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Integrated Framework on Safety & Risk Management in Construction Projects: Different Perspectives

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Abstract: An integrated framework for the management of safety, quality and risk is needed, with an information management system based on a safety models. The construction projects are one of the most centric focus points for safety and risk management. Therefore, the air of this paper is to framework an integrated model for safety and risk management to large scale construction projects. The manuscript discussed the different perspectives of the safety climate, cultures, environment, and objectives. Based on these perspectives, the different models are proposed for further safety risk management and evaluations. These model will help to implement the "zero accident" goals in large scale construction projects. Furthermore, this will enhance the current understanding of policy makers and field engineers to implement the safety measures.

Keywords: Construction projects, Safety Management, Risk Management

1. Introduction

Currently, construction organizations recognize the need to integrate safety into all decision making process. The scientific community believe that strategic safety management is a way of achieving the level of integration which is symbolic of a mature organization. Many developed economies have made significant improvement in safety management through the use of systems, structures and modern technology, and found it great to achieve exponential improvements in safety performance. Thus, construction organizations recognized the need to balance and integrated framework, when implementing safety management.

Construction safety has undergone a substantial evolution in the past century and organizations are continuing the progressive pathways for same. The evolution of safety has significantly improved safety performance in the construction industry. However, in recent years, it appears that this improvement has plateaued and the industry is facing difficulties in achieving further improvements, while injuries and fatalities still occur on a regular basis. Despite having an important role in the global and national economies, the construction industry has a notorious reputation as being one of the most dangerous industrial sectors. It provides employment for about 7% of the world's workforce, but is responsible for 30–40% of work-based fatal injuries. The International Labour Organization (2003) estimated that there are at least 60,000 fatalities on building sites every year.Due to the high rates of accidents and injuries in the construction industry, much effort has been taken through research and better work practices to improve safety performance. The domains of research and practice aimed at promoting safety performance improvement in the construction projects.

Therefore, the safety managements plan for a construction projects are important by following meanings (Reese & Eidson, 2006): 1) Government have laws that require construction organizations to provide safe work conditions and adequate supervision, 2) Lack of safety increases the probability of accidents, which may lead to human suffering, disabilities and death, 3) When an accident happens, the morale of workers is weakened. On the contrary, accident prevention programs strengthen morale and improve on-site productivity, 4) A safe operation in the workplace is considered a moral obligation by the current society; thus good safety practices are essential to improve and maintain reputation, 5) A good safety record and proven safety management system are valuable marketing tools to attract new clients and support business expansion and 6) A safety management program contributes to the financial health of construction organizations by helping them avoid costs associated with accidents. The premise of this paper is that viewing safety management from the strategic perspective serves as a unique view point that has not been covered in the current body of safety knowledge. Figure 1 is a conceptual model which illustrates the relationship of strategic safety management to the other relative themes contained in this manuscript.

Figure 1. A conceptual model which illustrates the relationship of strategic safety management to the other relative themes

Behavior-based safety management:

A behavior-based approach to industrial safety management has been advocated by many authors and has been found to effectively improve safety performance in different industrial settings and on different continents. Behavior-based safety management techniques aim to motivate employees to improve their performance. In most instances, an analysis of hazards associated with an employee's job is carried out and specific behaviors representing safe and unsafe practices are identified. These behaviors then become central to the measurement of employees' safety performance. Measurement is carried out, using a behaviors pacific instrument, by directly observing employees at work. Motivational activities that focus on the desired behavior are then implemented and employees' behavior is monitored. These techniques of performance measurement, participative goal setting, and the provision of performance feedback were introduced in a carefully controlled field experiment on seven public housing construction sites. Behavior-based safety techniques were highly effective in bringing about improved performance in site housekeeping, but significant improvements in access to heights were only observed on two of the seven sites, and there was found to be no significant improvement in the use of bamboo scaffolding during the experimental intervention. This paper discusses factors that may have contributed to the limited effectiveness of the techniques in the latter two performance categories.

Psychological, Environmental and Corporate Safety

Safety culture has three dimensions: psychological, environmental and corporate. The psychological dimension refers to safety climate, which encompasses the attitudes and perceptions of employees towards safety and safety management systems. The environmental dimension is concerned with what employees do within the organizational conditions. The corporate dimension refers to the organization’s safety policies, operating procedures, management systems, control systems, communication flows and workflow systems. Developing a strong safety culture requires managers to focus on developing five sub-cultures: informed (collective alertness towards things that could go wrong), reporting (the readiness and willingness to report safety issues), just (the organization’s willingness to be accountable towards safety), learning (the willingness to learn and change), and flexible cultures (the ability to decentralize during emergency) The safety culture maturity of an organization can be measured by how the subcultures are manifested in each safety culture dimension.

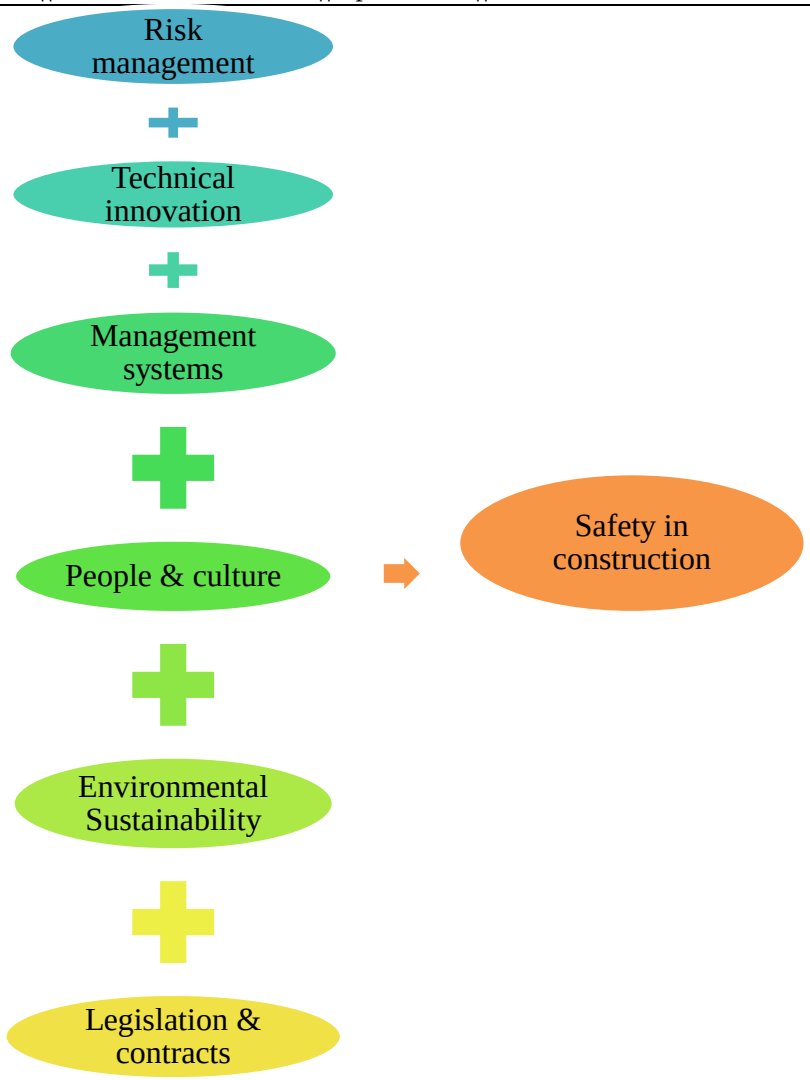

Figure 2. Indicative interfaces between safety and other domains of research and practice in construction projects

Safety research methods and research-practice nexus

Performing safety research is a viable strategy to ensure continuous safety performance improvement. This paper presents three research methodologies (quantitative, qualitative and mixed methods) commonly used in social science research and the philosophical assumptions behind them. The analysis on recent safety-related research found that quantitative methodology was the dominant methodology.The integration of the realms of theory and practice is crucial to ensure the practicality of research findings, which leads to real safety improvement. Consequently, this chapter proposes a mixed-methods research design to exploit the strengths of both quantitative and qualitative methodologies, and to achieve a safety-research practice nexus through iteration between the realms of theory and practice to promote co-production of knowledge by researchers and practitioners.

2. Safety Dimensions

Safety climate

The origin of safety climate perhaps can be traced back to the idea of organizational climate coined in the 1930s. Thereafter, research on organizational climate evolved into studies on the perceptions of the workforce towards the social and managerial aspects of the work environment. Today the concept of organizational climate is widely accepted as an indicator of organizational effectiveness. The term safety climate itself was first used by Zohar (1980) when he conducted a study to measure the safety climate of Israeli industrial organizations. He defined safety climate as ‘a summary of molar perceptions that employees share about their work environments’.

A construction organizationmaybemanagingmanyprojectsconcurrentlywhereeachproject is a unique work environment with a different safety climate condition. A study by Sunindijo and Zou (2012) shows that even within one project there may be different and separate levels of safety climate. Project personnel at the managerial level may have different safety perceptions and attitudes to that of the supervisors or workers. Recognizing these differences is important for aligning safety performance through out the organization and project.

Safety culture

Construction safety culture can thus be defined as an assembly of individual and group beliefs, norms, attitudes and technical practices that are concerned with minimizing safety risk sand exposure of workers and the public to unsafe acts and conditions in the construction environment (Zou,2011).

There are three distinct but interrelated dimensions of safety culture: corporate, psychological and behavioral. The corporate dimension can be described as what the organization has, which is reflected in the organization's policies, operating procedures, management systems, control systems, communication flow sand work flow systems. The psychological dimensions about how people feel and think about safety and safety management systems. The psychological dimension of safety culture actually refers to the safety climate of the organization, which encompasses the attitudes and perceptions of individuals and groups towards safety (Wiegmannetal.,2002). In the OGP culture study, the maturity levels from low to high are listed as follows (Hudson,2003,2007): Pathological: Safety is a problem caused by workers. The main drivers of safety are the business and a desire not to get caught by the regulator, Reactive: Organizations start to take safety seriously but there is only action after incidents, Calculative: Safety is driven by management systems, with much collection of data. Safety is still primarily driven by management and imposed up on rather than looked for by the work force, Proactive: The workforce assesses and responds to safety risks proactively by using standard methods, processes and safety management system, Generative: Safety is perceived to be an inherent part of the business. Organizations are characterized by chronic unease as a counter to complacency. There is active participation at all levels.

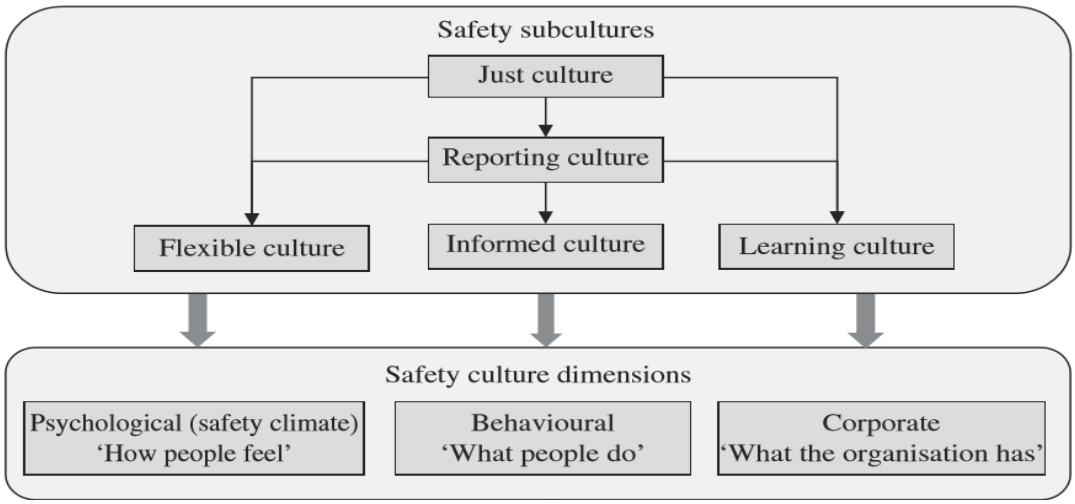

Figure 3. Construction safety culture maturity measurement framework

3. Skills Model for Safety Management

Construction is known as an ambiguous work environment because of the wide variety of components that have to be managed. Various external and uncontrolled factor sand forces may create uncertainties and influence the achievement of business objectives. Therefore, the four sets of essential skills, comprising conceptual skill, human skill, political skill, and technical skill, for project management personnel to perform their safety leadership roles. On the bases of review of 16 studies on managerial skills from the fields of general management, project management, and construction management, the figure is scaled for better framework of skills for safety in construction projects.

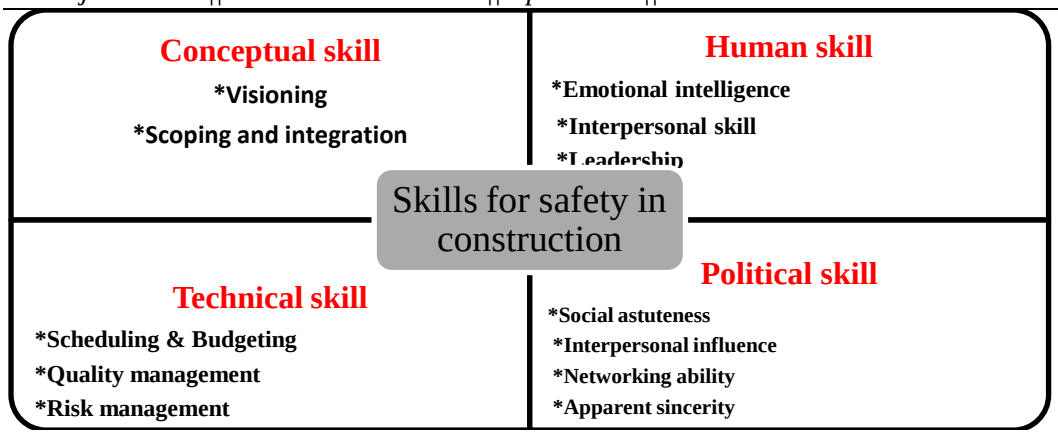

Figure 4. Skills for safety for construction and or large scale projects

Due to the diversity of construction project systems, conceptual skill is paramount in ensuring that the systems function as an integrated whole (Goodwin, 1993). When there is a change in one system, the impacts should be considered against different indicators, such as control strategies, budget, schedule, and environment (Katz, 1974). This conceptual skill is also useful for viewing the project as one of many inter-related projects within the organization. In the context of safety management, project management personnel need conceptual skill to appreciate the impacts and necessities of good safety practices towards the workers and their families, the organization, the community, and the achievement of project objectives. Conceptual skill provides (as shown in figure 5) an overall view and understanding on the roles of safety in a construction project, thus helping project management personnel realize that safety is actually an integral part of the project.

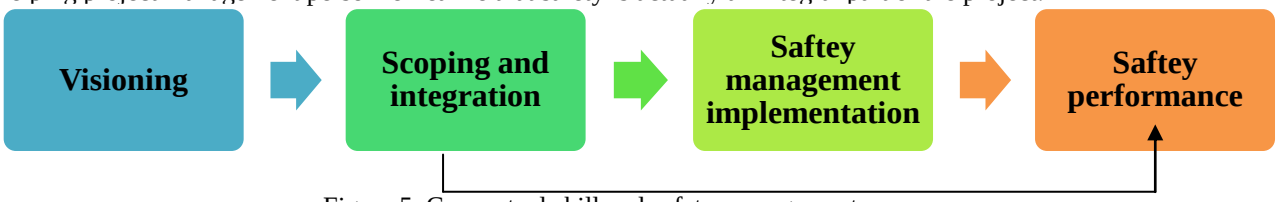

Figure 5. Conceptual skill and safety management

Humans kill is referred to as the ability to work with and through other people (Goodwin,1993; Katz,1974), which is understandably crucial in a construction business due to the involvement of various stakeholders and its labour-intensive work nature. This is also true when it comes to safety where project management personnel depend on the others to perform the work in a safe manner. Furthermore, project management personnel need to use political skill to cultivate relationships with the power holders and make the deals that are needed to improve safety. Political skill also enables project management personnel to adapt their behavior and influence tactics to suit others, thus inducing others to implement safety strategies for generating and maintaining as a safe work environment.

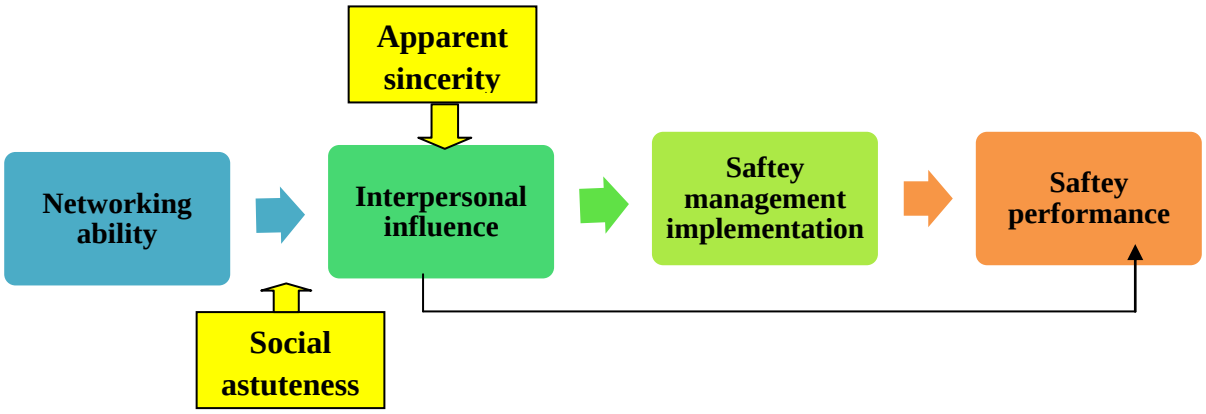

Figure 6. Conceptual model of political skills framed for construction projects.

In relation to safety management, project management personnel have to exercise their technical skill to ensure that all site activities are performed in a safe manner. There are different components of technical

skill have been identified as shown in figure 7, particularly relevant in the construction context (Sunindijo & Zou, 2011).

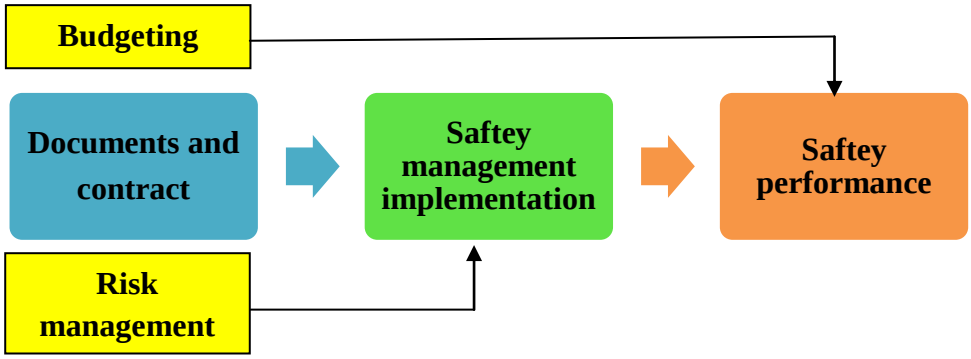

Figure 7. Technical skill and safety management framed for construction projects.

The first component is scheduling, which involves an understanding in determining the dates when different activities will be performed, recognizing activities that drive other activities. The second component is budgeting and cost management, which involves determining the types and quantities of resources needed to perform various project activities, developing cost estimation for all resources, allocating the budget to individual work activities and controlling changes to the project budget (Project Management Institute, 2013). The third component is quality management, which includes activities such as identifying relevant quality standards and determining how to meet them, evaluating project performance periodically to provide confidence that the project will meet the standards and monitoring specific results to determine their compliance with the standards, as well as finding ways to eliminate unsatisfactory performance (Farooqui et al., 2008). The fourth component is document and contract administration, an understanding of procedures for implementing construction contracts according to the accepted practices and regulations within the construction industry. In addition, it includes the setting up of a management system for keeping records and reports of daily activities (Fisk, 1997). The fifth component is risk management, normally involving five steps: establishing the context, risk identification, risk analysis, risk evaluation and risk treatment. The sixth component is procurement management, which includes the processes required to obtain goods and services from outside the organization or from external parties such as consultants, subcontractors, vendors, and suppliers (Project Management Institute, 2013). In relation to safety management, project management personnel have to exercise their technical skill to ensure that all site activities are performed in a safe manner.

4. Safety Risk Management

A number of different approaches and tools have been developed so that safety risks can be identified either during the designing process or via a project design review process. These processes include design reviews and checklists used to identify, assess and mitigate safety risks in a projects design. Designers and engineers in charge of designing should include safety as one of the key tasks and objectives during project design. Risk management has become an important management tool due to the potential detrimental impact of a risk on businesses. British Standards BS6079-3:2000 defines risk management as a systematic application of policies, procedures, methods, and practices to the tasks of identifying, analyzing, evaluating, treating, and monitoring risks (British Standards Institution, 2000). In which, risk identification process of identifying which risks may affect the safety objectives a documenting their characteristics. The risk identification process should be systematic and include not only what the risks are, but also where, when, why and how they might happen (McGeorge & Zou, 2013). Similarly, Risk analysis and evaluation process. Outcomes of the risk identification process is a list of hazards and scenarios that could represent a threat to project safety objectives. These need to be analyzed to understand their potential impact on the safety objectives so that they can be ranked and prioritized. Risk analysis aims to determine risk magnitude which is a combination of a risk's consequence and its likelihood. Risks can be quantified by the following formula:

Safety risk magnitude= likelihood of occurrence × severity of resulting harm.

Risk treatment, response and control having identified and analyzed the risks, the next step is risk response and control, which is an action or a series of actions designed to deal with the presence of risk (McGeorge & Zou, 2013). In this step, the level of risk determined in the analysis process is compared

against criteria of whether to treat the risk. The options are: no action is required, the risk is monitored, the risk level must be reduced using existing knowledge, the design must be changed, and further analysis is required to define the best controls.

Figure 8. Risk management model for construction projects

5. A Case Study

Using the proposed methodology, a safety survey was conducted in construction sites. The survey showing the intensive injuries in different parts of body parts of the workers, presented in figure 9.

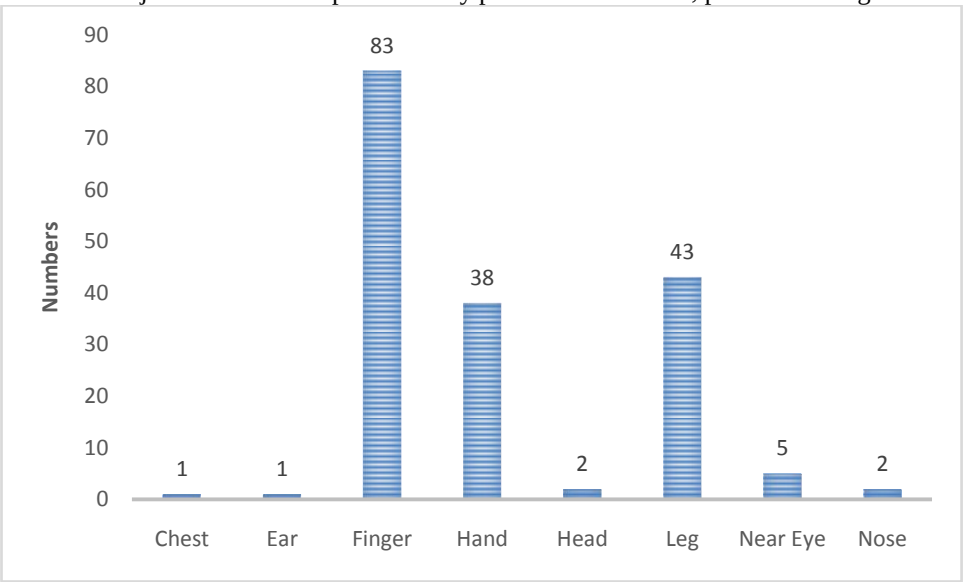

Figure 9.Numbers of workers having different injuries at construction sites

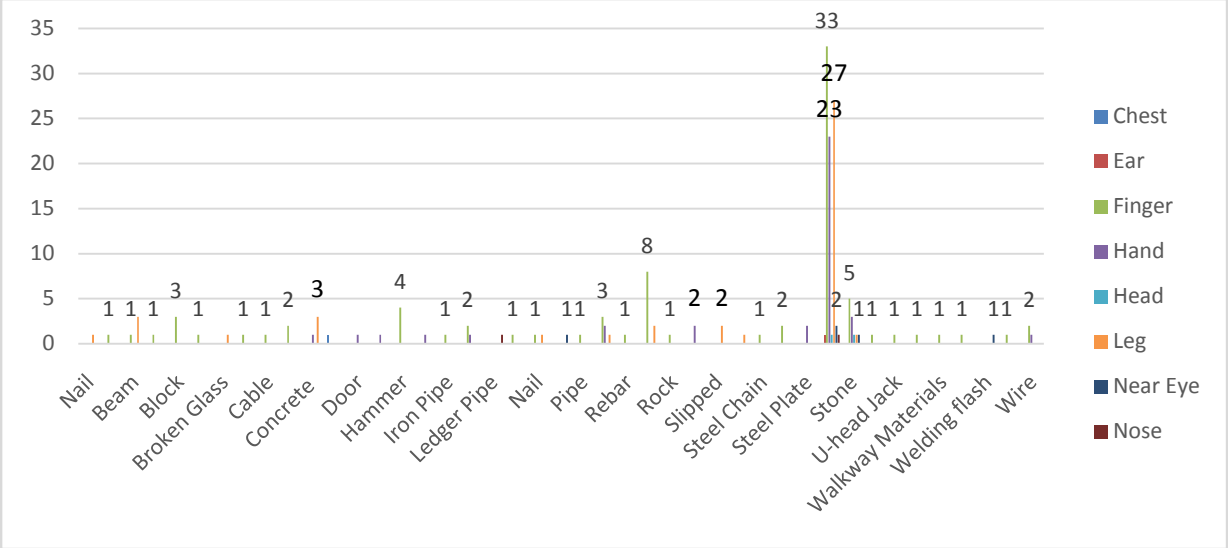

Figure 10. Injuries risk of different body part by different construction materials

It is found that 88 workers injured by steel rod, in which > 90% unskilled (Helper) persons. They have no any professionals skilled to work. So, they were engaged in shifting of steel rod from one place to another at the site. It is need to provide them training and awareness that How to shift steel rod from one place to another. How many persons should be engaged during shifting of material? Which type of Personal Protective Equipment's (PPEs) should be required to wear? It is observed that maximum injury occurred to Helper having working experience less than ½ year. These helpers mostly belongs to village, which engaged in agriculture work. They comes in city for part time job for only 2-3 month. They have no any professionals skilled to work, so they are hired as a helper to work with skilled persons. They are not aware about safety measures at working site, Personal Protective Equipment's (PPEs) etc. These unskilled persons change their location and occupation 2-3 times in a year. They cannot got professionals skilled for any specific work, because their location and work changes in every 2-3 month. It is main reason that unskilled persons get injured easily at site.

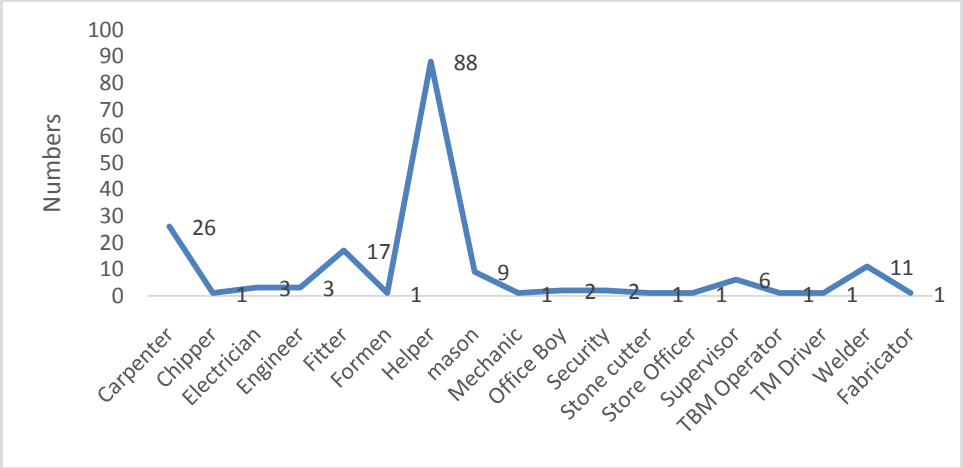

Figure 11. Numbers of injuries to different level of resources persons involve in construction sites

6. Conclusion

Developing safety culture for a construction projector organization does not occur overnight; it is a journey rather than a destination, and it requires a commitment from top management and supervisors, right down to individual employees' involvement over an extended period of time. Construction organizations adopting a new approach to safety management must continue to champion the new philosophy, value, and belief, and to monitor performance, while learning the lessons and feeding them back into business processes and management practices. These efforts must be supported by an effective training, motivation and performance appraisal system to reinforce appropriate behaviors. The vision of 'zero incidents' can be achieved only by

balancing the two side softheco in, the 'science' and 'art' of safety management in construction.

Project management personnel have important roles in developing, implementing and evaluating safety management strategies in construction projects. This paper has discussed four essential skills (and their components), namely, conceptual skill, human skill, political skill and technical skill, in order for project management personnel to play their safety roles successfully in construction projects. The proposed skill development model provides simplified relationships between the skill components and suggests how project management personnel should develop their skills for safety. The model should help senior managers and project management personnel simplify and make sense of the complex social process involved in the sekill development and application to influence the implementation of safety strategies. The implementation of the safety risk management process is fundamental to overcome these barriers. The risk management process has been detailed in this paper, together with case studies on the implementation of safety in design in the construction Projects.

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