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عنوان البحث

The Impact of Risk Management in Accelerated Construction Projects on Safety, Quality, and Occupational Health: An Applied Study in the Construction Sector of the Kingdom of Saudi Arabia

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1. Introduction

The **construction industry** which we are witnessing now is not started in modern era, it dates back to the **prehistoric period**, with early humans building **stone shelters and mud huts** around **10,000 BCE**. The **ancient Egyptians (2600 BCE)** advanced large-scale construction and the **Great Pyramids** is an example of it, while the **Romans (500 BCE – 476 CE)** introduced advanced engineering, including **concrete, aqueducts, and road networks**.

The only things which changed from the past to present is the technology and competition, which created the urge of survival of the fittest in the market, in which the contractor need to complete the project quickly as possible to stand out from the other competitors to better their chances to secure new projects.

Construction is a risky profession to work in because of the numerous workplace accidents that often occur. The construction industry is among the largest industries in the Kingdom of Saudi Arabia (KSA). On top of facing significant workplace accidents, the characteristics of the construction industry make it the highest contributor to occupational injury and fatality rates. The importance of the construction industry is evident, as it provides the infrastructure essential for other industries to grow. To ease this negative impact and improve the safety, quality, and health of construction workers, industries need to embrace innovative systems and tools like safety risk assessments and safety, quality, occupational health (SQH)-risk management tools or methodology. Hence, the main goal of this research is to explore the impact of risk management on accelerated construction projects with respect to safety, quality and occupational health.

Work in the construction sector is meant to improve the safety of occupational conditions and to reduce the injury accidents that occur among construction workers with a particular emphasis on the relevance of opportunities for intervention. Despite the continuing decline in SRM adoption, countries such as the USA and Australia have adopted building code requirements as part of their building approval application procedures for certain large-sized buildings. The construction industry in KSA is huge and its contribution exceeding 9 percent to Saudi GDP. Furthermore, the construction sector plays an important role in the ongoing development of the infrastructure in several sectors of the Kingdom of Saudi Arabia (Suresh et al., 2016). Of particular importance is the occupational health and safety performance indicators in the Saudi construction sector. The required indicators are a statistically measurable quantity that demonstrates to

what extent good safety or health outcomes are achieved as a result of intervention, controls, or self-regulated approaches in various workplace environments (Suresh et al., 2017).

The main reasons for selecting this topic :

- Increasing requirement for managing risk in accelerated construction.
- Improving safety standards and reducing accidents
- Protecting occupational health and worker welfare

Historical Context for selecting this topic:

Historically, the construction projects focused mainly on cost cutting and time efficiency often by compromising the worker health and safety. The concept of managing risk in the construction industry has been significantly evolved over the past. The development of safety standards, such as OSHA (Occupational Safety and Health Administration) in the United States and similar regulatory bodies worldwide, underscored the need for systematic risk management. Due to which the organizations are forced to manage risk in this accelerated construction industry.

Focusing the study in relevance with the society:

This study focuses on enhancing workplace safety thereby reducing accidents which help for better and happy society.

It also helps in improving Construction Quality which helps in improving quality of life by making them safe and secure.

It focuses on promoting Occupational Health and Well-Being of people from society.

1.1. Background and Context

Your organization is only as safe and healthy as the people who work in it. In general terms, occupational safety and health are usually considered as an afterthought; generally, it turns into action only after getting the problem. In many workplaces, occupational health and safety's affairs can play an essential role in preventing labor accidents and various diseases. Due to the complex nature of the construction process, risk can be easily propagated between all the different stages. Inversely proportional in the interest of time and cost, the research field of the risk management problem of construction projects is one of the top tasks in the construction industry. Rapid urbanization and population growth in many countries require simultaneous investment in construction activities for

infrastructure development. In this case, the risk management concept is repeatedly developed for monitoring and analyzing the pure risk in construction projects.

Despite some recent improvements, the construction industry continues to have one of the highest levels of accidents and fatalities associated with construction work worldwide. Over the past few years, construction companies have taken some steps to improve their health, safety, and environmental practices by establishing safety management divisions staffed with qualified personnel, adopting various safety incentives, reportedly spending billions on enhancing safety, and enforcing stricter penalties on those found violating safety rules at work. Previous research has shown that construction health and safety practices are not as developed as they could be. Consequences to this lack of attention include large numbers of accidents and fatalities, ranging from industrial accidents to ergonomics related disorders, and stress among the construction labor force. However, construction workers have been found looking at safety in general favorably, which is typical when workers come out relatively unscathed from serious accidents and fatalities. Furthermore, even when facing this dire situation of unfavorable safety conditions, construction workers have at least managed to have high satisfaction with the safety education and training provided by their companies; showing some cognizance as to this avenue of safety from companies. Non-compliance with the health and safety laws by many employers poses difficult challenges in improving health and safety practices in this industry.

1.2. Research Problem and Justification

Backed by its young and growing population, Saudi Arabia is becoming increasingly urbanized and is developing its transportation infrastructure in response. During this expansion, however, the kingdom's construction sector has more frequently turned to accelerated project delivery. These projects yield savings in payroll and material costs that justify the relatively high risks they entail. Some of these risks are natural to construction work; factors such as weather, for example, are beyond a contractor's control. Others, however, are preventable. Recent years have witnessed an increase in occupational injuries and illnesses coupled with heightened labor activism in Saudi Arabia. The Kingdom's Ministry of Labor and Social Development reported 185,214 worksites accidents resulting in 1,113 fatalities in 2016 alone. Eyeing Vision 2030 and its economic diversification goals, the kingdom is disproportionately investing in construction and infrastructure undertakings (Suresh et al., 2017). For accelerated projects, this intensifies the commensurate health and safety risks. In light of this context, there exists goodwill amongst construction stakeholders to bolster the safety of workers and operatives while maintaining construction quality and timeliness.

In Saudi Arabia, the construction industry is among the most unsafe. Workers are continuously exposed to severe hazardous conditions, which can have a serious impact on their health. Due to the urgency of accelerating project delivery, constructors have passed over H&S guidelines in order to meet deadlines, which has a negative effect on construction safety. Therefore, to promote safety standards and mitigate the impact of accelerated project delivery on safety, an integrated risk management (IRM) model specified for construction projects in Saudi Arabia is proposed. The IRM model combines quantitative hazard analysis with fuzzy logic and has been held to take an enterprise-specific approach to construction risk management. Using this approach, unknown risks (or hazards) to a given construction project can be preempted; it also allows for risk allocation to various stakeholders, and provides an actionable plan wherein risks are prioritized. Ultimately, the IRM model aims to bolster the safety of construction operatives and quality of construction under accelerated project conditions. In doing so, it addresses a known research gap, as well as provides added value to the construction business at large.

1.3 Importance of study

The importance of the construction industry cannot be overstressed for the large economies in general and the Kingdom of Saudi Arabia in particular. A significant portion of contractual value is worked out based on risks involved. However, the construction projects in Saudi Arabia face more time and cost overruns than comparable projects in developed countries. By employing a timeout option on contracts and studying the firms' choices in that matter, firms are hypothesized to minimize the time and budget overruns that would occur. It is shown that these contractual clauses lead to an equilibrium point where contracts of average length are preferred by the firms, as they are proved cost minimizing. Moreover, it is seen that contractors with higher efficiency use shorter contracts, while higher complexity in contracts leads to contracts of average length (Moosa, 2018). This predicts good and bad equilibrium ranges based on the characteristics of the industry. The proposed model is tested by implementation of the idea on contracting data for projects funded by the European Union in the Balkans with great success. As far as the regulators are concerned the paper's findings suggest that they should be cautious with the use of short term contracts, as these are mostly employed by the efficient firms, and are proved to be increasing costs in the long run.

The construction projects in the Kingdom of Saudi Arabia last for more than 12 months, with more than 5% of the projects being unfinished. The main aim is to investigate the building and civil projects of the Saudi contractor firms. A combination of techniques with on-site safety team visit is used, with a highly structured checklist approved by experts (Suresh et al., 2017). Bracing, wall, and horizontal working area are identified as

the building factors affecting safety the most. Strategy planning and the quality of the construction activity are identified as the civil factors most affecting safety. The results indicate a strong relationship between safety factors and levels of safety; hence, when a building or a civil factor is rated as hazardous, the need for more safety measures increases. The information derived from this study can be used to assess the impact of safety factors on the safety level of each construction project in the early stages of the project design.

1.3. Research Aim and Objectives

The construction sector is considered one of the most important sectors in the economy, as it directly affects the safety and comfort of workers in their work, as well as construction quality. Unfortunately, the opposite picture is often true, as it is one of the most dangerous sectors in the Kingdom of Saudi Arabia, due to the nature of the tasks performed in the sector and due to the intense working conditions and the multiple rushes to complete projects, in addition to the lack of an effective system of follow-up and control for project management.

Based on the above, the research identified critical risks related to the sectorials of (Construction and earthwork), and then developed a set of safety, quality, and occupational health criteria as contributing to risk management, in addition to this, the research required evaluating the implementation level Obligations, as well as these 3 criteria, were evaluated on 10 projects in each of the three cities (Abha and Khamis Mushait and Jazan), to evaluate the effect of the level of implementing the standards on the risks related to the projects of construction work, earthwork, in addition testing the effect of these levels of implementation on the critical risks, and then conducting questionnaire survey on the workers in these projects to identify the most critical risk from the worker point of view, in the context of the data used by the research evaluated the satisfaction level of workers regarding the implementation of these standards on the project for the contractor and the project executive.

Who might be benefitted from this study:

The study has a significant potential benefit for workers' health and wellbeing in the construction sector of the Kingdom of Saudi Arabia (KSA). It received scant attention in the past compared to the EU countries, where mature scheme have been carried out to analyze and mitigate health risks due to occupational exposure. This possible benefit is based on the followings: Identification of main chemical classes, chemical families, and risk phrases assigned by the safety data sheets (SDS); Quantitative estimation of exposure to chemicals in terms of percent of daily exposure limit and urinal biomarkers; The

generated knowledge base will be useful with quantitative summarized exposure profile; Merits of the considered approach in terms of efficiency, effectiveness, and fast feedback of the result to the key stakeholder; (Moosa, 2018) The impacts of the proposed measures will provide means to assist in prioritizing risk management strategies for improved worker health and safety.

1.5 Study questions

The research approach in this study comes in the context of ‘risk management’ and inquires about its impact, yet in a broader understanding. Therefore, the direct influence of more broadened risk management practices on the ‘occupational health and safety, quality of construction products and deadlines’ are inquired about. A reference group of around 300 construction firms in the Kingdom was selected. The study posed different questions. Some of these questions concerned the investors’ level of awareness and application of a rather comprehensive array of risk management strategies during the past 5 to 6 years. Other questions probed the consequences. Different possible effects of risk management practices introduced during the electoral period of analysis were discussed with the selected investors in terms of their potential to influence the firms’ occupational health and safety records, the quality of the construction products, and deadlines. The survey took place with the managers of the about 300 construction firms. A number of about 56 construction investors could be closed. This elongation makes it possible to come up with some important ‘lessons’. But first, the results.

The results in this section back the common wisdom that the construction industry is one of the most hazardous sectors in Saudi Arabia. The industry continued to employ a large number of workers whose records in occupational health and safety are still unsatisfactory. The recent statistics of the Ministry of Labour and Social Development and some exceptional reports have all shown the persistence of a high level of accidents and fatalities in construction. It is even argued the official figures of such incidents might still remain below the actual number (Suresh et al., 2017). It stems from the very specific construction sector structure in the Kingdom, which features the dominance of subcontractors and usually very short-term project contracts. The findings show that the ‘incidence rate’ of fatal industrial accidents in the Saudi construction sector was considerably higher compared to the other economic sectors between 1999 and 2008.

1.6. Research Methodology

There are many methods used in accelerated construction projects in order to decrease construction period, such as design management, work sequence management, supplier management, resource management, quality management, risk management, time

management, safe working environment management, change and variation management. Different companies have started to increase the number of accelerated construction projects that they entered. The accelerated construction projects which are controlled are likely to order for their activity and facility with fast planning and safe working, and to make possible the completion of the project in a short period of time.

According to an approach, it was aimed to carry out a risk assessment study, which reflected the working conditions of a fast ground rail system construction project, in terms of the safety of the work execution, safety of the facilities, safety of the use, safety of the surroundings and health of the personnel. In current study, the purpose was to identify the occupation accidents and dangerous situations that occur in accelerated construction projects in terms of the safety, quality and occupational health affects, to evaluate with response of workers and employer on these affects, to determine the risk levels of occupational accidents and dangerous situations, and to put forward risks of occupational accidents and dangerous situations at work with the risk assessment tools that would be properly selectable for accelerated construction projects focusing on the fast ground rail construction project.

When the effects of worker's and employer's responses on safety, quality and occupational health are examined, there is a difference between averages in terms of the safety and quality and the results are found to be statistically significant. Essentially, construction is a human resource-based industry, and as such, its contribution to the national economy of any nation is very large. But at the same time, it has been recognized as one of the most hazardous industries. Risk assessment in the construction industry has increased significantly worldwide. This is because of the nature of construction, which is a complex and often unpredictable type of work. Many factors are involved in these risks, such as materials used, working at heights, excavation work, etc. Correct risk management is therefore necessary, and by correctly identifying hazards, the right controls can be put in place to save many lives and financial losses each year.

2. Literature Review

It is widely recognized that health and safety accidents frequently occur in the construction domain worldwide. It has been reported that the construction industry accounts for a considerable portion of all fatal occupational health and safety (OHS) accidents (up to 40%) and that workers in this domain are at the greatest risk of suffering fatal OHS accidents in comparison to the general working population. In 2013 the private construction sector witnessed a total of 796 deaths, the highest number of fatalities reported among all industries monitored. Similarly, Saudi Arabia exhibits higher fatality rates in the construction domain (more than 30%). Therefore, the construction domain in

Saudi Arabia confronts considerable challenges in terms of health and safety management. Risk factors in the construction working environment can be attributed to manual labor, squatting, kneeling, jumping, working at heights, routine lifting of heavy items, and the use of vibrating machinery and hazardous materials (Suresh et al., 2016). Consequently, construction work involves considerable risks to workers in terms of execution of tasks, mechanical and warehouse handling, and work in poorly compliant atmospheres. This work, therefore, underscores the necessity for improved management of the construction domain within the umbrella of this study.

Historically, findings have indicated that the construction sector tended to have a negative reputation for abuse to its workers and adverse working conditions, often dubbed as the “sick man of the industry” (Suresh et al., 2017). Death and injuries are rife on construction sites due to the use of hazardous materials, heavy tools, equipment, machinery, and blockages of scaffolding on building sites. These have had a negative impact over workplaces’ productivity where financial institutions and companies have been slow to lend money to the industry.

2.1. Conceptual Framework of Risk Management in Construction Projects

Risk management (RM) is vital in accelerated construction projects as it guarantees the safety, quality, and occupational health of all related parties. RM figures out all potential risks which may endanger the objectives and prevents harm as much as possible. Afterward, it identifies strategies to manage and control the risks that cannot surveil enough and sets an action plan to follow. RM outlines all potential risks which affect accelerated construction work. Through the RM plan, controlling time and cost would be considerably prepared and emergency safety precautions would be granted through increased monitoring and checking of safety and health issues for all related works. Concerted with the safety and health requirements, the 4th goal of safety, RM supplies a clearer understanding among project tasks, making it more operative to monitor risks and developing plans of contingencies before development. Most importantly, urgency is given to the objectives of project time, cost and productivity and the function of safety, quality, and health issues, and then strategies are developed to ensure the objectives are attained while tending all relevant precautions (Moosa, 2018). The RM plan deals with controlling risks stemming from the increased speed of the construction task in the elevated railway project. The list of risks is in-depth to ensure that all risks are considered and analyzed; however, the time realization does not suffice all risks, and practical risks are concerned. It is recommended that each work orders risk inspections more often and emergency safety measures are equipped for all constructed works. The top 5 risks with

the highest net exposure value are explained further in terms of their emergency safety precautions and actions to be taken.

2.2 Theoretical premises of study

Theory and Research interdependency:

As the theory and research in this field of risk management and construction safety are deeply interconnected.

For many years, risk assessment has been considered to be crucial in tackling project risks. Clearly, risk analysis and evaluation of situation that resulted in accidents in construction sites would contribute in enhancing safety, and due attention may be given to accidents on construction sites in order that preventive measures and resources required can be exerted as needed. This would help assess the cost impact and evaluate the project completion schedule, create awareness of the risks entailed in construction site works causing accidents and threatening life safety, and the preliminary establishment of the risk assessment of work on construction sites can be an effective way to reduce the chance of accidents. Not considering project risks could result in fewer efforts and resources being devoted for mitigation and management of the risks related to the project. Further, major accidents would result in negative impacts on project performance leading to time delays, additional costs, and legal disputes and risks have to be taken into consideration from the early stages of construction projects. Risk assessing in construction sites appears as enterprises identify a clear need to protect the health and safety of employees in the workplace, which becomes a crucial instrument to foresee the risks involved and later establish and implement prevention measures (Moosa, 2018). Broadly speaking, the performed analysis can encompass different types of risks, specifically, among others, those related to workers activities, protection of property, accidents and/or incidents caused by third party action, accompanying bureaucratic obligations and environmental safeguards, among either things organizations are ought to comply with.

It is therefore of utmost importance for companies operating in construction sites to gain a detailed understanding not only of the existing policy framework and the requirements that are posed by such a framework, but primarily of the scope of the risks themselves,

for in-depth data of risks can significantly help in designing an effective safety management plan and in the re-assessment of actual compliance with legal provisions. The concept of risk assessment, defined as the process of evaluating the risks to health and safety in the workplace arising from these risks of general hazards, falls, falls of objects, slips, trips, fatigue, poor welfare facilities, inadequate house-keeping, heavy manual handling, excessive noise emission, lack of personal protective equipment and inappropriate fire-fighting installation, inadequate provision of safety information and training and training medical surveillance, is addressed in the relevant European Directive and its correspondent national regulation.

2.3. Accelerated Construction Projects: Definition and Characteristics

Accelerated construction projects are designed to be carried out and delivered in shorter durations than normal projects. This trend intensifies competition in the race to win new tenders, beat project deadlines, and reduce overall costs, but safety and quality are often weakened. The Kingdom of Saudi Arabia (KSA) has accelerated its construction activities in energy, infrastructure, and healthcare sectors as a driver for economic growth and national transformation. However, its construction sector has been reporting several defects in construction projects related to safety, quality, and occupational health. These defects may lead to serious consequences. Therefore, risk management is considered essential to be applied in accelerated construction projects in order to help accelerate problem detection and decision-making in dealing with risks related to safety, quality, and occupational health concerns in a timely manner.

In the construction industry, multiple engineering activities must be conducted with a series of synchronized operations and involved factors; thus, it needs a well-planned project management system to ensure timely completion and successful achievement of safety, quality, cost objectives specified in the project. This coordinated engineering activity in these complicated tasks leads to the formation of numerous risks and jeopardizes the achievement of the project objectives. The construction industry, a stimulating economy sector in most parts of the globe and KSA, is a major part of the economy that contributes to the continuity of organizations, development programs, creating new projects to meet socio-economic needs, providing employment, the spread of training, and supporting the state treasury by collecting fees and taxes from projects and companies involved in the construction field. As a result, risk management has emerged as an important concern for the construction industry. It can immediately lead them to eliminate these risks and solve the problem effectively. Therefore, it is planned to discuss Assessments related to project risk management in accelerated construction projects in the construction sector in KSA in order to improve the overall situation based on experimental results, scientific theories, field information, and practical knowledge

about risks that affect safety, quality, and occupational health in the construction sector in KSA (Moosa, 2018).

2.4. Safety in Construction Projects

In construction projects safety is one of the tools that must be available, this is because human loss is excessive compared to any other type of projects, for all nations the death of people for other reasons is better than death for accidents in buildings /projects at all, therefore protection and health for workers is the most priority in construction sites including control the environmental pollution, occupational diseases, and environmental noise that due to construction and building activities. The owners of construction projects daily seem to be that, construction accidents are a normal incident that should not attract the attention of the safety inspector or others associated with the project. Statistical data show that the losses in the construction industry amount to huge numbers of workers' injuries, disabilities, and death, thanks to construction accidents, in proportions much larger than in many other industries. The research seeks to identify the impact of Risk Management in accelerated construction projects on the variables of safety, quality, and occupational health on the construction industry in the Kingdom of Saudi Arabia, studying the numerical value of these effects and dealing from there with this. In this context, 182 accidents, 1517 injuries, and 180 deaths occurred in 2014 (Suresh et al., 2016). With a Fatality Rate of 9.72, the construction industry in the Kingdom of Saudi Arabia is classified as one of the most dangerous sectors. It is expected that the construction projects will continue to increase in the coming years due to the large number of expansion and construction projects. On the safety aspect of the projects the worker is exposed to many potential risks, due to the type of work in the construction sector, the construction site itself and the number of workers on the same construction site are large. This makes building construction projects more risky compared to other types (Suresh et al., 2017). The construction industry will always be a fundamental industry for the socio-economic development of all countries. This industry in the Kingdom of Saudi Arabia has presented abundant lessons to be applied studying the Safety aspect in construction projects. The construction industry in the Kingdom of Saudi Arabia is also considered one of the most important industry in the country for its sound role in supporting other facilities. It also played a prominent role in providing the basic needs of citizens as a place of residence and work.

2.5. Quality in Construction Projects

The construction sector is considered one of the most intricate and challenging sectors because of the simultaneous engagement of various types of stakeholders. It is worth mentioning that a robust and sound infrastructure is fundamental for national economic development. This is achieved primarily through an assortment of sizeable construction projects. The Kingdom of Saudi Arabia (KSA) has been investing huge quantities of its capital in infrastructural projects to boost the domestic economy.

While engaging in construction projects can prove to be advantageous, it poses several safety risks. Construction projects worldwide have common characteristics indicating that completing them on time and on a budget without sacrificing safety, quality, and occupational health standards is a momentous challenge. Numerous scholars therefore agree that exemplary risk management practices are essential. However, societal and behavioral factors mean that people engage less in activities deemed risky and hazardous (Alghaseb & Alshamlani, 2022). A variety of risks can affect the project, including safety, scope creep, location, finance, and occupational health, and it has therefore been of interest to researchers. Despite this, there is a reduced examination of the impact of risk management on these risks collectively in the context of accelerated construction projects.

2.6. Occupational Health in Construction Projects

A construction project is one of the most hazardous projects in the industrial sector of any country because of the high potential risks associated with such projects. The construction sector's contribution to the gross domestic product of the Kingdom of Saudi Arabia (KSA) accounts for approximately 9.6%, whereas the construction sector in Egypt contributes approximately 5.6% to gross domestic product measured at constant prices. Also, it is estimated that the construction sector in the European Union is responsible for 30% of all workplace accidents. In relation to financial losses, the amount of direct and

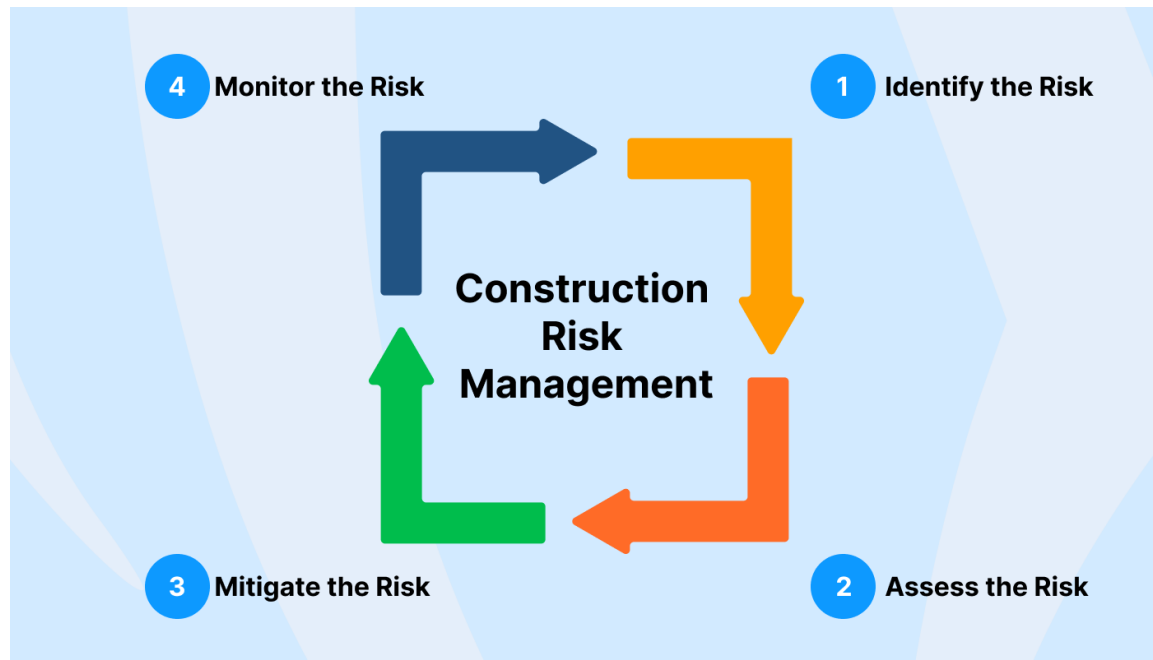
indirect losses caused by occupational injuries and accidents is substantial because of the high construction activity that is associated with mega construction projects over relatively short time periods. The rapid progress of construction activities necessitates that all concerned parties must take into account any prospective construction risks, which will decrease the exposure to the potential risks before they occur.

Occupational health in construction projects is a vital aspect in the global construction industry, about 42 million workers globally are employed in the construction sector. Additionally, the construction sector in the European Union contributes to 7% of the European Union (EU-15) workforce. The construction industry worldwide accounts for higher accident rates in comparison to other industries; it accounts for 30% of accident rates and 20% of fatal accidents out of the total registered accident cases worldwide. Based on the Eurostat report, the construction sector has been ranked as the sixth dangerous sector in the EU-15 workforces; it accounted for a range from 6-18% concerning related accidents among the different industrial sectors in the European Union (EU). A similar scenario is observed in the KSA. The construction sector accounts for 30% of the total industrial activity of KSA and for 39% of occupational injuries and illnesses. Eurostat reported that the construction sector workforce experiences a high frequency of accidents in the EU from 1991 to 2007 which is considered the highest value in comparison to other sectors, and it almost accounted for 20% of all registered accidents.

3. Risk Management in Construction Projects

The risk management is important in the construction industry which involves different steps:

- Identifying the risk
- Assessing the risk
- Mitigating the risk
- Monitoring risk



This chapter draws its discussion from the literature as the first step in investigating the extent to which risk management can improve the safety, quality, and occupational health performance of accelerated construction projects. It begins by outlining the process of risk management in construction projects, including identification, risk analysis, and evaluation. This is followed by elaborating on the effect of risk management for each of the project objectives: safety, quality, and occupational health. The final part of this chapter sets out methodological details of the risk management approach that is applied to accelerated construction projects. Due to its unique nature, gaps, ambiguities and disagreement in earlier studies on the potential risk impacts on safety (S), quality (Q), and occupational health (OH) performance of accelerated construction projects, the research case study was narrowed down to this type of construction project. The research results should be considered as an initial effort to examine the impact of risk management on safety, quality, and occupational health in accelerated construction projects. At the same time, the proposed approach can be considered as an example of how risk management principles could be implemented throughout the whole project cycle, including project delivery and procurement methods. The discussion includes applicable experience, ongoing studies, and research into risk management and performance improvement of accelerated construction projects.

One of the most important issues that a project manager must address in construction project management is the management of risk. The term "risk" describes the variation in the results from a possible decision and is often used to describe a decision that involves exposure to danger, harm, or loss (Nketekete et al., 2016). Risk management is the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, treating, and monitoring (i.e. controlling) risk (Tadayon

et al., 2012). In the context of construction projects, all parties involved are exposed to various types of risk, including risks relating to financial and construction management. Recent years have witnessed the emergence of a number of innovations and advances in contracting, design, and materials, leading to rapid growth in the construction industry. Initially, concerns were raised about slowing growth in this industry. Special measures have therefore been taken to overcome such concerns; among these measures is the accelerated construction project. Rather than taking the traditional approach of extending project schedules, the accelerated construction project requires project specification to be maintained. In addition, there is necessity for the completion of the project before a specified deadline. To accommodate such restrictive conditions, accelerated construction projects obviously need special treatment in terms of design and procedure.

3.1. Risk Identification and Assessment

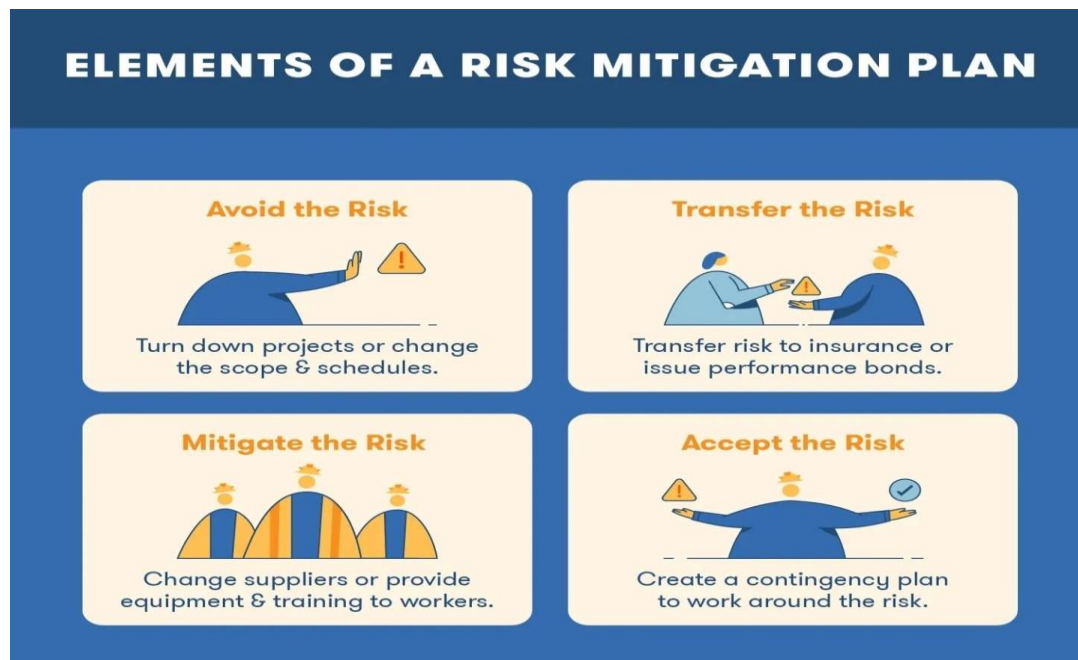
Risk identification and assessment were preformulated before and throughout the construction of 60 projects. Two experts identified multiple risks for each job operation, calculated the Risks Index Rate (RIR) of each risk, and suggested relevant precautions. The highest and lowest risks were time corresponding, as well as the time for the highest and lowest risk precautions. The construction industry is ubiquitous in modern city-scapes and is increasingly significant to modern economies. However, construction projects are recurring prone to time over-run. Today, conventional methods of execution are considered to be too lengthy, leading construction companies to explore alternative methods to accelerate their work. One of the most effective and efficient methods is the acceleration of construction projects. However, accelerated construction projects are believed to have a higher risk potential chain of the activities to be carried out in the fastest possible time, resulting both in an escalation of risk and the obligation of the supervisors and / or contractors to implement safety precautions extensively which could, in turn, have an adverse effect on quality. Ultimately, site workers are the ones who will suffer and whose health may be put at risk. (Moosa, 2018) explored three significant aspects in the construction sector; they were safety, quality, and occupational health, and their associations with a single construct of risk management in the context of accelerated construction projects.

The following shows the 4 types of risks construction business could face accelerated pace:



3.2. Risk Mitigation Strategies

Risk management planning should be proactive, rather than reactive. To achieve this, a constructed facility may be exposed to many risks, both external and internal, and from simple to highly complex situations. To mitigate those risks, a response strategy should be developed to achieve a reasonable balance between the risk level, the cost and allocate the resources optimally. A framework of the risk management planning process is developed which emphasizes the key elements of the process, including the probable countermeasures for probable risks.



The prepared risk management planning process model summary can be listed as definition:

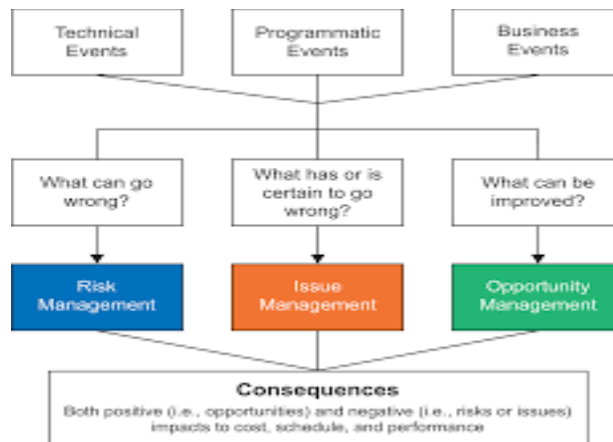
The definition step of the risk management planning process identifies the construction project and establishes the objectives and goals of the defined construction project. An understanding of the project procurement methodology is also necessary to define the identified facility. The major role players of the facility construction project must be identified, and the needs and expectations of the potential clients of the facility must also be considered. This step also determines the project scope and the execution strategy for the envisaged risk management planning process. A simple checklist can be used to verify if every issue is addressed in the definition step of the developed road map for construction project risk management planning process. Then the explained road map may be updated to optimize its utilization in the construction industry. Personal experience of constructing and managing construction related projects was utilized to ascertain the practice of risk management in construction projects (Salah, 2015).

3.3. Risk Monitoring and Control

From the risks that have been identified and assessed successfully, a road network risk register might contain a number of entries ready for monitoring and control. The entry will be dated by, or during, the act of control, and the outcome of the control action must

also be entered. In most cases, the action taken in response will involve communicating the required information on the impact of the risk to the party at risk – and generally a reply to that communication is requested and recorded (Salah, 2015). Very many risks will be specific to a specific project and would have to be identified on a for- that project basis. However, from experience in the industry, expertise in probabilistic risk assessment and analysis is known to be the best achievable. As such, probability consequences of highway network risks have been identified and assessed in terms of the belief and the infrastructure owner (DEMISSE GUTA, 2017). A road network hazard register will be established with entries for all identified hazards. For this study, however, risks only have to be addressed, and entries will identify the risks themselves (a hazard register might list the characteristics or locations of hazards that render them potentially risky), and assign responsibilities for further analysis, monitoring, and control (giving the actual responsibilities of the assesses in UMS). The area, parameters, and more significance of accelerated construction needed to be defined. This could be measured in terms of the value of output per worker, which would vary from location to location and time to time.

The following diagram illustrates what can be monitored:



4. Accelerated Construction Projects in the Kingdom of Saudi Arabia

The accelerated construction project and execution time are defined accurately. The factors affecting accelerated construction projects and their relation to the risks are evaluated, as well as the risks for accelerated construction projects in the Kingdom of Saudi Arabia. A total of 84 risks is identified in all of these factors. The risks are ranked in 15 groups as total by their RII values. Safety, quality, and occupational health risks are also evaluated by determining the scale, potential effects, and the probability. As well as,

the comparisons of all risks, determined scale – weighted average risk probability, hole in the safety – hazard dimension, hole in the quality – defecting activities, procedures and equipment, and the hole in the occupational health – the threat to health are also investigated. The case study is conducted by surveying 80 practitioners of the construction sector in the Kingdom of Saudi Arabia. The proposed frameworks provide the professionals with a methodology to manage the occupational health risks in the accelerated construction projects. The construction industry plays a critical role in the development of every country. The capital investments of the construction industry globally are approximately 20% of the renewable primary energy. However, this sector contributes 25% - 40% to the world's gaseous emissions. The Achilles heel in construction projects is thought to be the occupational health and safety risks in the construction sectors. The construction processes of the project delivery method with cost – time – quality hits should be done as planned. It's not easy in the construction industry, the construction operations require greater attention than the other industries necessary for overcoming the difficulties. Control in cost, quality, and time is essential in the construction industry (Moosa, 2018).

4.1. Overview of the Construction Sector in KSA

4.1. Overview of the Construction Sector in KSA The construction sector plays one of the key roles in the economies of the developed and developing countries. This sector is a driving force for various development plans as a constructed building gives added value to the resources of the country and its products. One of the most important sectors is the construction sector, as it is the first sectors exposed to financial risks. The nature of the construction projects is highly dispersed in nature starting from “design and preparation” followed by the “construction” operation and last stage is “operation and demolition”. This sector also contains a large number of the workforce, which is varied starting from technical labors, engineers, to the technocrat. The construction sector in the Kingdom of Saudi Arabia (KSA) has continued to undergo significant development, however the pace of construction is too fast; so that quality and safety is overlooked. The construction sector nowadays plays a vital role in the KSA economy and has significant growth. The two holy cities Makkah and Madina have had major plans by the government to increase the number of visitors for Haj, which requires the new construction of various infrastructure. The domestic production companies are insufficient to fulfill the high demand for the construction sector. Hence, preference has been given to the international firms leading to a rapid construction of the project. This trend could lead to future economic problems as higher profile projects are given to international firms resulting in the mediocre projects awarded to national firms (Suresh et al., 2016). Further, by reviewing the latest statistics released by the ministry, it is important to identify that the rate of accidents in construction sites have been increasing year by year. In addition, the

accidents could result in many God gifted precious life losses. This trend clearly indicates that for future prosperous growth, safety concerns should be the top most priority. In the construction sector, there are many opportunities that there is a high possibility of failure in case of higher risk. These risks or uncertainties associated with these projects could lead to a failure in the project completion in terms of the cost overrun, quality problem, or schedule. The projects could achieve failure in terms of any one of these constraints. Safety is the primary concern to a construction project; it ensures the project development with no injuries or accidents. The poor safety performance leads to a bad imaging of the construction sector (Suresh et al., 2017). This study focuses on the impact of the Risks in the accelerated construction projects particularly to the safety, quality, and occupational health in the KSA construction sector.

4.2. Factors Driving Accelerated Construction Projects in KSA

ACPs as a new trend in the construction industry have been a focus for many building contractors, project managers, and construction academicians and researchers. The pace of change in society, competition, and technology requires the completion of construction projects in a shorter period than previously practiced. Accelerated construction projects are being utilized in the construction industry to meet these expectations. The constructors in the Arab Gulf States, particularly in Saudi Arabia, are actively seeking applications that produce fast construction project schedules, maximize efficiency, and increase levels of performance quality. The fundamental goals of ACPs are to complete the project before the expected completion date, to reduce the direct cost, and to increase the performance in means of quality. The popularity of ACPs as an approach to completing projects on time and to accommodate the rising demand for buildings is increasing in the Kingdom of Saudi Arabia. The KSA government has initiated several substantial infrastructure projects in order to comply with the National Development Plan. Several researchers have argued that ACPs are beneficial for employers because the quality and cost of the final output are controlled. Therefore, most of the new innovative projects in the construction sector are adapting accelerated techniques, which in turn have made safety and health hazards a critical issue.

Researchers, academicians, and safety professionals have been extensively exploring accidents and the adverse impacts on the surrounding environment. For this reason, a new trend of constructing safe and healthy buildings called “Construction Safety Management” has been the norm for discussion debates in universities and construction industries. For the last several years, the construction sector has been focused on the planning and implementation stage of safety techniques to achieve accident-free project completion. This increasing concern about construction safety has encouraged

constructive dialogues and research to understand the impact of various factors of safety management on construction projects.

4.3. Challenges and Opportunities in Accelerated Construction Projects in KSA

Accelerated construction projects are characterized by tight project schedules, heavy workloads, the mobilization of many construction workers for a short period, higher levels of risks, uncertainties, and complexity. Several challenges and opportunities are encountered in carrying out accelerated construction projects in the Kingdom of Saudi Arabia (KSA). Common risks commonly occur in accelerated construction projects include scope changes, project delays, cost overruns, the reduced quality of work, non-availability of materials, inflation, and failure in the building construction; opportunities are gained cost saving in materials, labor, overheads, temporary building, and work acceleration; higher wages for labors are gained through work over hours, weekend work and work in a hazardous environment, while incentives have been given as monetary gain and bonuses amidst projects competitions (Suresh et al., 2016). Labor unions, Safety, and security organizations in the Kingdom of Saudi Arabia, need to pay more attention to the Occupational health and safety of construction workers. As a whole, it identifies that risks, safety hazards, and security risks are classified in a medium category in sectoral, national, and multinational organizations of sophisticated buildings sectors. Analysis of Variance (ANOVA) revealed that there are significant differences in the above range of organizations in working safely among the mitigating safety, health, and security risks in construction sites.

Segmentations and Focus groups were employed in a qualitative stage to gain a broader understanding of internal and external attitudes, while a PESTLE analysis, SWOT analysis, and a questionnaire based on a Likert scale were used during the quantitative stage. The results of the study: 74% of labor satisfaction working on existing economic and political conditions in the Kingdom of Saudi Arabia and 83% of the satisfaction on the availability of Safety, Health, and welfare facilities at the construction site. However, only 59% of the labor satisfaction working on available Safety, Health, and welfare facilities, also suggests that further improvement opportunities will be identified to increase the satisfaction level of construction labor in Safety, Health, and welfare facilities at the construction site in the Kingdom of Saudi Arabia (Suresh et al., 2017).

5. Safety Management in Accelerated Construction Projects

The construction sector is critical in a nation's economic growth and development. It is at the forefront of providing infrastructure such as bridges, roads, highways, buildings and more. As a comprehensive approach, this study investigates the impact of risk management on safety, quality, and occupational health in accelerated construction projects. The building industry is famously a high hazardous industry because of the high rates of accidents.

Risk management is the methodical application of operations through the organization's policies, procedures, and the practices. These may involve action plans, responsibilities, and allocating resources to minimize the prosecution of risk and controlling the effect of any accidents. Each construction process involves many risks including ground risks, economical risks, design risks, contractor risks, and more. In addition, accelerated construction is a tower rising speed in project completion times in order to gain some social, economic, or other benefits. Drowning, exposure to harmful substances, cave-ins, electrocution, narcotic, and even some psychological disorders can be resulted from construction risks. Safety management is concerned with beliefs, attitudes, norms, and practices that minimize risks that workers and the public face due to the unsafe acts and hazardous conditions in construction environments. Quality is a measure of compliance with the contract requirements and objectives, which assure the client that the finished output of the project will be reliable. On the other hand, occupational health also concerns with the beliefs, attitudes, norms, and practices that minimize risks which employees face due to unsafe acts and hazardous conditions in construction contexts. Thus, it can be concluded that safety, quality, and occupational health all are connected with risks and interact with it. Furthermore, in the present-day competitive world, healthier, safer and productive construction site are essential to enhance output and quality. Experience reveals that occupational health is an important factor that impacts on overall project performance. Even construction projects increasing work productivity will pose risks for the safe and healthy use of diverse resources, therefore, it is imperative and urgent to control risks deriving from a construction site. Contrary to the traditional approaches, a good understanding of interrelations among risks, occupational health and desired end result are needed, along with coordinated efforts for oversight and more safety-oriented construction site. However, remarkably, the research on the interrelation among those aspects in accelerated construction projects is considerably unnoticeable. Yet, is a question, does the risk management impact on safety, quality and occupational health in accelerated construction?

6. Quality Management in Accelerated Construction Projects

Due to the relatively high levels of risks, hazards, and uncertainties in construction projects, many construction projects delay or exceed their original schedule. Different

world agencies have developed programs, proposals, and recommendations to promote the safety and health of construction workers and the public affected by construction activities. One recommendation is to accelerate the execution of construction projects. Due to the relative high risks, hazards, and uncertainties in construction projects compared to projects in other industries, acceleration is likely to increase the probability of incidents of risks, hazards, and uncertainties. However, how accelerated projects increase the safety risks and hazards in a construction project is still unknown and decreases the health of construction project workers and the public close to the project. Quality circulates in the construction industry's bloodstream; it controls the industry's life. Most accidents are associated with inferior quality of works. One major problem industry faces today is inferior quality. The lower the quality of a project, the higher the risks of delays and disputes. Quality problems have significant implications on the performance of every construction venture. Each party in the construction process considers the other parties as solely responsible for quality, and simply pleads for better quality themselves. Useful sites that deliver to critical information for safety and quality engineering of construction projects are acknowledged by every decision-maker in construction management and project control. Therefore a reliable Risk and Decision Framework tool for managing and controlling construction projects undertaking for the risk and quality engineering aspects is critical. This comprehensive risk and decision-based framework will make a significant contribution to the efficient management and control of these projects (Alghaseb & Alshmlani, 2022).

7. Occupational Health Management in Accelerated Construction Projects

Construction work is one of the most risky and hazardous of all industries and construction workers face different safety and health challenges. Because of fast-track project completion and an increase in on-the-job incidents, emphasis is placed on reducing hazards associated with daily construction operations. This study aims to identify and evaluate significant hazards in a number of construction operations and to develop a risk management strategy to minimize the likelihood of their possible occurrences. A checklist and field score assessment scale were used to identify the significant hazards arising from construction works that the contractor or trade contractors can face. The risks associated with these hazards were analyzed, and a risk management strategy was developed. Proper management of significant hazards will reduce the cost of the project which contractor might face in terms of lost time, injury frequency rate, and severity rate. Hence, the results of this control measure can be extremely useful to contractor's efforts to ensure a smooth construction operation and to make it safer.

Risk management is one way to prevent accidents or to minimize their consequences, whether they are risks resulting from natural events, industrial activities, or human behavior. Risk management is a technique for investigating, assessing, and preparing for a hazard before accidents occur. Quite a number of common hazards can occur during any project construction. The identification and control of these hazards, which can affect the outcome of construction, are necessary for project managers to effectively and profitably manage a construction project. Efficient site organization and better management of the construction process can help make a project economically viable. Successful companies and a successful industry as a whole depend on effective and efficient risk management where risks are controlled, minimized, or avoided altogether.

8. Integration of Safety, Quality, and Occupational Health in Accelerated Construction Projects

This section will discuss how safety, quality, and occupational health are integrated in construction projects. Policies and procedures are always applied to protect workers and progress in construction projects; however, accelerated construction projects ignore policies and procedures, resulting in overburdens. Consequently, it is necessary to identify and analyze risks in accelerated construction projects. The focus of the risk management process is to identify and analyze risks. Interaction between risks, potential causes, and results is studied through the relationship between risk factors. Fuzzy logic is used to make decisions based on uncertainty. An applied model for risk management in accelerated projects is based on this process. This model is implemented to investigate accelerated construction projects in Saudi Arabia.

It is found that firms are concerned with technologically related risks, whereas other important risks are inadequately addressed. Moreover, a significant relationship is found flexibility to adverse potential results (output quality, occupational accidents, and occupational diseases). However, the relationship between this risk factor and potential results is low and identified by inadequate expertise, poor design documentation, poor communication, the inadequacy of personnel and equipment, poor working conditions, improper handling, and lack of coordination. This study is an important study from which a foundation is set out for the Saudi firms in regards to managing risks in their accelerated construction projects to enhance outputs with minimum flexible potential negative results. Further, other studies can be expanded, particularly to investigate the most risky and complicated cases. Subsequently, pragmatic practice and strategies engaged in the output quality, occupational safety, and occupational health performance of the accelerated construction projects are to be elaborated.

9. Case Studies and Empirical Analysis

Construction is considered to be an important sector for economic progress and growth in every nation. The progress of any nation is often stipulated by the level of investment and growth of its various engineering and infrastructure sectors. The construction industry in the Kingdom of Saudi Arabia is one of the largest and fastest-growing industries, playing a significant role in the investment of resources and the provision of outstanding career opportunities. However, the construction industry presents some of the most hazardous workplaces. The rate of accident and fatalities in the construction industry is deemed to be very high, despite recent technological advancements, safety equipment, and regulations enforced by construction firms and governmental authorities.

The construction sector is recognized as one of the most unsafe working areas because works of construction projects mostly depend on the atmosphere. There is always the risk of incidents in this fast environment, from minor injuries to tragic accidents, causing fatalities as opposed to other industrial or manufacturing sectors. A large number of construction workers are injured in construction projects, and many lose their lives due to regular site events. Several construction projects in numerous countries fall behind schedule, especially the shortage of ordinary figure workers in the construction sector, which is an extensive gap in skills or competence and knowledge, resulting in work to be observed as incompatible with the decided project deadlines, and also the occupational health principles, instructions, and rules and construction individual necessities. So, there is an important need to review the relevance amongst management of risk in accelerated construction and the occupation health and safety of personnel and quality standpoint and time schedules.

10. Discussion and Analysis of Findings

Risk management performance affects schedule compression in construction projects as measured by speed of work, quality of work, and time and cost overruns. It proposes that risk recognition is positively associated with safety considerations prior to schedule compression. Earlier considerations in the analysis of safety result in better safety

outcomes in compressed durations. Risk management activities often involve the identification of changes or events that could have an impact on the success or failure of a project. Since construction projects are complex and involve many stakeholders, they are prone to unexpected risks that may arise during execution. Risks outside the initial project plan can delay the planned schedule and the impact of risks in construction projects in various ways can accelerate while execution proceeds (Moosa, 2018). In the accelerated construction projects, risk management activities are often overlooked, particularly when several parties are involved and the construction duration is aggressively compressed. This study presents a novel approach to investigate the impact of risk management performance on the schedule compression of accelerated construction projects with a series of logical linkages, including the quality of the work, specific risk management activities to accelerate project completion, and consideration of safety that shapes the execution of time- and budget-constrained construction work.

The proposed framework has the potential to contribute to a comprehensive understanding of safety quality and occupational health implications in accelerated construction projects with efforts to compress the schedule. From a research perspective, this research is possibly the first empirical study that focuses on risk management of construction projects executed in very short periods with a focus on consequences for safety, quality, and occupational health. The emerging economy of the KSA has recently seen a surge in such construction projects, but research on the consequences that have traditionally been paid less attention, are still lacking. It was thought important, from a theoretical and practical point of view, to understand the links between risk management activities, quality of work, speed of work, and time and cost overruns in such projects, and how these elements could influence safety performance, work quality, and occupational health. By offering possible explanations that should be considered or addressed by the parties involved in the plan, design and implementation of an accelerated construction project, this study will give a modest contribution.

11. Implications for Practice

Accelerated construction projects (ACPs) are executed by contractors significantly reducing the time required to complete a construction project. This research has focused on the impact of risk management on ACPs compared to traditional construction projects related to safety, quality, and occupational health. This research conducted an empirical

study to identify the impact of risk management on the safety, quality, and occupational health performance of ACPs that have been implemented within the construction sector of the Kingdom of Saudi Arabia compared with similar construction projects that have been executed through traditional methods.

The construction industry in the Kingdom of Saudi Arabia has experienced a significant boom and growth due to the exploration of its oil resources and the increasing demand for infrastructure construction projects by the government. The construction sector consumes significant resources and cost, and the completion time of construction projects is a critical and important factor for contractors as they can significantly affect the amount of resources and cost consumed within the project. Since the very beginning of ACP, parties, including construction clients, consultants, designers, contractors, and other stakeholders, have been interested in managing and controlling the risks related to ACPs. Many stakeholders are involved in managing ACP risks and their interrelations are complex. The impacts of risk management on construction projects have been frequently investigated and evidenced. However, there is no empirical evidence of the impact of risk management on ACPs taking into consideration the three main performance criteria (safety, quality, and occupational health) compared with regular construction projects. This research has demonstrated an empirical study to conceive the interrelations between the risk management process and the three main performance criteria (safety, quality, and occupational health) of implemented ACPs. Additionally, the impacts and realization of ACP risks have been examined to allow the completion of the ACP projects within the planned time, cost, and quality parameters and achieve the desired goals and objectives of the construction project.

Study Tools

To conduct this research effectively, various study tools will be employed to gather and analyze data related to risk management in accelerated construction projects. The key study tools include:

1. **Surveys and Questionnaires**, which help in gathering information from different professionals.
2. **Site Observations**, will also be conducted in order to observe the impact of risk management in accelerating construction industry.

3. **Case Studies**, the detailed case studies of past accelerated construction projects in Saudi Arabia will be analyzed to understand the impact of risk management strategies on safety, quality, and occupational health.

By integrating these study tools, this research will ensure a comprehensive and data-driven approach to evaluating risk management in Saudi Arabia's accelerated construction sector.

12. Conclusion and Future Research Directions

Accelerated construction projects seem to have found their way into the Saudi market due to their time saving advantages. However, the impact of risk management on accelerated construction project (RMCIP) on the safety, quality and occupational health are not adequately looked at by previous researches. Hence, this research aims to fill that gap and investigate the impact of the RMCIP on the accident rates, productivity, quality improvement along with occupational health practice on accelerated construction projects in Saudi Arabia. A mixed-method approach was chosen due to the dearth of research findings related to the study objectives in the local market. First, an extensive literature review was conducted. Based on the literature review, accident rates; 90% of the respondent's projects has a rate of accident lower than 0.1 which is lower than the general rate of the government (0.5). Furthermore, all projects that implement a risk management regime have an accident rate less than that of their peers with similar durations. It may infer that a good risk management regime might reduce the number of accidents during the construction phase (Moosa, 2018).

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