of the total articles reviewed for this research. About 70.83% of the articles in this category were published between 2017 and 2021, except for review papers with 81.82%, other categories were 16.67%, 25% and 52.17%. This is a clear indication that researchers are beginning to focus more on this area. This could be the resulting effect of previous approaches 'inability to capture complex, multiple feedback and highly dynamic interactions among several risks (Korytarova & Hromadka, 2021; Guan, et al., 2020; Boateng, 2017).

## CONCLUSIONS AND RECOMMENDATIONS

Journal articles on review of literature surrounding risk abounds in construction management studies. However, such considerations have assumed a silo approach to risk management, for instance, focus on processes, thereby neglecting the holistic perspective to risk management. This research has therefore, brought forth a holistic perspective to risk management through a systematic review of articles in this domain over the last decade (2010-2020).

The study found that there are very few articles focusing on risk management practice, probably because the area is saturated or because the problems of risk management has more to do with the development of systematic methodologies rather than the practices.

Similarly, very few studies have focused on RMM over the last ten (10) years, although, renewed efforts on RMM are geared towards developing strategies on how to move from a lower maturity level to a higher level.

Findings shows that risk management studies have largely focused on risk management process (risk identification, assessment, response, monitoring and controlling) with particular emphasis on risk assessment, other categories such as risks management practices, maturity and interactions have been paid little attention. This finding is in tandem with that of Cakmak & Tezel (2020) whose research was on the present knowledge and future directions of researches in risk management. Also it was observed that, there is no clear distinction between risk factors and risks in literature, as several studies (Abdulrahman, et al., 2019; Maina, & Mbabazize, 2016; Boateng & Chen, 2012) have used both terminologies interchangeably, which in fact are different. Studies by Siraj & Fayek (2019) also reported similar findings on risk management literature lacking a standardized risk classification approach. Consequently, studies in this facet are overwhelmingly replicative and so have failed to advance the frontiers of risk management knowledge.

Lastly, studies on risk interactions have also begun the trend of replicating studies by focusing solely on risk interactions at the assessment and response stages of the risk management process. The point made does not invalidate existing studies; it only means that there is need to look at other components within the risk management system.

This research will benefit researchers in showing research trends in this domain as well as future directions in each category within risk management studies, as highlighted below:

With regards to articles on review and risk management practices, there are no clear future directions, as they seemed saturated.

For articles on RMM, future research should focus on developing strategies on how to move and sustain a higher maturity level across different categories of organisations

Future research on risk management process should focus on;

- Establishing a clear difference between risk factors and risks
- Determining a standard methodology for risk classification.
- Using artificial intelligence techniques in risk management

Finally, studies should research into risk interactions by focusing on other stages such as; the interactions between the causes of risks and risks and the interactions within the entire risk management system. That is the interactions between risk factors, risks, risk assessment, risk response, risk monitoring and controlling should be researched.

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# APPENDIX A

**Table 1: List of articles reviewed**

| S/N | Year | Authors | Article Classification | Project Type |
|---|---|---|---|---|
| 1 | 2011 | Taroun, et al. | Review paper | Building Construction Projects |
| 2 | 2013 | Taroun | Review paper | Infrastructure Projects |
| 3 | 2016 | Tesfaye, et al. | Review paper | Building Construction Projects |
| 4 | 2017 | Islam, et al. | Review paper | Building Construction Projects |
| 5 | 2017 | Bahamid & Doh | Review paper | Building Construction Projects |
| 6 | 2017 | Yu, et al. | Review paper | Infrastructure Projects |
| 7 | 2019 | Siraj & Fayek | Review paper | Building Construction Projects |
| 8 | 2019 | Afzal, et al. | Review paper | Building Construction Projects |
| 9 | 2019 | Muthuveeran, et al. | Review paper | Infrastructure Projects |
| 10 | 2020 | Tetteh, et al. | Review paper | Building Construction Projects |
| 11 | 2020 | Nabawy & Khodeir | Review paper | Large Projects |
| 12 | 2013 | Yirenkyi-Fianko & Chileshe | Risk Management Practices | Building Construction Projects |
| 13 | 2014 | Chileshe & Kikwasi | Risk Management Practices | Building Construction Projects |
| 14 | 2015 | Serpell, et al. | Risk Management Practices | Building Construction Projects |
| 15 | 2016 | Renault, et al. | Risk Management Practices | Building Construction Projects |
| 16 | 2017 | jin, et al. | Risk Management Practices | Building Construction Projects |
| 17 | 2010 | Zuo, et al. | Risk Management Maturity | Building Construction Projects |
| 18 | 2012 | Mafakheri, et al. | Risk Management Maturity | Building Construction Projects |
| 19 | 2013 | Mu, et al. | Risk Management Maturity | Infrastructure Project |
| 20 | 2013 | Coetzee & lubbe | Risk Management Maturity | Building Construction Projects |
| 21 | 2014 | Motaleb & Kishk | Risk Management Maturity | Building Construction Projects |
| 22 | 2015 | Salawu & Abdullah | Risk Management Maturity | Infrastructure Project |
| 23 | 2017 | Wibowo & Taufik | Risk Management Maturity | Building Construction Projects |
| 24 | 2019 | Abdulrahman, et al | Risk Management Maturity | Building Construction Projects |
| 25 | 2010 | Kutsch & Hall | Risk Management Process | Building Construction Projects |
| 26 | 2010 | Kululanga & Kuotcha | Risk Management Process | Building Construction Projects |
| 27 | 2010 | Ojo | Risk Management Process | Building Construction Projects |
| 28 | 2011 | Rezakhani | Risk Management Process | Building Construction Projects |
| 29 | 2011 | Ibironke, et al. | Risk Management Process | Building Construction Projects |
| 30 | 2012 | Oyewobi, et al. | Risk Management Process | Building Construction Projects |
| 31 | 2013 | Junior & Carvalho | Risk Management Process | Building Construction Projects |
| 32 | 2014 | Rostami, et al. | Risk Management Process | Building Construction Projects |
| 33 | 2014 | Serpella, et al. | Risk Management Process | Building Construction Projects |
| 34 | 2014 | Qing, et al. | Risk Management Process | Infrastructure Project |
| 35 | 2014 | Irimia-Dieguez, et al. | Risk Management Process | Large Projects |
| 36 | 2015 | Toth & Sebestyen | Risk Management Process | Building Construction Projects |
| 37 | 2015 | Baghdadi & Kishk | Risk Management Process | Aviation Project |
| 38 | 2015 | Boateng, et al. | Risk Management Process | Large Projects |
| 39 | 2015 | Dziadosz & Rejment | Risk Management Process | Building Construction Projects |
| 40 | 2016 | Grabovy & Orlov | Risk Management Process | Large Projects |
| 41 | 2016 | Rostami & Oduoza | Risk Management Process | Building Construction Projects |
| 42 | 2016 | Park, et al. | Risk Management Process | Large Projects |
| 43 | 2016 | Maina & Mbabazize | Risk Management Process | Building Construction Projects |
| 44 | 2016 | Sy, et al. | Risk Management Process | Infrastructure Project |
| 45 | 2016 | Algathany, et al. | Risk Management Process | Building Construction Projects |

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| 46 | 2017 | Szymanski | Risk Management Process | Building Construction Projects |
| 47 | 2017 | Timofeeva, et al. | Risk Management Process | Large Projects |
| 48 | 2017 | Khallaf, et al. | Risk Management Process | Large Projects |
| 49 | 2017 | Maseko | Risk Management Process | Building Construction Projects |
| 50 | 2017 | Oduoza, et al. | Risk Management Process | Building Construction Projects |
| 51 | 2017 | Firmenich | Risk Management Process | Building Construction Projects |
| 52 | 2017 | Abd El-Karim, et al. | Risk Management Process | Building Construction Projects |
| 53 | 2018 | Honsy, et al. | Risk Management Process | Infrastructure Project |
| 54 | 2018 | Odimabo & Oduoza | Risk Management Process | Building Construction Projects |
| 55 | 2018 | Basaif, et al. | Risk Management Process | Building Construction Projects |
| 56 | 2018 | Gupta & Thakkar | Risk Management Process | Building Construction Projects |
| 57 | 2018 | Deng | Risk Management Process | Infrastructure Project |
| 58 | 2018 | Adeleke, et al. | Risk Management Process | Building Construction Projects |
| 59 | 2018 | Keshk, et al. | Risk Management Process | Building Construction Projects |
| 60 | 2019 | Khattak, et al. | Risk Management Process | Building Construction Projects |
| 61 | 2019 | Nawaz, et al. | Risk Management Process | Building Construction Projects |
| 62 | 2019 | Issa, et al. | Risk Management Process | Building Construction Projects |
| 63 | 2019 | Cakmak & Tezel | Risk Management Process | Building Construction Projects |
| 64 | 2020 | Yaseen, et al. | Risk Management Process | Building Construction Projects |
| 65 | 2020 | Chou & Lin. | Risk Management Process | Infrastructure Project |
| 66 | 2020 | Pereira, et al. | Risk Management Process | Building Construction Projects |
| 67 | 2020 | Wang, et al. | Risk Management Process | Infrastructure Project |
| 68 | 2020 | Osman, et al. | Risk Management Process | Building Construction Projects |
| 69 | 2020 | Ferede, et al. | Risk Management Process | Building Construction Projects |
| 70 | 2020 | Sanda, et al. | Risk Management Process | Building Construction Projects |
| 71 | 2010 | Armstrong & McCulloh | Risk Interactions | Building Construction Projects |
| 72 | 2012 | Fang, et al. | Risk Interactions | Large Proects |
| 73 | 2012 | Boateng, et al. | Risk Interactions | Large Projects |
| 74 | 2014 | Wan & Liu | Risk Interactions | Building Construction Projects |
| 75 | 2015 | Marle | Risk Interactions | Building Construction Projects |
| 76 | 2015 | Mhatre, et al. | Risk Interactions | Building Construction Projects |
| 77 | 2015 | Boateng, et al. | Risk Interactions | Large Projects |
| 78 | 2016 | Siraj, Fayek | Risk Interactions | Building Construction Projects |
| 79 | 2016 | Wang & Yuan | Risk Interactions | Infrastructure Project |
| 80 | 2016 | Zhang & Zhang | Risk Interactions | Building Construction Projects |
| 81 | 2017 | Williams | Risk Interactions | Large Projects |
| 82 | 2017 | Dandaje, et al. | Risk Interactions | Building Construction Projects |

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|---|---|---|---|---|
| 83 | 2017 | Boateng, et al. | Risk Interactions | Building Construction Projects |
| 84 | 2017 | Xu, et al. | Risk Interactions | Building Construction Projects |
| 85 | 2017 | Ongkowijoyo & Doloi | Risk Interactions | Infrastructure Project |
| 86 | 2018 | Kimiagari & Keivanpour | Risk Interactions | Building Construction Projects |
| 87 | 2018 | Chatterjee | Risk Interactions | Building Construction Projects |
| 88 | 2019 | Xie, et al. | Risk Interactions | Large Projects |
| 89 | 2020 | Qazi, et al. | Risk Interactions | Building Construction Projects |
| 90 | 2020 | Taofeek, et al. | Risk Interactions | Building Construction Projects |
| 91 | 2020 | Su, et al. | Risk Interactions | Large Proects |
| 92 | 2020 | Guan, et al. | Risk Interactions | Building Construction Projects |
| 93 | 2020 | Erol, et al. | Risk Interactions | Large Projects |
| 94 | 2021 | Korytarova & Hromadka | Risk Interactions | Infrastructure Project |