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Risk Management Practices of Project Engineers in Building Construction: It's Implication to Safety Construction

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Abstract: This study aimed to determine the risk management practices of project engineers in building construction and its implication to safety construction. The descriptive method was used with questionnaire as the main tool in gathering data employed statistical tools such as weighted mean and t-test to analyze and interpret the data.

Results of the study revealed that 1) the project engineers' weighted mean scores are greatest in the following categories: "Fire Protection," "Lighting of Working Areas," "Protection from Falling Materials," "Personal Protective Equipment," and "Scaffoldings." The weighted mean of construction workers is greatest for "protruding nails and loose materials", "demolition", "personal protective equipment", "alternative methods and materials", and "electrical". 2) Project engineers and construction workers had similar assessments of risk management practices; it has no significant differences. 3) Based on the average of how serious the problems with building construction management were, project engineers and construction workers both given a descriptive grade of "Serious." For project engineers, the sections with the highest weighted means are "Scope and design changes," "Unavailability of Fund," and "Construction Delays," whereas for construction workers, the sections with the highest weighted means are "Unavailability of Funding," "Inadequate Management Skills (Coordination")," and "Poor Safety Practices." 4) According to the data, there were considerable differences between the two sets of respondents' assessments of the issues experienced with building construction management.

To prevent accidents and damages the researcher suggests that the project engineer follow the standards based on the Department of Labor and Employment (2005) with regard to 1) Fire Protection, 2) Lighting of Working Areas, 3) Protection from Falling Materials, 4) Personal Protective Equipment, and 5) Scaffoldings. Whereas for construction workers the researcher suggest that they also abide the rules with regard to 1) protruding nails and loose materials, 2) Demolition, 3) personal protective equipment, 4) alternative methods and materials, and 5) Electrical.

***Index Terms* - Building Construction, Risk Management Practices, Project Engineers, Safety Construction**

I. INTRODUCTION

The construction industry generated a lot of risk problems. Lots of risk are generated by the construction industry annually. With these risk problems, sometimes, the majority ends up in blaming system between the parties. In addition, the construction industry was a leading consumer of resources; many materials are consumed by the industry each year. This level of resources consumption and material wastage needed to be addressed as civilization of the society, competition of the civilization becomes tougher and as supplies of resources depleted further. In recognition of the problem, there were engineers who set a target of reducing construction risks but build a safer construction (Taroun, 2014).

The Project Engineers of the construction industry is reduced through anticipation. A substantial proportion of responsibility for improving solution to the risk management practices in the construction industry that falls in every construction whether it is small or large scale of building, through on-site, risk and solution questionnaire surveys. Manpower risks, financials risks, safety-gears risks, paper works are all of the major risks in every building construction management project. It is perceived that a considerable proportion of risk generated is unavoidable because of the current working practices (Smith, 2014).

Risk analysis is described as a systematic methodology and an on-going process by which the occurrence may substantially affect the end products or simply the risks that could be identified, quantified, modeled, managed and monitored (Cameron, 2005). This tool was used as a method of good project management and planning. Mitigating risk is applied to a project cost schedule, quality or performance, safety and business operations.

Risk Management practices of project engineers is an organized method of identifying and measuring possible risks that may lead to developing, selecting, implementing and managing other options for addressing the risks (Smith, 2020).

Construction risks as it seats have a several types and it should be considered by an owner and the contractor as to the technical building requirements, the manpower, in construction site, the construction materials, the appropriate construction safety gears or outfits and as to the finance, too. Risk management practices are ongoing and iterative process, which are conducted throughout the lifecycle of the construction project. Risk must be reviewed on a monthly basis or as frequently as possible. The cycle is composed of identifying the risks starting from initiation, planning, design, construction, commissioning, and up to the close out. Next is to analyze the identified risks, plan to mitigate the risks to arrive at a solution, implementation of the solution and lastly reviewing all the risks and the solutions.

Background of the Study

The study of the four private construction projects that were chosen and are now being carried out in Santiago City by various Project Engineers falls under the infrastructure and residential categories. By categorizing projects in this way, gives an understanding of the facility's purpose as well as the building methods and tools that could be necessary.

The four key types of construction include residential, commercial, industrial, and infrastructure, which covers nearly every construction project. Residential buildings like single and multi-family homes. Commercial buildings, such as offices or warehouses. Industrial facilities, like factories or large-scale production facilities. Infrastructure projects, such as roads, bridges, airports, or wastewater systems (Wolfe, 2023).

Construction Management is the act of planning, organizing and overseeing the various tasks that are involved in a construction project. It is performed by individuals known as the project managers or project engineers, who represent the builder or contractor that is hired to perform all the work. Construction project management is a complex task that would change dramatically from project to project. Employees or construction workers that are working in the field find that all the requirements and all the processes of management are constantly shift depending on the specifications of the building construction project (Jasmani, 2016) .

This study aimed to assess the risk management practices of project engineers in building and its implication to safety construction.

Research Questions

1. What are the risk management practices of project engineers in building construction as assessed by the project engineers themselves and the construction workers?
2. Is there a significant difference in the risk management practices of project engineers in building construction as assessed by the project engineers themselves and the construction workers?
3. What is the degree of seriousness of the problems encountered in building construction management as assessed by the project engineers themselves and the construction workers?
4. Is there a significant difference in the degree of seriousness of the problems encountered in building construction management as assessed by the project engineers themselves and the construction workers?
5. What measures may be proposed to improve the risk management practices in building construction?

Hypothesis

1. There is no significant difference in the risk management practices of project engineers in building construction as assessed by the project engineers themselves and the construction workers.
2. There is no significant difference in the degree of seriousness of the problems encountered in building construction management as assessed by the project engineers themselves and the construction workers.

Significant of the Study

The proposed study serves as a guide or basis in order to have knowledge in risks identification, risks mitigation process and risks reduction plans on a building construction project: identifying possible risks throughout the construction period and making possible solutions to lessen the hazards that are identified risks to the engineers, workers and to the people near the construction area. In addition, the results of this study will be beneficial to the following:

Management Engineers. This study ensures the prevention in the aspect of technical building requirements as to paper works, plans and specifications, organizational chart and financial risks aspects due to the implementation of the building construction project management.

Construction Workers. This study ensures knowledge on much safer building construction place and with the proper usage of the appropriate construction safety gears or outfits the protection within the construction site.

Students. This study might awaken the students to become aware of their parts in the community and make them realized and preserved to continue the civilization in every community.

Future Researchers. Other researchers may find in this study a similar or related topic with regards to risks construction that will contribute to the reduction of risks and show a possible solution on building construction projects.

Theoretical Background

Theoretical Framework

Risk analysis has been presented based on the application of utility theory. This procedure embraces the following: data about conditions of construction, data about the economic situation, including a relationship between supply and demand, seasonality. Besides this approach includes variants of decisions, historical data, conditional probability, utility function. The method of defining the utility function can be briefly described as follows: the decision maker (for example, a project engineer, building site manager) is faced with a choice between a certitude of a given result (a monetary value), and a lottery was to extreme results. The two contrasting (but practical) cases of function of utility, that is characteristic of a decision maker with an aversion to risk, and decision maker with a predilection to risk, are then analyzed in detail. The economic effects of their decisions are then presented.

Project Management Institute (PMI) and Association for Project Management (APM) define risk management as "The systematic process of identifying, analyzing and responding to project risk. It includes maximizing the probability and consequences of positive events and minimizing the probability and consequences of adverse events to project objectives" (PMI, 2016). "A process whereby decisions are made to accept known or assessed risk and/or implementation of actions to reduce the consequences or probability of occurrence" (APM, 2012).

Wang, Jia, and Zhang (2019) sought to diminish the occurrence of risks and accidents during the construction phases of engineering projects while enhancing the risk management capabilities of the project stakeholders.

Conceptual Framework

The study is anchored in the basic system framework of input-process-output. The input box contains the project engineers' risk management practices in building construction and the problems encountered in building construction.

The process box includes assessing risk management practices of project engineers and construction workers in building construction and assessing the seriousness of the problems encountered in building construction through survey questionnaire.

The output box presents the proposed measures to improve risk management practices in building construction.

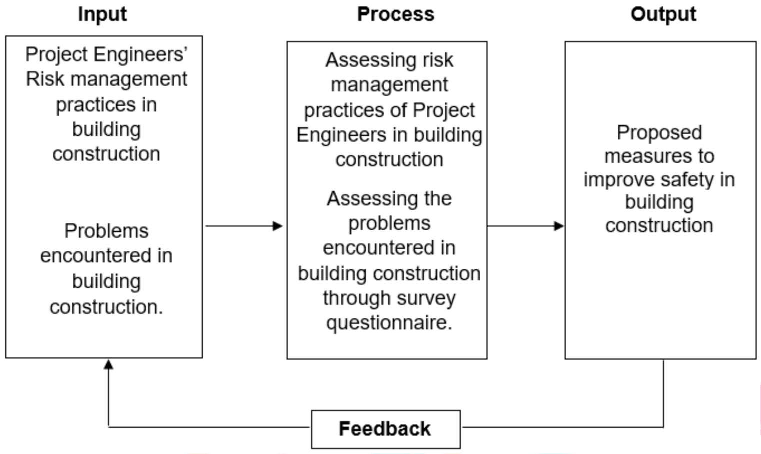

Figure 1. Paradigm of the Study

Literature Review

Construction Industry

Construction industry refers to the industrial branch of manufacturing and trade related to building, repairing, renovating, and maintaining infrastructures. It is a determinant of the country's technological and technical advancement, often regulating the growth of the country's infrastructural development that often directs to the country's advancement in terms of sustainability assurance. Unfortunately, the construction industry is one of the largest waste generating industries currently (Hussain, 2021).

The construction industry is recognized as a sector with great contribution to the economic and social development of a country, particularly due to the number of direct and indirect jobs generated and its influence on several other sectors which produce materials, equipment, and services in its production process (Paz, 2020). It is usually one of the first sectors to signal a region's financial situation, in times of both exponential growth and economic recession. On the other hand, population growth in large urban centers has led to an increase in the demand for the construction industry in the last decades in several sectors, which has led to generation of a significant volume of construction and demolition waste.

Construction industry is one of the most dynamic, risky, and challenging industries which has both a project-based and multi-organizational nature (Mills, 2001). Due to construction projects" complexity and uniqueness, not only does the number of risks present invariably go beyond those found in other industries but the risks also change from one construction project to the next (Panthi, 2009).

Construction Management

Harris (2021) construction management addresses the effective planning, organization, application, coordination, monitoring, control, and reporting of the core business processes of marketing, procurement, production, administration, accounts, and finance necessary to achieve economic success and/or profitability for an enterprise or organization engaged in the provision of construction facilities. The functions may be performed by a client, contracting company, consultant firm, public body or a combination of such stakeholders contracted to bring a project or series of projects to safe completion on time, to budget, to the set quality and
expected innovative, aesthetic, socially responsible, and environmental impact.

Construction Project Management focuses on the delivery of a specific solution by contracting with stakeholders who undertake combinations of the following indicative sub-processes relating to a specific project: Scoping and budgeting the project; Design coordination/management; Establishing the management structure of the management team; Marketing and procurement; Defining roles and responsibilities; Estimating and tendering; Stakeholder management; Project and construction methods planning, coordination, and control; Value and risk management; Organizing, leading, and implementing controls; Production and productivity management; Management of labour resources, temporary works provision, equipment, plant, subcontractors, and suppliers; Time and subcontractor interface management; Cost and budgetary control, including cash flow forecasting; Quality management; Contract and progress payments administration; Legal issues; Information and communications technology (ICT) management; Health and Safety management, education, training and welfare provision; Corporate Social Responsibility (CSR); Management of the potential environmental impacts of construction; Commissioning, auditing, and recording of the project(s) (Harris, 2021).

Project Management

Fewings and Henjewele (2019) states that project management involves not only the application of a specific set of tools but also the motivation of people and the responsibility to achieve goals and to perform within constraints. It requires proactive and reactive behavior in a dynamic situation. It is an integrated approach that brings many different parts together. The following definitions may be useful; project management is

a) the application of knowledge, skills and techniques to execute projects effectively and efficiently. It is a strategic competency for organizations, enabling them to tie project results to business goals.2

b) the application of methods, tools, techniques and competences to a project to achieve goals... [it] includes the integration of the various phases of the project life cycle... [and] ensures efficient use of resources, satisfying the needs of the project stakeholders.3

c) the planning, organizing, monitoring and controlling of all aspects of a project and the management and leadership of all involved to achieve the project objectives, safely and within agreed criteria for time, cost, scope and performance/quality.

Armenia et al. (2019) propose a new conceptual framework linking five key dimensions of sustainable project management: corporate policies and practices, resource management, life cycle orientation, stakeholders' engagement, and organizational learning.

Kerzner (2019) states that project management allows us to lower our cost of operations by accomplishing more work in less time and with fewer resources, without any sacrifice in quality or value. Project management provides us with better control of scope changes. Good project managers try to avoid unnecessary scope changes.

Project Engineers

Kourmentza (2022) states that a Project Engineer is a professional who is responsible for all technical and engineering aspects of their assigned projects. They plan, schedule, predict, and manage all the technical tasks of their assigned project to assure accuracy, proper resources, and quality from start to finish.

Simplilearn (2023) states that the project engineer manages any technical or engineering projects. The engineers are technical leaders who approach the job from an engineering perspective. They work closely with all project stakeholders and are responsible for managing the project's budget, planning, and personnel to ensure every element meets technical requirements.

Responsibilities of the Engineer

Performance monitoring of the Contract is a key function of proper contract administration. The purpose is to ensure that the Contractor is performing all duties in accordance with the contract and for the Employer to be aware of and address any developing problems or issues.

Usually a contract is monitored based on time, cost and quality using the Contractor's works program, contract price and contract specification as baselines respectively.

Engineer is responsible for supervision of construction works, to ensure the Works meet the required standards stipulated in the Specifications/Employer's Requirements. Usually this is achieved through establishment of Quality Control and Quality Assurance procedures to monitor the quality of Works, Materials, Plants and workmanship. The Engineer shall ensure quality of Works through tests, inspections, investigations and quality audits (Samarathunga, 2022).

Duties of the Employers

OSHS (2005) Health and Safety committees play very important roles in eliminating work hazards. Developing workers' interest and participation in the planning and development of safety program is the responsibility of the employer. The employer must exercise the necessary leadership and provide support to make the program work. The principal duties of the employer are: (1) Establishes and adopts in writing administrative policies on safety in conformity with the provisions of this Standards outlining therein his responsibility and authority delegated. (2) Reports to the enforcing authority in two (2) copies of the policies adopted and the health and safety organization established to carry out the program on safety and health within one month after the organization or reorganization of the health and safety committee. (3) Reports to the enforcing authority having jurisdiction at least once in every three (3) months, counting from January, the health and safety program of the organization outlining the activities undertaken including its safety performance, health and safety committee meetings and its recommendations and measures taken to implement such recommendations. (4) Acts on recommended measures by the health and safety committee by adopting the elements of the health and safety program in the production process or workplace and in case of non-adoption of the Health and Safety Committee's recommendation, to inform the committee of his reasons.

Duties of the Workers

OSHS (2005) (1) Works in accordance with accepted safety practices and standards established by the employer in compliance with the provisions of this Standards. (2) Reports unsafe conditions and practices to the supervisor by making suggestions for correction or removal of accident hazards. (3) Serves as members of the Health and Safety Committee. (4) Cooperates actively with the Health and Safety Committee. (5) Assists government agencies in the conduct of health and safety inspection or other programs.

Risk

Smith (2014) states that those who distinguish uncertainty from risk define risk as being where the outcome of an event, or each set of possible outcomes, can be predicted on the basis of statistical probability. This understanding of risk implies that there is some knowledge about a risk as a discrete event or a combination of circumstances, as opposed to an uncertainty about which there is no knowledge. In most cases, project risks can be identified from experience gained by working on similar projects. Risks fall into three categories; namely known risks, known unknowns and unknown unknowns. Known risks include minor variations in productivity and swings in material costs. These occur frequently and are an inevitable feature of all construction projects. Known unknowns are the risk events whose occurrence is predictable or foreseeable. Either their probability of occurrence or their likely effect is known. Unknown are those events whose probabilities of occurrence and effect are not foreseeable by even the most experienced staff. These are usually considered as force majeure (Smith, 2014). Some texts classify risks as 'epistemic' and 'aleoteric'; epistemic risks being those due to a lack of knowledge and aleoteric risks being due to natural variability. Unknown are clearly epistemic. In some situations, the term risk does not necessarily refer to the chance of bad consequences, it can also refer to the possibility of good consequences; therefore, it is important that a definition of risk must include some reference to this point. Risk and uncertainty have been defined as: risk exists when a decision is expressed in terms of a range of possible outcomes and when known probabilities can be attached to the outcomes; while uncertainty exists when there is more than one possible outcome of a course of action but the probability of each outcome is not known (frequently termed estimating uncertainty).

Loosemore (2006) have further improved the definition of risk as "A potential future event which is uncertain in likelihood and consequence and if it occurs, could affect a company's ability to achieve its project objectives."

Project Management Institute (PMI)"s definition of risk considers existence of both positive and negative consequences of risk as "an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality" (PMI, 2013). These potential effects of the possible and uncertain event would be named as "threat" in case of negative effects and "opportunity" in case of positive effects (Figueiredo and Kitson, 2009).

Risk categories can be defined as the classification of risks as per the business activities of the organization and provides a structured overview of the underlying and potential risks faced by them (Bera, 2022). Most commonly used risk classifications include strategic, financial, operational, people, regulatory and finance.

Risk Management in Construction Industry

Having a risk management in a building construction project is the most challenging part of a project because the task of molding the minds of the workers is a very serious matter. It is a lot easier to build a project without having or encountering any risks, some engineers would say, accordingly, it is very impossible for a project to not to have any risk encounters and having a risks in a building construction project is the most worrying matter too, especially for the newly full pledge engineers.

Toole's research (2002) points out that construction safety remains the concern of all individuals and organizations involved in construction projects and that all parties to a construction project must communicate their expectations of site safety roles throughout the project's duration. His research concluded that the capacity of architects/engineers, general contractors and sub-contractors to influence onsite construction safety differs according to the respective professions. He found that, under the traditional design-bid-construct project structure, where subcontractors heavily influenced the root causes of accidents, general contractors retained a moderate ability to influence activities onsite. On the other hand, architects/engineers exercised little influence over the root causes of accidents. Furthermore, he determined that site safety expectations should not only be practical in nature and reflect the influential abilities of each construction party, but also should be project and company specific. He also emphasized the importance of each of the different construction parties with respect to establishing realistic and shared expectations about the safety role that each entity can fulfill. Shared expectations of safety outcomes and processes are also argued to assist in the prevention of onsite construction accidents.

Charles et al. (2008) and Knutson et al. (2008) state that the construction management is about controlling time, money and quality and producing work in a safe manner. Managing risks means minimizing the risk, insuring against the risks, and sharing risks. To a construction contractor, a risk is an event will cause costs that were not planned and from which no profit will result. The concept of risk management is that we want to minimize risks, no matter whose risks they are. Risks are best assumed by the party with the greatest ability to control the risk. Contractors need a formal process to apply to all projects at the start and throughout the work to identify, quantify, and allocate risks.

According to Baula (2010) when project manager and laborers are involved in the risk management an effective and sustainable implementation of the risk management practices is risk project analysis. When these conditions are met, it is possible to properly manage the wastes generated by building construction project and to lessen their capacity.

The purpose of risk treatment is to determine what will be done in response to the risks that have been identified, in order to reduce the overall risk exposure. Unless action is taken, the risk identification and assessment process has been wasted. Risk treatment converts the earlier analyses into substantive actions to reduce risks. The primary inputs to this step are the lists of risks and their agreed priorities from the previous step and the current project plans and budgets. Risk treatment involves: identifying the options for reducing the likelihood or consequences of each Extreme, High or Medium risk; determining the potential benefits and costs of the options; selecting the best options for the project; and developing and implementing detailed Risk Action Plans. Risk Action Plan Summaries are usually required for each risk classified as Extreme or High on the agreed risk priority scale (Walker, 2013).

Construction Safety

Fang (2020) states that the unsafe behavior that is seen everywhere on construction sites is the biggest challenge for further improvement of construction safety performance. Focusing on the "human" related issues in construction safety, this paper reviews the research and practices of safety management and comes up with three key elements to look at, namely safety leadership, safety culture, and safety behavior. Through systematic exploration on the connotation of and interaction between safety leadership, safety culture, and safety behavior, a Leadership-Culture-Behavior (LCB) approach for construction safety is proposed with the kernel - leadership driven culture development and behavior control. The LCB approach emphasizes the role of safety leadership to not only directly reduce unsafe behavior but also to fundamentally change the causes of unsafe behavior through safety culture development, ultimately achieving the goal of reducing unsafe behaviors sustainably and preventing accidents. The LCB approach has been implemented in a number of railway and building projects in mainland and Hong Kong SAR, China, and Singapore. Significant improvement of L/C/B has been observed. Taking a high-speed railway project in China as an example, safety leadership, safety culture, and safety behavior of the project stakeholders at all levels were significantly improved.

In China, the conventional construction safety benchmarking approach is to assess safety performance by evaluating the physical safety conditions on site as well as the accident records, while no attention has been paid to the management factors that influence site safety (Fang, 2004). Based on the survey and interview data collected on safety management factors in 82 construction projects in China, the safety management index as a means to evaluate real-time safety management performance by measuring key management factors was developed. The quantified factors were compared with the commonly accepted physical safety performance index, which was derived from inspection records of physical safety conditions, accident rates, and the satisfaction of the project management team. Multifactor linear regression was conducted and the result indicates that safety management performance on site is closely related to organizational factors, economic factors, and factors related to the relationship between management and labor on site. Based on this benchmarking study, a practical safety assessment method was developed and then implemented on six construction projects. The results show that this method can be an effective tool to evaluate safety management on construction projects.

Bansal (2011) execution schedule and 2D drawings are generally used for hazards identification in the construction safety planning process. Planner visualises 2D drawings into a 3D model and mentally links its components with the respective activities defined in the schedule to understand the execution sequence in safety planning. Sequence interpretation and accordingly the hazards identification vary with the level of experience, knowledge and individual perspective of the safety planner. Therefore, researchers suggest the use of four dimensional (4D) modelling or building information modelling (BIM) to create the simulation of construction process by linking execution schedule with the 3D model. Both however lack in the features like: generation and updating of schedule, 3D components editing, topography modelling and geospatial analysis within a single platform which is now a major requirement of the construction industry. This work facilitates 4D modelling, geospatial analysis and topography modelling in the development of safe execution sequence by using geographic information systems (GIS), both 3D model along with its surrounding topography and schedule were developed and linked together within the same environment. During safety review process if planned sequence results a hazard situation, it may be corrected within the GIS itself before actual implementation. Paper also discusses the use of GIS in the development of safety database from which safety information are retrieved and linked with the activities of the schedule or components of a building model. 4D modelling along with topographical conditions and safety database in a single environment assist safety planner in examining what safety measures are required when, where and why. Developed methodology was tested on a real-life project in India, lessons learned from the implementation have been discussed in the potential benefits and limitations section. At last, paper highlights major research areas for further improvements.

Udo (2016) Injury while handling materials/objects is the most common accident that occurs on construction site. This is in consonance with the findings of HSE (2009) whose provisional statistics reported that construction sector accounted for the highest proportion of injuries to workers resulting from handling. The findings of the study also provided insight into the effect of lack of payment of attention to safety issues on construction sites. Demotivation of workers/ reduced morale rank as the most severe effect. Negative impact on reputation of firm, increased project cost and payment of settlement of injury/death claims were also considered as having severe impact. The result agrees with the position of Okolie and Okoye (2012), Hrymak and Perezgoneales (2007).

Also, Mthalane et al (2008) had identified payment of settlement for injury or death claim and increased insurance cost as major economic impact of site accident in construction. Cost of court cases/litigation was not considered as having a severe effect on construction in this study, and this finding appear to go contrary to the finding by Li and Poon (2000) which revealed a substantial number of court cases with respect to workers compensation for non-fatal construction accidents in Hong Kong.

Udo (2016) The prevalence of accidents on construction sites may have considerable impact of worker productivity and performance. It is also capable of undermining the reputation of construction companies and increasing expenses incurred by firms. Construction managers should ensure that only properly trained workers should be involved in handling of materials/ objects on construction sites to minimize the risk of accident. Construction organizations should improve their attitude towards safety issues by promoting safety and enforcing safety policies. Training and continuous education on safety precautions should be conducted for employers periodically to minimize construction accidents.

Okolie and Okoye (2012) stress that the importance of safety on construction sites and safety of construction workers can never be over emphasized, because when accidents happen on site, they cause many human tragedies, de-motivate workers, disrupt site activities, delay project progress, and affect overall project cost, productivity and reputation of the firms concerned.

In addition, Mthalane, Othman and Pearl (2008) identify loss of productivity, disruption of current work, training cost for replacement, damages to plant, equipment, completed work, corrective actions to prevent re-occurrence of accident, degradation of efficiency expenditure emergency equipment, slowdown in operations, costs of workman's compensation, medical payments, insurance premium, costs of rescue operations and equipment, loss of function and operations income, payments for settlements of injury or death claims, legal fees for defense against claims and increased insurance costs as major economic impact of site accident on construction companies.

In Hrymak and Perezgonzalez (2007), case studies on twenty (20) construction sites in Ireland show that a wide range of negative costs and effects resulted from the accidents in terms of financial costs to employer. Employer costs from the accidents included salary costs for replacement staff or overtime payments, production and productivity losses, retaining costs, personal injury claim compensation, repair bills, medical and travel expenses and increased supervision.

Problems Encountered in Construction

Mthalane (2008) 40% of the causes of site accidents are resulted from falling of people due to their negligence or not adhering to health and safety regulations. The decrease in standard of living and the loss of productivity represent the highest economic impacts on the affected families and construction companies respectively. The loss/injury of the family provider and the depression of employees and work fellows represent the highest social impacts on the families and construction companies respectively. The government should enforce the current H&S procedures and take active actions to ensure the applications of H&S procedures on site. Construction firms have to follow the H&S procedures, train all their employees, be stricter to individuals who violate H&S rules, appoint safety representatives to make safety a major priority in the construction site. Employees have to adhere and respect all H&S rules placed on site, practice safe construction measures, wear required personal protective equipment, be aware of their surroundings and report any unsafe activities to management.

Also, Li and Poon, (2009) reveal that there are substantial number of court cases in Hong Kong with respect to worker's compensation for non-fatal construction accidents. Hong Kong is notorious for her high construction accidents rates. Although the accidents rate has dropped from 350 per 1000 workers in mid 1980 to 60 per 1000 workers in 2007, it still accounted for nearly one-fifth of all the industrial accidents in Hong Kong. Contractors were economically pressed and battered by exorbitant compensation over the years. Li (2009) presents a comprehensive study of non-fatal accidents compensation court cases from 2004 to 2008. Although approximately one-third of the cases with injured persons aged between 47 and 56, the percentage of court cases over construction employees by age group was highest in age group 17-26. In terms of trade of workers, General laborers/causal workers stood the highest, then came electrical technicians and painters/decorators/plasterers. The highest rates of injury were falling from height and hitting by falling objects. Increasing from HK$10,997,637 in 2004, the total compensation reached the peak of HK$39,643,353 in 2006. The heaviest compensation was HK$13,800,000 among 101 cases. Most of the victims were compensated under loss of earnings and Pain Suffering and Loss of Amenities. While general laborers marked the highest number of cases, less than one-fourth of them were awarded compensation which exceeded HK$1,500,000. Four out of seven steel benders who filed court cases, however, received compensation greater than HK$1.5 million for each case. Those who were struck by objects had relatively the highest chance to be compensated with a huge sum of money.

Occupational safety and health is one of important issues for workforce movement among ASEAN countries. The objective was to study laws, main agencies, and law enforcement regarding occupational safety and health in Thailand, Indonesia, Malaysia, Philippines, and Singapore. This documentary research covered laws, main agencies' duties, and occupational safety and health law enforcement in Thailand, Indonesia, Malaysia, Philippines, and Singapore. Thailand has its Occupational Safety, Health, and Work Environment Act 2011. Its main agency was Department of Labor Protection and Welfare. Indonesia had Work Safety Act (Law

No. 1, 1970). Its main agency was Department of Manpower and Transmigration. Malaysia had Occupational Safety and Health Act (OSHA) 1994. Its main agency is the Department of Occupational Safety and Health.

The Philippines has its Occupational Safety and Health Standards. Its main agency was Department of Labor and Employment. Singapore has its Workplace Safety and Health Act 2006. Its main agency is Occupational Safety and Health Division. Occupational safety and health law enforcement among each country covers work environment surveillance, workers' health surveillance, advice about prevention and control of occupational health hazards, training and education of employers and employees, data systems, and research. Further in-depth surveys of occupational safety and health among each ASEAN country are needed to develop frameworks for occupational safety and health management for all ASEAN countries.

Project Construction

According Fajardo (2000) project construction has always been regarded as a unique one-time operation designed to accomplish a specific set of objectives. Comparatively, Project Construction Management differs much from management of a more traditional activities because of its limited framework. Construction management, consider time as the controlling factor of all available resources from money, manpower, facilities and equipment. Most projects have certain elements in common. They often involved considerable cost involving large number of activities that must be carefully planned and coordinated, if the project is to be completed within a specified time, cost, and performance guidelines. Construction Management is a process and a function. A process of directing and facilitating the work of people who are organized for a common purpose. And a function of getting things done through the efforts of others. It is the application of authority and the assumption of responsibility.

Project Risk Analysis

According to Lionel Galway (2004), there has been extensive development of methods for quantitative project risk analysis over the past two decades. Starting from the need to coordinate and control large, technically complex projects, theoreticians and practitioners have developed several related methodologies to estimate cost and schedule for these projects and to attach uncertainly estimates to these numbers. The methods have had varying degrees of use in different areas: for example, CPM is in widespread use in the construction industry, where technological innovation is not the dominant feature of a project. The picture in the area of high technology is more mixed. Despite the substantial history of the methods, it seems fair to say that practitioners and users are ambivalent about the usefulness and applicability of these techniques to these types of projects.

Factors Relevant to Success or Failure of Construction Project

Lock (2014) states that the success of the contractor and the project manager will usually be judged according to how well they achieve the three primary objectives, which are usually acknowledged as: 1. Project completion within the approved cost budget; 2. The project finished on time; 3. Good performance, which requires that the project satisfies its specification and delivers the intended benefits.

Factors for achieving these three objectives include the following: good project definition and a sound business case at the outset; Appropriate choice of project strategy; Strong support for the project and its manager from higher management; Availability of sufficient funds and other resources; Firm control of changes to the authorized project; Technical competence; A sound quality culture throughout the organization; A suitable organization structure; Appropriate regard for the health and safety of everyone connected with the project; Good project communications; Well-motivated staff; Quick and fair resolution of conflict.

These issues are all important for good project management. Some projects fail to satisfy all their objectives yet can be considered, in retrospect, to have been successful. For example, the Eurotunnel was seriously overspent yet those of us who use it would consider it a great success.

RULE 1080 (Personal Protective Equipment and Devices)

According to Department of Labor and Employment (2005) every employer (1) Shall at his own expense furnish his workers with protective equipment for the eyes, face, hands and feet, protective shields and barriers whenever necessary by reason of the hazardous nature of the process or environment, chemical or radiological or other mechanical irritants or hazards capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact. (2) Deduction for the loss or damage of personal protective equipment shall be governed by Article 114, Book III, Labor Code of the Philippines, and Section 14, Rule VIII, Book III, Omnibus Rules Implementing the Labor Code.

RULE 1210 (Electrical Safety)

According to Department of Labor and Employment (2005) (1) No electrical installation shall be undertaken without the plans having been approved by the Secretary or his authorized representative. (2) No service or power supply shall be connected to any electrical installation by any utility company supplying electricity or by any person until the necessary final inspection is conducted and a safety certificate/permit issued by the Regional Labor Office or authorized representative having jurisdiction over the case. (3) The following are excluded in the coverage of this Rule; a. electric generating plants with franchises which are under the jurisdiction of the Board of Power and Waterworks. b. electric generating plants and electrical installations in radio and television station which are under the jurisdiction of the Department of Public Works, Transportation and Communications, and c. electrical installation for conveyances used in connection with water transportation which are under the jurisdiction of the Bureau of Customs. (4) The exemptions under 3 (a) and (b) are only for the design and construction, the electrical installation may be inspected by the Regional Labor Office or authorized representative, if such poses danger to the safety and health of the workers therein. (5) The practice of electrical engineering as required under this Rule shall be subjected to the provisions of the Philippine Electrical Engineering Law, R.A. 184.

RULE 1960 (Occupational Health Services)

(1) Every employer shall establish in his place of employment occupational health services in accordance with the regulation and guidelines provided for under this rule. (2) The employer, the workers, and their representatives, where they exist shall cooperate and participate in the implementation of the organizational and other measures relating to occupational health services (Department of Labor and Employment, 2005).

RULE 1200 (Machine Guarding)

All moving parts of prime movers, transmission equipment and all dangerous parts of driven machinery shall be effectively guarded, unless so constructed or located to prevent any person or object from coming or brought into contact with them.

Synthesis

From the literature and studies reviewed it could be surmised that the practices of the engineers determine the prevention of the risk and building management construction project. But they are many aspects of these practices such as: Building construction rules and regulations management, anticipations of waste materials, to be able to deal with possible risks during the construction project, the researcher perused literature and studies that have provided a clearer insight to dimensions of these very important practices of the engineers to help the project become successful.

METHODS

Research Design

This study utilized a descriptive research methodology to explore the relevance of risk management practices among project engineers in building construction and its implications for construction safety. The descriptive research approach aims to provide a comprehensive and systematic description of a population, condition, or phenomena without delving into the reasons or causation (McCombes, 2020). This methodology allows the study to address questions pertaining to what, where, when, and how, but not the why. By employing a descriptive research strategy, the study can examine one or more variables using a variety of research techniques.

A descriptive research method is appropriate for investigating the risk management practices of project engineers in building construction and their implications for safety. This approach offers an objective, real-world perspective, allowing for a comprehensive examination of factors influencing safety in construction. Descriptive research enables the collection of rich and detailed data, providing baseline information for identifying trends and areas of improvement. Unlike experimental research, where manipulation is involved, the descriptive approach solely involves the observation and measurement of variables in the context of risk management practices in construction projects.

Study Site and Participants

The study was conducted in selected private construction projects in the City of Santiago. Santiago City is an independent component city. It lies in the southwestern part of Isabela in Northern Luzon island of the Philippines, whereas, it is the gateway to the Valley of Cagayan. The total land area of the city is 80% flat or nearly level land in the portions of the northwestern, eastern and western parts of the city.

On December 17, 1993, the bill converting Santiago into an independent component city was approved. Eventually, on May 5, 1994, by virtue or Republic Act 7720 signed by President Fidel V. Ramos, Santiago was pronounced as an independent component city, the first in the Cagayan Valley Region.

The participants of this study are the project engineers and the construction workers in four private construction projects at the City of Santiago.

Population, Sample Size and Sampling Method

All in all, there are seventy-eight (78). There were four (4) project engineers and seventy-four (74) construction workers. Since the respondents are limited for the study, it used complete renumeration.

Instruments

In this study, data were primarily collected using a questionnaire as the main data gathering instrument. The Questionnaire on risk management Part I was designed based on the construction safety guidelines outlined in Rule 1410 of the Department of Labor and Employment (DOLE, 2016). Additionally, Part II of the questionnaire drew inspiration from the research conducted by Renuka (2014) in the Journal of Civil Engineering Research, Vol. 4(2A), pages 31- 36.

The questionnaire has two parts. Part I. The degree of seriousness on the building construction risks management encountered by the Project engineers and Construction worker of selected building constructions in the City of Santiago. It has twenty five (25) items, regarding: Health and Safety Committee, Alternative Methods and Materials, Electrical, Machine Guarding, Fire Protection, Lighting of Work Areas, Lifting of Weights, Pipelines, Protection of the Public, Protection from Falling Materials, Protruding Nails and Loose Materials, Protection against Collapse of Structure, Safe Means of Access, Storage of Materials, Storage of Cylinders, Traffic Control, Vehicular Loading, Vehicle Driving, Internal Combustion Engine, Personal Protective Equipment, Excavation, Scaffoldings, Demolition, Mechanical Demolition and Explosives. Part II. Elicited information about seriousness on the building construction management problems encountered by the Project engineers and Construction worker of selected building constructions in the City of Santiago.

Data Gathering Procedures

Certain procedures were followed to ensure the proper conduct of the research. The researcher sent a letter to the Project Managers and owner of the five private construction project to request permission to conduct the study in the different sites of building construction currently undertaken and seek their support and cooperation for granting the permission to float the questionnaire and retrieved it immediately to ensure a 100 percent retrieval.

The researcher ensures a well-executed and valid survey process. Moreover, the researcher examined the questionnaires whether the respondents properly answered and no questions were left out, before retrieving them. The data were tallied, classified and presented in tabular form and subjected for statistical computations to give more pleasing data to the data gathered.

Data Analysis

The data that were gathered were submitted to statistical treatment such as follows

1. **Weighted Mean** was used to assess the level of implementation and the seriousness of the problems encountered in building construction management.

2. **T-test** was used to determine the statistically significant difference in the risk management practices of most engineers in building construction as assessed by the project engineers themselves and construction workers.

3. **Likert scale** was used in rating the evaluation on the survey performed. The Likert scale technique presents a set of attitude statements. Subjects were asked to express agreement or disagreement in a four-point scale. The Likert scale used in the study, measures the extents to which a person agrees or disagrees with the questions. The researcher utilized a 4 – point Likert scale. The scale has the following descriptions:

Scale	Range	Qualitative Description
4	3.51 - 4.00	Always/ Very Serious
3	2.50 – 3.49	Often/ Serious
2	1.50 – 2.49	Seldom/ Slightly Serious
1	1.00 – 1.49	Never/ Not Serious

Ethical Considerations

Respondents in this study must sign a permission form affirming that their participation in the study is voluntary and that the researcher would uphold their right to privacy, anonymity, and confidentiality. While assuring them that their answers would be kept private and used solely for academic and research reasons, it clearly informed respondents of the analysis's aim. The analysis was conducted with the assurance that no one was hurt or mistreated by the researcher.

RESULTS

Part 1. Risk Management Practices of Project Engineers in Building Construction as Assessed by the Project Engineers Themselves and the Construction Workers.

Table 1 Risk Management Practices of Project Engineers in Building Construction as Assessed by the Project Engineers Themselves and the Construction Workers

	Items	Project Engineers WM	Construction Workers WM	Composite Mean	
1.	Health and Safety Committee At every construction site there is an organized and maintained a Health and Safety Committee conforming with Rule 1040 and a medical and dental service conforming with Rule 1960.	3.25	2.81	3.03	Often
2.	Alternative Methods and Materials The construction, composition, size, and arrangement of materials used may vary provided that the strength of the structure is at least equal to that herein prescribed.	2.25	3.46	2.85	Often
3.	Electrical Before any construction is commenced, and during the construction, steps are taken to prevent danger to the workers or operating equipment from any live electric cable or equipment either by rendering the cable or apparatus electrically dead or by providing barriers to prevent contact.	2.5	3.32	2.91	Often
4.	Machine Guarding All moving parts of machinery used are guarded in accordance with the requirements of Rule 1200.	2.25	1.95	2.1	Seldom
5.	Fire Protection Fire Protection equipment are, provided in accordance with the requirements of Rule 1940.	3.5	2.83	3.16	Often
6.	Lighting of Work Areas Every work-area and approach thereto, every place where raising or lowering operations with the use of a lifting appliance are in progress, and all openings dangerous to workers, are lighted with the minimum requirements provided in Rule 1210.	3.5	2.94	3.22	Often
7.	Lifting of Weights For continued lifting, a male worker is not be made to lift, carry or move any load over fifty kilograms (50 kgs.) and female workers over twenty-five kilograms (25 kgs.). Weights over these shall either be handled by more than one worker or by mechanical means	2.5	3.19	2.84	Often
8.	Pipelines Repair work on any section of a pipeline under pressure is not undertaken until the pipeline is released of the pressure or the section under repair is blocked off the line pressure to ensure that no worker will be endangered.	2.5	2.16	2.33	Seldom
9.	Protection of the Public A safe covered walkway is constructed over the sidewalk for use by pedestrians in a building construction work less than 2.3 m. (7 ft.) from a sidewalk or public road.	2.75	2.96	2.855	Often

10.	Protection from Falling Materials Steps are taken to protect workers from falling materials, such as the provision of safety helmets and safety shoes.	3.5	3.26	3.38	Often
11.	Protruding Nails and Loose Materials Material or lumber with protruding nails is not used in any work or be allowed to remain in any place where they are a source of danger to the workers.	3.25	3.69	3.47	Often
12.	Protection against Collapse of Structure All temporary structure are properly supported by the use of guys, stays, and other fixings necessary for stability during construction.	2.25	2.49	2.37	Seldom
13.	Safe Means of Access Safe means of access and egress are provided and maintained to and from every place where work is undertaken.	2.25	2.41	2.33	Seldom
14.	Storage of Materials Building materials and equipment are not placed or stored on a permanent or temporary structure exceeding its safe load carrying capacity.	2.5	2.34	2.42	Seldom
15.	Storage of Cylinders Compressed gas cylinders are stored in upright position protected against heat and overturning and when not in use, the control valves shall be covered by protective caps screwed to proper positions.	2	1.91	1.96	Seldom
16.	Traffic Control In construction sites where a worker's safety is likely to be endangered by a vehicular traffic, flagmen, warning signs, barriers or lane control devices are installed.	2.5	1.49	1.995	Seldom
17.	Vehicular Loading No person shall remain on or in a vehicle during loading or unloading except those required to be there and only when all necessary protection against hazards are provided.	2.5	2.45	2.48	Seldom
18.	Vehicle Driving No person operates any vehicle or equipment in a construction site unless he has adequate training and experience to operate such vehicle or equipment and is authorized by his immediate supervisor	2.5	2.46	2.48	Seldom
19.	Internal Combustion Engine No internal combustion engine is operated in an enclosed area unless: the exhaust gases or fumes are discharged directly outside to a point where the discharge gases or fumes cannot return to the enclosure.	2.25	2.17	2.21	Seldom
20.	Personal Protective Equipment Personal Protective equipment as required in Rule 1080 are provided to the workers.	3.5	3.54	3.52	Always
21.	Excavation The walls of every excavation over 1 m. (3 ft.) deep is supported by adequate shoring and timbering to prevent collapse, provided that this shall not apply to an excavation:	3.25	2.45	2.85	Often
22.	Scaffoldings Every scaffold is of good construction of sound materials and strength for the purpose for which it is intended.	3.5	2.45	2.98	Often
23.	Demolition All demolition operations of building or other structure over six (6) meters high are under supervision of a competent person. No person except the workers who are directly engaged in the demolition shall enter a demolition area to within a distance equal to 1 1/2 times the height of the structure being demolished, where this distance is not possible the structure shall be fenced around and no unauthorized person shall be allowed within the fenced area.	2.25	3.56	2.905	Often
24.	Mechanical Demolition The demolition area where work is done by mechanical devices such as weight balls or power shovels shall: (a) be barricaded for a minimum distance of 1 1/2 times the height of the structure.	2	1.94	1.97	Seldom
25.	Explosives A competent person is appointed in charge of and personally present at a blasting operation who shall supervise the fixing of all charges and other blasting, activities.	2.5	2.46	2.48	Seldom
	Overall Mean	2.7	2.67	2.68	Often

According to the data presented in Table 1, the frequency of encountering building construction risk management issues was assessed among Project Engineers and Construction Workers in selected building constructions within the City of Santiago. The composite mean is 2.68 equivalent to "often"

The data indicates that there is a lower degree of response among the construction workers than the project engineers. There is a 0.03 difference in the overall mean however, such difference did not cause a big difference in the level of the scale used.

The composite mean for Health and Safety Committee is 3.03, which means often. Alternative Methods and Materials was rated 2.85 which is equivalent to often. Electrical was rated with 2.91 which means often. Machine Guarding was rated with 2.1 which means seldom. Fire Protection was rated with 3.16 which means often. Lighting of Work Areas was rated with 3.22 which means often. Lifting of Weights was rated with 2.84 which means often. Pipelines was rated by respondents with 2.33 which means seldom. Protection of the Public was rated by respondents with 2.855 which means often. Protection from Falling Materials was rated by respondents with 3.38 which means often. Protruding Nails and Loose Materials was rated with 3.47 which means often. Protection against Collapse of Structure was rated with 2.37 which is equivalent to seldom. Safe Means of Access Public was rated by respondents with 2.33 which means seldom. Storage of Materials was rated by respondents with 2.42 which means seldom. Storage of Cylinders was rated by respondents with 1.96 which means seldom. Traffic Control was rated with 1.995 by the project engineers, which is equivalent to seldom Vehicular Loading was rated by respondents with 2.48 which means seldom. Vehicle Driving was rated by respondents with 2.48 which means seldom. Internal Combustion Engine was rated by respondents with 2.21 which means seldom. Personal Protective Equipment was rated by respondents with 3.52 which means often. Excavation was rated with 2.85 which is equivalent to often. Scaffoldings was rated with 2.98 equivalent to often. Demolition was rated with 2.905 by the project engineers, which is equivalent to often. Mechanical Demolition was rated by respondents with 1.97 which means seldom. Explosives was rated by respondents with 2.48 which means seldom.

Specifically, for the project engineers, the highest of the weighted mean is on the area of "Fire Protection", "Lighting of Work Areas", "Protection from Falling Materials", "Personal Protective Equipment", and "Scaffoldings" (3.5). This was followed by "Health and Safety Committee", "Protruding Nails and Loose Materials", and "Excavation" (3.25). The least is on "Mechanical Demolition" and "Storage of Cylinders" (2).

For the construction workers, the highest of the weighted mean is on "Protruding Nails and Loose Materials" (3.69), followed by "Demolition" (3.56), then "Personal Protective Equipment" (3.54), fourth was "Alternative Methods and Materials" (3.46) and fifth "Electrical" (3.32). The least was "Storage of Cylinders" (1.91) and "Traffic Control" (1.41).

Part 2. Significant Difference in the Risk Management Practices of Project Engineers in Building Construction as Assessed by the Project Engineers Themselves and the Construction Workers.

Table 2. Significant Difference in the Risk Management Practices of Project Engineers in Building Construction as Assessed by the Project Engineers Themselves and the Construction Workers.

Respondents	Mean	S.D.	Computed t	Probability	Decision
Project Engineers	2.7	0.51	-0.101	0.9196	Not Significant
Construction Worker	2.67	0.58			

Table 2 shows that the t test yielded a computed value of -0.101 with a probability of .9196 which is greater than .05, revealing no significant differences in the assessment of the project engineers themselves and construction workers on the perceived risk management practices

The null hypothesis of no significant difference is accepted. In other words, there is no significant difference along the assessment of both groups of respondents. This implies that the project engineers and construction workers mutually agree that they have the same.

Part 3. Degree of Seriousness of the Problems Encountered in Building Construction Management as Assessed by the Project Engineers Themselves and the Construction Workers

Table 3 presents the problems encountered in building construction management as assessed by the project engineers themselves and construction workers.

Table 3. Degree of Seriousness of the Problems Encountered in Building Construction Management as Assessed by the Project Engineers Themselves and the Construction Workers

Items	Project Engineers		Construction worker		Composite Mean	
Scope and design changes	3.5	S	2.89	S	3.20	S
Site conditions and Unknown Geological Condition	3.25	S	3.1	S	3.18	S
Inflation	2.5	SS	3.33	S	2.92	S
Unavailability of Funds	3.5	S	3.67	VS	3.59	VS
Inadequate Managerial Skills (Coordination)	1.75	SS	3.46	S	2.61	S
Lack of Availability of Resources	2	SS	3.12	S	2.56	S
Weather and Climatic Conditions	1.5	NS	3.27	S	2.39	SS
Statutory Clearance and Approvals	1.5	NS	2.47	SS	1.99	SS
Poor Safety Procedures	3.25	S	3.37	S	3.31	S
Construction Delays	3.5	S	3.29	S	3.40	S
Overall Mean	**2.63**	**S**	**3.20**	**S**	2.91	**S**

The overall mean of 2.63 and 3.20 for the project engineers and construction workers, respectively give a descriptive rating of "Serious" for both groups.

As presented in table 3, both group of participants agreed that they have encountered very serious problems in building construction management in terms of unavailability of funds (CM=3.59). Meanwhile both group of participants affirmed that they have encountered serious problems along the following: Construction delays (CM=3.40), poor safety procedures (CM=3.31), scope and design changes (CM=3.20), site conditions and unknown geological condition (CM=3.18), inflation (CM=2.92), inadequate managerial skills (CM=2.61), and lack of availability of resources (CM=2.56). On the other hand, both group of participants confirmed that they encountered slightly serious problems on weather and climatic condition (CM=2.39) as well as statutory clearance and approvals (CM=1.99). With an overall mean of 2.91, this implies that the project engineers themselves and construction workers encountered serious problems in building construction management.

Specifically, for the project engineers, the highest of the weighted mean is on the area on "Scope and design changes", "Unavailability of Funds" and "Construction Delays" (3.5). This was followed by "Site conditions and Unknown Geological Condition" and "Poor Safety Procedures" (3.25). Third is "Inflation" (2.5). Fourth is "Lack of Availability of Resources" (2). Fifth is "Inadequate Managerial Skills (Coordination)" (1.75). The lowest is "Weather and Climatic Conditions" and "Statutory Clearance and Approvals" (1.5).

On the other hand, for the construction workers, the highest of the weighted mean is on "Unavailability of Funds" (3.67). The second highest weighted mean is "Inadequate Managerial Skills (Coordination)" (3.46). Third highest weighted mean is "Poor Safety Procedures" (3.37). Fourth is "Inflation" (3.33). Fifth is "Construction Delays" (3.29). Sixth is "Construction Delays" (3.29). Seventh is "Weather and Climatic Conditions" (3.27). Seventh is "Lack of Availability of Resources" (3.12). Eighth is "Site conditions and Unknown Geological Condition" (3.10). Ninth is "Statutory Clearance and Approvals" (2.47). Tenth is "Scope and design changes" (2.89)

The data indicates that there is a lower degree of response among the project engineers than the construction workers. There is a 0.33 difference in the overall mean however, such difference did not cause a big difference in the level of the scale used.

Part 4. Significant Difference in the Degree of Seriousness of the Problems Encountered in Building Construction Management as Assessed by the Project Engineers Themselves and the Construction Workers

Table 4. Significant Difference in the Degree of Seriousness of the Problems Encountered in Building Construction Management as Assessed by the Project Engineers Themselves and the Construction Workers

Respondents	Mean	S.D.	Computed t	Probability	Decision
Project Engineers	2.63	0.82	-1.95	0.033	Significant
Construction Workers	3.2	0.32			

Table 4 shows that a computed t value of -1.95, with a probability of 0.033 which is lesser than .05, indicates that there is a significant difference in the assessment of the two groups of respondents. The project engineers gave lower mean responses than the construction workers. Hence, the null hypothesis of no significant difference is rejected. In other words, there is significant difference in the assessment of both groups of participants. This implies that he project engineers and the construction workers do not mutually agree on the degree of seriousness on the building construction management problems encountered. This may be attributed to the fact that the project engineers expect higher level of building construction management on their construction projects than construction workers.

Part 5. Proposed measures to improve the risk management practices.

Based on the findings, it is evident that both project engineers and construction workers face serious challenges in building construction management. The identified problems include unavailability of funds, construction delays, poor safety procedures, scope and design changes, site conditions, unknown geological conditions, inflation, inadequate managerial skills, and lack of availability of resources. Additionally, weather and climatic conditions, as well as statutory clearance and approvals, were perceived as slightly serious problems.

To improve risk management practices in building construction, the following proposed measures can be considered:

1) **Financial Planning**. Develop robust financial planning strategies to address the issue of unavailability of funds. This may involve exploring alternative funding sources, securing financing early in the project, and contingency planning for financial uncertainties.
2) **Project Scheduling and Safety Procedures.** Implement effective project scheduling techniques to minimize construction delays. Enhance safety procedures and training to address concerns related to poor safety procedures, ensuring a safer working environment.
3) **Change Management**. Establish a systematic change management process to handle scope and design changes. This includes clear communication channels, impact assessments, and proper documentation of changes.
4) **Site Investigation.** Improve site investigation processes to better understand site conditions and geological factors. Conduct thorough geotechnical studies to mitigate risks associated with unknown ground conditions.
5) **Inflation Mitigation.** Develop strategies to mitigate the impact of inflation on project costs. This may involve fixed-price contracts, inflation-adjusted budgets, and monitoring economic indicators that influence construction costs.
6) **Managerial Skills Enhancement.** Provide training programs to enhance the managerial skills of project engineers. This could include leadership development, communication skills training, and project management workshops.
7) **Resource Management.** Improve resource management practices to address concerns about the lack of availability of resources. This may involve optimizing resource allocation, maintaining effective supplier relationships, and considering alternative suppliers.
8) **Climate-Responsive Planning.** Develop climate-responsive planning measures to address weather and climatic conditions. This could include incorporating weather forecasts into project planning and implementing weather-resistant construction techniques.
9) **Streamlining Statutory Processes.** Work with relevant authorities to streamline statutory clearance and approval processes. Establish clear communication channels with regulatory bodies to expedite approvals and reduce delays.
10) **Enhanced Risk Management Practices**. Strengthen overall risk management practices by implementing comprehensive risk assessment methodologies, regularly reviewing and updating risk registers, and fostering a culture of proactive risk identification and mitigation.
11) **Collaboration and Communication**. Foster collaboration and open communication between project engineers and construction workers. Ensure that insights from both groups are considered in decision-making processes, enhancing overall project understanding and success.

DISCUSSION

Part I. The risk management practices of project engineers in building construction as assessed by the project engineers themselves and the construction workers

The following are the risk management practices of project engineers in building construction as assessed by the project engineers themselves (in order of rank). "Fire Protection", "Lighting of Work Areas", "Protection from Falling Materials", "Personal Protective Equipment", and "Scaffoldings". This was followed by "Health and Safety Committee", "Protruding Nails and Loose Materials", and "Excavation". Third is on "Protection of the Public". Then, "Electrical", "Lifting of Weights", "Pipelines", "Storage of Materials", "Traffic Control", "Vehicular Loading", "Vehicle Driving", and "Explosives". Fourth is on "Alternative Methods and Materials", "Machine Guarding", "Protection against Collapse of Structure", "Safe Means of Access", "Internal Combustion Engine", and "Demolition" The least is on "Mechanical Demolition" and "Storage of Cylinders".

For the construction workers, the following is their assessment (in order of rank): Protruding Nails and Loose Materials, Demolition, Personal Protective Equipment, Alternative Methods and Materials, Electrical Protection from Falling Materials, Lifting of Weights, Protection of the Public, Lighting of Work Areas, Fire Protection, Health and Safety Committee, Protection against Collapse of Structure, Vehicle Driving, Explosives, Scaffoldings, Excavation, Vehicular Loading, Safe Means of Access, Storage of Materials, Internal Combustion Engine, Pipelines, Machine Guarding, Mechanical Demolition, Storage of Cylinders and Traffic Control. The least was "Storage of Cylinders" and "Traffic Control".

There are three types of fires and explosions that could probably occur on construction sites. These are small fires, large fires and blowouts. The probability is that small fires are least dangerous and blowouts being the most severe (Gloss & Wardle, 1984). By far the largest category is falls, which include people falling or objects and material falling (this includes structure or part of a structure collapsing). Each year about 70-80% of all fatalities and 35-40% of all injuries may be attributable to falls due to negligence or not obeying health and safety rules. About 25% of all accidents that result in workers being unable to carry out their normal duties for at least 3 days are due to the incorrect manual lifting and carrying, generally of too heavy loads, which results in strain and sprain injuries. A further 10% are due to stepping on or striking against objects (i.e. stepping on protruding nails) (Davies & Tomasin, 1990).

Part II. Significant difference in the risk management practices of project engineers in building construction as assessed by the project engineers themselves and the construction workers

There are no significant differences in the perceptions of the project engineers and construction workers on the perceived risk management practices

The null hypothesis of no significant difference is accepted. In other words, there is no significant difference along the perception of both groups of respondents. The project engineers and construction workers mutually agree on the degree of perceived risk management practices. This implies that the position of the respondents be it project engineers and construction workers, is not a factor to determine whether the both groups of respondents have different perception in the perceived risk management practices of selected building constructions in the City of Santiago.

El-Gohary (2014) revealed that the following five factors, ranked in descending order, are the most significant in their effects on construction labor productivity in Egypt: (1) labor experience and skills; (2) incentive programs; (3) availability of the material and ease of handling; (4) leadership and competency of construction management; and (5) competency of labor supervision. Industry practitioners and researchers can use the primary outcomes of this study in developing systems to enhance and improve construction labor productivity in Egypt. This serve as a guide for contractors and construction managers for the effective management of construction labor forces and help to achieve a competitive level of quality and a cost-effective project.

Part III. The degree of seriousness of the problems encountered in building construction management as assessed by the project engineers themselves and the construction workers

The overall mean of for the project engineers and construction workers, respectively give a descriptive rating of "Serious" for both groups.

Specifically, for the project engineers, the highest of the weighted mean is on the area on "Scope and design changes", "Unavailability of Funds" and "Construction Delays". This was followed by "Site conditions and Unknown Geological Condition" and "Poor Safety Procedures". Third is "Inflation". Fourth is "Lack of Availability of Resources". Fifth is "Inadequate Managerial Skills (Coordination)". The lowest is "Weather and Climatic Conditions" and "Statutory Clearance and Approvals".

On the other hand, for the construction workers, the highest of the weighted mean is on "Unavailability of Funds". The second highest weighted mean is "Inadequate Managerial Skills (Coordination)". Third highest weighted mean is "Poor Safety Procedures". Fourth is "Inflation". Fifth is "Construction Delays". Sixth is "Construction Delays". Seventh is "Weather and Climatic Conditions". Seventh is "Lack of Availability of Resources". Eighth is "Site conditions and Unknown Geological Condition". Ninth is "Statutory Clearance and Approvals". Tenth is "Scope and design changes".

The data indicates that there is a lower degree of response among the project engineers than the construction workers. There is a small difference in the overall mean however, such difference did not cause a big difference in the level of the scale used.

(Kiprop, 2022) The construction industry in Kenya and the world at large is subject to more risks and uncertainty than many other industries. The process of delivering a project from inception, completion and finally into use is complex. The complexity of the work involved in construction activities, therefore, makes construction projects more predisposed to risk events. In times of increasing global competition, the success of projects becomes more decisive to an organization's business performance. However, many projects still present delays, changes in their scope, failures and premature termination. The skills that enable firms to cope with uncertainty and gain performance through risk management are imperative. The study identified technical risks, client related risks, financial risks, and socio-political risks as the construction risks. Specifically, technical risks had the highest influence on performance, followed by Client related risks, then financial risks. Socio-political risks had the least influence on performance of Kenya Urban Roads Authority projects in central region of Kenya. All the variables explained 76.5% of performance of Kenya Urban

Roads Authority projects in central region of Kenya. Kiprop (2022) recommends implementation of project risk management practices to turn the risks in to opportunities.

Part IV. Significant difference in the degree of seriousness of the problems encountered in building construction management as assessed by the project engineers themselves and the construction workers.

Statistics indicates that there is a significant difference in the perceptions of the two groups of respondents. The project engineers gave lower mean responses than the construction workers.

The null hypothesis of no significant difference is rejected. In other words, there is significant difference along the perception of both groups of respondents. The project engineers and the construction workers do not mutually agree on the degree of seriousness on the building construction management problems encountered. This may be attributed to the fact that the project engineers expect higher level of building construction management on their construction projects than construction workers.

Renuka (2014) states that the critical risk factors identified by many researches done in different type projects like residential, industrial, commercial, infrastructure etc. in various foreign countries. Factors like, Country risk (Inflation, country economic condition), Environmental and geological risk (Weather and climatic conditions), Statutory Compliance Risk (Statutory clearance before planning a project), design risk (scope and design changes), Project Execution risk (new technology implementation, Poor Safety procedures, Construction Delays, Inadequate managerial skills, improper coordination between teams), Resource Risk(Lack of availability of resources) are the critical risk factors in various international projects. It is concluded that, there is an urge for a knowledge map which depicts the sources of critical risk factors and its impact on the successful completion of the construction Project.

Part V. Proposed measures in the building construction management at Santiago City.

Based on the results of the risk management practices of project engineer in building construction: it's implication to safety construction survey the following measures are hereby proposed:

1. In order to minimized the risk assessed by the project engineers and construction workers the researcher recommend improving risk management practices in building construction thru the following:

- Develop a Risk Management Plan: Create a comprehensive risk management plan for each construction project. Identify potential risks, assess their impact and likelihood, and define appropriate strategies for mitigating or addressing each risk (Datta, 2001).
- Promote Safety Culture: Foster a culture of safety throughout the organization. Emphasize the importance of risk identification and management from the top down. Encourage workers to report hazards and near-miss incidents, and ensure that everyone understands their responsibility for maintaining a safe working environment (Pidgeon, 2000)
- Provide Training: Conduct regular training programs (Wang, 2018) to educate project engineers and construction workers on risk management practices. Train them on identifying hazards, understanding safety protocols, using personal protective equipment (PPE), and implementing safe work practices. Make sure they are aware of relevant regulations and codes.
- Risk Identification and Assessment: Encourage project engineers and workers to actively identify potential risks and hazards (El-Sayegh, 2021). Conduct thorough risk assessments at various stages of the project, from design and planning to construction and maintenance. Involve workers in the process, as they often have valuable insights and on-the-ground experience.
- Regular Review and Updates: Review and update risk management practices regularly to ensure they remain relevant and effective (Clough, 2000). Stay updated with industry best practices, regulatory changes, and new technologies that can enhance safety and risk mitigation efforts.

By implementing these steps, project engineers and construction workers can significantly improve risk management practices in building construction, leading to safer work environments and successful project outcomes.

2. Improving risk management practices for project engineers and construction workers in building construction is crucial for ensuring safety, reducing accidents, and minimizing financial losses. Here are some steps to enhance risk management in the construction industry:

- Effective Communication. Establish clear lines of communication between project engineers, construction workers, and other stakeholders (Dainty, 2007). Ensure that everyone understands the risks involved and the measures in place to address them. Encourage open dialogue and regular meetings to discuss safety concerns, updates, and lessons learned.
- Use Technology. Leverage technology to improve risk management (Platonov, 2000). Implement Building Information Modeling (BIM) systems to identify clashes and hazards during the design phase. Use mobile apps or digital platforms to report incidents, conduct inspections, and share safety-related information. Explore virtual reality (VR) or augmented reality (AR) for training and simulation purposes.
- Regular Inspections and Audits. Conduct regular inspections and audits to assess the effectiveness of risk management practices on-site (Sarens, 2006). Inspections should cover areas such as scaffolding, electrical systems, equipment, and overall compliance with safety protocols. Address any issues promptly and document corrective actions taken.
- Continual Improvement. Encourage a culture of continual improvement in risk management (Vargas, 2017). Collect and analyze data on incidents, near-misses, and safety performance indicators. Use this information to identify trends, implement preventive measures, and update risk management strategies for future projects.
- Collaboration and Lessons Learned. Foster collaboration and knowledge sharing among project teams (Ni, 2018), construction workers, and industry peers. Encourage the sharing of lessons learned from past projects and incidents to improve risk management practices across the organization and the industry as a whole.

By implementing these steps, project engineers and construction workers can significantly improve risk management practices in building construction, leading to safer work environments and successful project outcomes.

Conclusion

Based on the findings of the study, the following conclusions are drawn:

1. In the City of Santiago, both project engineers and construction workers faced significant challenges in managing the hazards associated with building construction. The project engineers' highest weighted mean scores were observed in the categories of "Fire Protection," "Lighting of Working Areas," "Protection from Falling Materials," "Personal Protective Equipment," and "Scaffoldings." On the other hand, construction workers' highest weighted mean scores were recorded for "Protruding Nails and Loose Materials," "Demolition," "Personal Protective Equipment," "Alternative Methods and Materials," and "Electrical."
2. Project engineers and construction workers shared similar assessments of risk management practices, indicating no significant differences between their perceptions.
3. Both project engineers and construction workers reported the severity of problems with building construction management as "Serious" based on the average weighted means. For project engineers, the sections with the highest weighted means were "Scope and Design Changes," "Unavailability of Fund," and "Construction Delays," while for construction workers, the sections with the highest weighted means were "Unavailability of Funding," "Inadequate Management Skills (Coordination)," and "Poor Safety Practices."
4. The data revealed considerable differences in the assessments of the issues experienced with building construction management between the two sets of respondents.

Recommendations

Based on the aforementioned conclusions, the following recommendations were made:

A. For the Project Engineers

1. to be always aware of the risk and possible problems that may arise in the construction project.
2. to assess both the predictable components mentioned in this research and the uncertainties to successfully complete the project because there are several risks involved with building projects, which have an impact on the project's cost, timeline, and quality.
3. To collect and analyze data on incidents, near-misses, and safety performance indicators. Use this information to identify trends, implement preventive measures, and update risk management strategies for future projects.

B. For the Construction Workers

1. construction work is risky, and employees must use precaution to avoid becoming wounded or ill while doing their tasks.
2. personal protective equipment must be use always like helmets and safety shoes, safety belts, life lines and safety nets.
3. promote safety culture: Foster a culture of safety throughout the organization. Emphasize the importance of risk identification and management from the top down. Encourage co-workers to report hazards and near-miss incidents, and ensure that everyone understands their responsibility for maintaining a safe working environment.

C. For the Future Researchers

1. to conduct a similar study may be conducted focusing on the variables not covered in the study.

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