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ENHANCING SAFETY IN CONSTRUCTION SITES BY GAP ANALYSIS

ASWANTH T S, Dr. D. BHUVANESHWARI, Dr. A. KUMAR

Department of Civil Engineering, RVS TECHNICAL CAMPUS, Coimbatore.

INTRODUCTION

Identifying the critical factors affecting the successful implementation of safety programs from safety literature and previous research and evaluating these critical factors in order to rank them and finding out the gap according to its importance and actual status in construction sitesand to provide recommendations for reducing the gap

.BACKGROUND

Construction industry is generally considered as accident-prone industry. In developing countries such as India, construction is more labour-intensive than that in the developed areas around the world. It has always been reported that construction work has a very high rate of injuries and deaths, since the workers were exposed to different kind of hazards day-by-day according to the variation in construction projects. Hence, there is a negative label regarding safety in the construction industry. Nowadays, most of the construction industries have considered safety as an important aspectwhich plays a vital role in maximizing the return on investments by reducing the cost associated with the work related accidents and injuries. Proper and effective safety management would save and protect life of workers and improves the morale and motivation of workers which leads to higher productivity.

Effective safety program is established, implemented and maintained in a construction project indicates an outstanding safety performance. Management can eliminate unsafe practices of workers by implementing effective safety programs which reduces accidents substantially, and will create safe working environments. There are certain activities or factors necessary for the successful implementation and improvement of safety program, which has to be taken into consideration.Most of the construction companies do have a safety policy on paper, even though employees are unaware of its existence. Nonetheless, most of the constructors do have a concern over safety and have implemented certain safety procedures.

There are several factors needs to be studied to implement a successful safety program. Studies have been undertaken to spotlight critical factors or activities which contributes for the successful implementation of safety program such as

involving workers in formulation of safety programs, support from the top management, allocating resources sufficiently etc. If these factors which decides the success of a safety program are not implemented properly and successfully, failure of the safety program may be miserable. So that they are considered as the critical success factors.It has been recognised and confirmed by safety researchers that the performance of a safety program depends largely upon these critical success factors. It is very important to identify critical success factors and evaluate them, so that it can give a clear idea about the urgency of improving these factors and rank them accordingly. So in these days, it is important to carry out Gap Analysis to measure the difference between degree of importance of critical success factors and actual status of the same in various construction sites, to obtain these rankings. The results from these studies will be helpful for the construction industry, to improve these critical success factors and to implement them successfully in safety programs. (Aksorn and Hadikusumo (2008))

OBJECTIVES

- To find out critical factors which influence the success of safety program by reviewing various literatures.
- To evaluate and rank these factors by finding gaps of existing safety management system with respect to recommendations of OHSAS 18001-2007.
- To provide recommendations for effective safety management.

METHODOLOGY

- Literature Review: An inclusive literature review was done of various articles from journals, newspaper etc.
- Conduct an on-site analysis of actual status of safety management by approaching construction professionals, using questionnaire survey.
- Assess this actual status against recommendations of OHSAS 18001-2007 to find out the gaps and rank them accordingly.

LITERATURE REVIEW

The purpose of this literature review was to survey literature relevant to this study. What is construction safety, how safety has an impact on construction industry, what is safety management, and what all factors influences the successful implementation of a safety program has been explained in here.

2.1CONSTRUCTION SAFETY

In construction industry safety is considered as a complex phenomenon, and

it will be more so when it comes to safety performance.In one side, safety is dealing with human cost of pain and misery in an accident, and on the other side it deals with delays in project including schedule on milestones, duration and cost overruns. If construction accidents occurring are 90% which leads to death, 70% of it could be prevented by proper safety management.(NING De-chun et.al; 2010).

Fang, Huang and Hinze (2004) has conducted a Benchmarking Study on Construction Safety Management in China which gives information to measure safety management performance in various construction sites. As far as they are concerned safety performance are assessed by evaluating the physical safety conditions on site and records of the accidents happened. They have paid little attention to the management factors which effects site safety.The authors has identified critical factors that influence safety management and a method for measuring safety management performance on construction sites has been developed. From this study it was clear that safety management performance on site was closely related to organizational factors, economic factors, and factors related to the relationship between management and on site labour. A practical safety assessment method was developed and then implemented on six construction projects based on this benchmarking study. Conclusion is that this method can be considered as an effective tool to evaluate safety management on construction projects.

Carcano and Franco-Poot (2014) have conducted a study on Construction Workers Perceptions of Safety Practices which is a case study in Mexico. In a construction site, Worker perceptions and Organizational characteristics are the main factors affecting the safety climate. Even though some perceptions of workers may seem ridiculous to others, these components were part of their representativeness. In workplace safety, worker behaviour was an extremely important factor as many accidents were often caused by insecure actions, in which combinations of human behaviour were the consequence of such perceptions. To explore workers perceptions of safety practices in their habitual work environment, a building site in Mexico was the main aim of this study. Worker perceptions of safety practices were captured using an instrument in which Education and training, Work motivation, Family and social integration, Work place and Safety awareness integration, and Accidents were taken under consideration. The authors concluded that workers have possessed a limited culture of safety awareness since they have received very little education about safety precaution, which was perceived as the main cause of accidents.

For the successful implementation of a safety program, a set of factors called as CSFs has a great impact. The safety program would fail catastrophically, if the objectives associated with CSFs are not achieved. So that, CSFs are considered essential to the success of any safety

program.(Zubair, Kanya Lal and Allah Bux (2013)) carried out a study in Pakistan construction industry to identify the critical factors affecting the safety program performance. To highlight the influence of the Construction Safety Factors a questionnaire survey was conducted. The author found out that critical factor for implementing the safety program on projects is management support. From statistical test, the author further concluded that management support factor as CSF (Critical Success Factor) which has been favoured by all respondent groups.In general, successful implementation of a safety program comes from desired events or things that need to happen. Amount or the extent of injuries to people, damage to equipment, machines and tools, loss of market share; damage to environment, damage to company image or brand name, increased productivity etc. are considered for measuring the success of a safety program.

CONSTRUCTION ACCIDENTS

General Information

(Karan Singh (2014)) Construction accidents are costly in human and financial terms. While considering construction safety, economic cost is not the only basis on which a contractor should be concerned. Humanitarian concerns, economic reasons, laws and regulations, and organizational image are the main reasons for considering safety. There are two ways for an organization to pay cost of safety. It is either through the uncontrolled cost of accidents or through the controlled cost of safety program. The uncontrolled cost of accidents consists of administrative time for investigations and disruption of schedules, loss of productivity, wages paid to the injured workers, adverse publicity, liability claims, and equipment damage. The controlled cost of safety program includes salaries of safety, medical, clinical personnel, expenses for safety meetings, inspections of tools and equipment, orientation sessions, site inspections, personal protective equipment, and health programs. It is a complex process to identify the root causes of construction accidents. Mitigation of accidents requires aninclusive understanding of construction process. Many projects have been carried out in congested spaces of cities, like Mumbai, Pune, Delhi, Chennai, etc. due to increase in population and expansion of urbanization. Not only the safety of the workers inside the site needs to be ensured but also the safety of people passing and residing in the adjacent should also be taken care of. Still there are accidents happening like, adjoining residents being killed in mishaps, pieces of reinforcement falling and piercing in someone's body, health hazards due to dusty environments of construction sites, etc., which is capable of bringing a legal stay over the project. Instead of making errands of walks to court could have been prevented if precautionary measures would have been taken. Construction industry plays a vital role for contributing 10 percent of a developing country's GNP, when accident statistics is considered in the economic point of view. As compared to a manufacturing industry,

construction industry is very hazardous with almost six times as many fatalities and twice as many injuries per hour. Helander analysed the occurrence of 739 construction fatalities in UK. What he found was that 52% occurred due to falls from roofs, scaffolds and ladders. 19.4% of deaths was due to falling objects and material, and transportation equipment (e.g. excavators and dumpers) were involved in 18.5%. He also found that 5% of construction accidents occur during excavation work. The categories that has been used for classifying fatal accidents were:

a) Falls
b) Falling material and objects
c) Transport and mobile plants
d) Electrical hazards
e) Other

Accidents that involved falls occurs mostly during work on roofs, scaffolds and ladders. Furthermore, collapsing of structures and falling materials also contribute for a large proportion of victims. Many of the hazards in safety are specific to different trades, and generally construction workers underestimate the hazards in their own work which in turn affects the motivation for adopting safe work procedures. It is possible to avoid a large proportion of these accidents, by establishing certain procedures and regulations to enhance safety. Also there are forceful financial incentives in construction safety as it is estimated that construction accidents amount to about 6% of total building costs and this in turnencourages the industries as well as the regulatory agencies to invest in construction safety.

Construction industry accidents represent a considerable on-going cost to employers, workers and society (Haslam, et al., 2005). Many parties in the construction industry have become very interested in finding ways of reducing construction related injuries and fatalities in the past decade (Jaselskis, Anderson and Russell, 1996; Everett and Frank, 1996; Joyce, 2001). Most of these interests have been deep-rooted in the escalating costs of injuries which attributed largely to the rising costs of insurance andmedical treatment.

When compared with other industries, construction industry has the second worst industrial record for health and safety in the world (Bomel, 2001). Lost productivity and overtime has been considered as the total financial impact of costs and it is estimated as much as $240 billion (about R2000 billion) in 2002. (Lopez, Ritzel, Fontaneda and Alcantara (2008))conducted a study on construction accidents in spain. They analysed how severe the industrial accidents that take place on construction sites. 18 variables were studied. They analysedwith respect to severity and fatality of the accident and was grounded in 1,630,452 accidents, representing the total number of accidents suffered by workers in the construction sector in Spain over the period 1990-2000. The authors concluded that age, type of contract, length of service in the company, company size,

time of accident, day of the week, and influenced the seriousness of the accident.

Direct costs for workers compensation in the United States were estimated as $48.6 billion (which is about R400 billion) for the most disabling workplace injuries and illness in 2006.(Bomel, 2001) By adding the indirect cost of workers compensation claims to be $38.7 billion (which is about R320 billion) in direct costs, the total economic burden of workplace injuries and illness has been estimated far greater ranging between $125 billion to $155 billion (between about R1000 billion to R1250 billion). The worst-case scenario was that accidents and injuries cost in excess of 15 percent of total construction costs (Everett and Frank (1996))

2.2.2 Cost of Construction Accidents

2.2.2.1 Direct cost

The costs of accidents that are incurred due to the treatment of an injury are direct costs and are normally reimbursed by workers compensation insurance. This comprises of medical costs, premiums for workers, compensation insurance, liability and property losses (Kapp et al., 2003). According to Griffin (2006) costs that are directly associated and payable by the employer or the insurance carrier on the employer's behalf are called direct costs. These costs were usually easy to establish and to quantify.

2.2.2.2 Indirect cost

Indirect costs of accidents consists of uninsured losses from damage to buildings, equipment, tools, products and materials,disruption of business operations, productivity lose which requires overtime to make up for delays caused, backup employees inefficiency, cost of training new employees, increase in insurance premiums, and damage to a company's reputation. (Griffin (2006))

There are several hidden costs associated with construction accidents. To quantify most of these costs are difficult and occasionally impossible. (Jallon, Imbeau and de MarcellisWarin, 2011). Basically, potential indirect costs as a consequence of construction accidents includes the following, namely:

- Disruption in production immediately following the accident
- Lower morale of workers effects on co-workers
- Allocation of personnel for investigating and writing up the accident
- Costs incurred for the recruitment and training of replacement workers
- Unidentified damage to equipment and materials and allocation is done through routine accounting procedures
- Reduction in quality of the product following the accident
- Reduction of productivity due to injured workers on light duty

- Damage of product
- Damage to plant and equipment
- Legal costs
- Delays in production
- Injured person transportation
- Loss of workers efficiency
- Use of temporary staff and overtime work
- Investigation costs
- Loss of experience and expertise.

CONSTRUCTION SAFETY PERFORMANCES IN DEVELOPING AND DEVELOPED COUNTRIES

There is so much variation in occupational structures, conditions of working environment and the health status of workers in different parts of the world, in different countries and in different areas of the economy. Hence, construction industry structureis not consistent around the globe. Nowadays, construction industry plays a vital role in the economic growth of any country, especially a developing country. It provides the infrastructure required for other sectors of the economy to prosper. Many studies have pointed out that construction industry plays a key role in bringing forth the economic development of a country. Everywhere in this worldconstruction industry faces difficulties and challenges. Nonetheless, in developing countries, as compared to developed countries, these issues and challenges are present together with a general level of socio-economic stress and a reduced productivity rate. (Ofori, 2000). Though it is presumed that the construction industry gives a good opportunities for different levels of employments and skills, from a general labour to semiskilled, skilled to specialist workforce.

Construction Safety in Developed Countries

In developed countries such as United States, construction deals with 13% of the gross national product and 5-6% of the labour force. It is also considered as one of the most dangerous industries, accounting for 15 percent of the occupational fatalities and 17 percent of all workers' compensation costs (Hoonakker et al, (2003)). The causes of accidents are majorly related to the unique nature of the industry, human behaviour, difficulties due to work-site conditions, and poor safety management, which in turn results in unsafe work methods, equipment, and procedures. When it comes about construction safety in USA, the role of OSHA in setting standards is impossible to ignore as it comes for safety and saving workers' rights of health and safety in construction and other industries. In 1970, the Congress passed the Occupational Safety and Health Act (OSH Act) where its essence is that workers should have been expecting a safe place to work. When the OSH Act was approved, it established three different agencies; one among it is the Occupational Safety and Health Administration (OSHA). OSHA standards focuses on general industry together with maritime, agriculture, and construction (Hinze, (1997)). Even though OSHA standards have been in force for more than 25 years, fatalities and injuries are still

higher. So it is essential to emphasize the role of OSHA consultation as regulations which is set to prevent accidents not to solve problems after they had happened. OSHA reported that in 2000, the injury rate of construction companies with more than 1000 employees was 4.3 while the construction industry rate was 8.2 (Howell et al, 2002). OSHA legislation, increased legal process, increasing worker medical expenses and compensation insurance costs gave advantage to contractors to get safer. (Howell et al, 2002). (Hinze and Bren (1996)in their study stated that accident causation in construction has habitually been attributed either to unsafe work conditions or to unsafe worker practices. The primary emphasis of research studies has been on unsafe worker practices in the past two decades. Unsafe behaviour is considered as the most significant factor which causes site accidents in construction industry and therefore provides evidence of a poor safety culture (Cited in Sawacha et al, (1999)). Accidents at work can be occurred either due to lack of training or knowledge or a lack of supervision or a lack of resources to carry out the task safely, or due to an error of judgment and carelessness (Enshassi, (2003)). In USA, after the increase of attention paid to safety issues, it is very common that most of the companies have their own safety programs. Even though an effective safety program can prevent or reduce injuries, not all contracting organizations implement safety programs. The traditional safety programs do not improve the results of safety always because they are centred solely on the technical requirements and on short-term results (Weinstein in Herrero et al, (2001)). During the tendering process, owners would not consider the pre-qualification of contractors on safety and health, so thatif one firm makes an allowance for safety and health requirements and the other does not will subsequently has financial advantage and will win the tender. (McWilliams et al, (2001), Enshassi, (2003)).

Construction Safety in Developing Countries

Construction in developing countries are more labour intensive than that in the developed areas around the globe (Koehn et al (1995)). However, construction safety is given a top priority in these countries also. Sohail (1999) in his research stated that construction industry is economically very much important as it typically contributes 10 per cent of GNP of a developing country. Only 5-10 percent of workers in developing countries and 20-50 percent of workers in industrial countries (exceptions applied) are estimated to have access to adequate occupational health services (Hogstedt and Pieris, (2000)). In spite of recent efforts to improve safety in the construction industry, statistics show that the accidents and injuries rate is still significantly higher in construction industry than most of other industries. These poor figures of safety in developing countries wasclear in statement of Jaselkis et al (2002) that greater determination is necessaryto control a construction project in a developing country especially in the areas of quality and safety. For example in

Hong Kong, Safety is considered as one of the most difficult issues facing the construction industry in there, since the accident rate in construction is reported as highest when compared to other industries. (Ahmed et al, 2002) In his study, emphasized that preventing occupational injuries and illness must be the primary concern of all employers. He also specified that, safety of both project personnel and construction workers cannot be guaranteed by the legislation alone, also safety should not be the sole responsibility of the employer or the contractor. Employees need to be involved. Features of construction safety in developing countries are as follows (Koehn et al, 1995):

- A significant difference is there between large and small contractors. Most of the large firms do have a safety policy, on paper, but generally employees are not aware of its existence.
- The prime concern of majority of contractors is maximizing profit – not safety.
- Generally injuries are unreported; yet, if necessary, a labourer might getfirst aid or preliminary medical care.
- Workers consider accidents as due to their own negligence by themselves, andwill acceptthat construction is a dangerous occupation.
- When work commences owners and consultants do stress safety, but as the workprogresses they will be concerned moreabout deadlines of the work and will be given priority to that and they tend to pay lessattention to safety.
- Compensation will be paid normally in the event of the death of a worker.
- Work sites will be periodically inspected by government officials to enforce compliance with the rules and regulations endorsed by the foregoinglegislation.In most of the cases, inspections are not regularly conducted.

Two key differences can be recognized in selecting diverse approaches to health and safety in developed and developing countries. The existence of legislation and its efficient execution is the most important thing; and the second is hazard awareness. Many laws and legislations exist in developed countries and they are executed effectively. Health and safety supervisors appointed will promote hazard awareness with the help of frequent safety training programs. However, in developing countries health and safety rules hardly exist at all. The construction industry in developing countries areusually underdeveloped, dysfunctional or non-existent. Many developing countries, particularly in Africa and Asia, do not have reliable national building codes and regulation. They are inappropriate wherever they exist, also out of date, ineffective, outmoded and based on conditions which prevailed while they were still being occupied. For example, consider the condition in India, there are no training programs for workers or

supervisors, no orientation for new staff or workers will be carried out; hazards would not behighlighted and no health and safety meetings are held (Koehn et al., 1995). Employees and workers are supposed to learn from their own mistakes and practice. Besides, lack of medical facilities, poor housing and insufficient sanitation conditions tend to exist on remote projects. In addition, regulatory authorities are usually very inefficient in implementing rules effectively and work hazards are either not observed at all or identified as to be less hazardous than they actually are.

Construction industry in developing countries could be a tool for effective economic growth. In spite of such advantages for boosting economies higher risk level in construction sector is acknowledged globally. ILO (2005) estimated that more than 30 percent of worksite fatalities are happening in construction sector (Murie, 2007). Construction sector contributes less than 10% to GDP, but take up more than 37% of all industrial accidents that happens in Singapore (Teo, Ling & Chong, 2005). In developed countries, strong measures are adopted for reducing these risks to an acceptable level. For example, in Singapore, a code of practice for construction safety called CP 79 is compulsory for work value above US $ 5 million (Teo et al., 2005). Though, construction risks are often unnoticed in developing countries spanning from Asia to South America. The condition is not so different in the subcontinent also. ILO (1995) reported that the OH&S has not been developed in Bangladesh. The basis of existing occupational and health conditions of Pakistan's construction industry is unsatisfactory and fragmented (Tahua, (2006)).

SAFETY MANAGEMENT

(Husrul Nizam Husin (2008)) The term 'safety management' is actually used for convenience and for concision, and wherever it is used it must be taken to refer to the management of occupational health and the environment as well as safety. Safety management is concerned with influencing human behaviour and with limiting the opportunities for making the mistakes which would result in harm or loss. As described in Occupational Safety and Health (OHSAS 18001), Occupational Health and Safety Management System (OHSMS) is, "Part of the overall management system that facilitates the management of the Occupational Health &Safety risks associated with the business of the organization. This comprises of organizational structure, planning activities, responsibilities, practices, processes and resources for developing, implementing, achieving, reviewing and maintaining the organization's Occupational Health &Safety policy." According to the World Health Organization (WHO) the term safety management is: "the process of allowing people to increase control over, and to improve their health" (WHO 1990). Generally, Safety Management is a concept that brings forth a more comprehensive approach and which allows participation

and contribution of all levels of management and workforce. This management approach is actually developed from the conventional safety management (CSM), by taking all the characteristics and actual on-site risks into consideration. Indeed, it has the potential to increase competitiveness and to improve productivity of an organization. Effective safety management has three main objectives, they are;

a) To make the environment safe,
b) To make the job safe, and
c) To make workers safety conscious.

The concept of Safety Management has outgrown the need to transform safety and health management from a strict compliance orientation to performance orientation in which compliance is an important issue but not the only issue. Safety and Health should be a key element in an organization's plan for gaining aneconomical advantage in the market around the world. Purpose of it is to give organizations the sustainable competitive advantage of a safe and health work environment. Basically, safety management concept is very much similar to quality management. The concept of Safety Management is based on a well-organized system in which the main pillar for this system is the roles and responsibilities of the consultants or participants involved within the project. The conception of safety programs comes in a very wide scope and there is just no limitation on the strategies that can be taken to provide an efficient and effective health and safety planning and procedures to be practiced. As construction site is considered as the main source of fatalities and accidents in the construction industry, the concept of the safety management which stressed the importance of a well-defined organization.Eventually, this concept is seen to be having the potentials on eliminating the hazard risks that normally occur in construction sites.

Choudhry and Fang (2008) conducted a research on the behaviour focus and found that workers are involved in unsafe behaviour because of lack of safety awareness, putting on a tough image, work pressure, economic and psychological factors, co-workers attitudes, and organizational. The author suggested in his recommendations site safety can be improved only by listening to the viewpoints of the subcontractor's workers. The reason behind this suggestion was that the subcontractors are the people who deals with different situations that judge their action on how best to work safely on a construction project.

SAFETY PROGRAM

The safety program of a construction organization is a compact package which includes asafety policy, safety department to implement the policy, and specially trained personnel to man it. Generally, safety inspection program that has to befollowed in Construction site are;(T. Subramani, R. Lordsonmillar (2014)

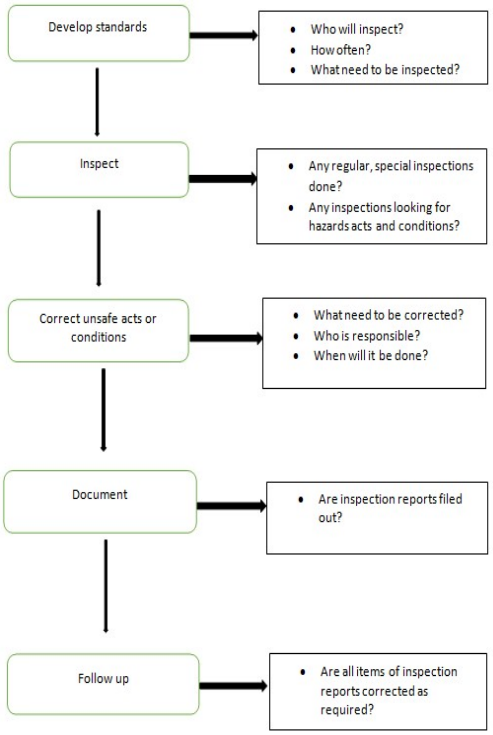

Fig 1. Safety inspection program in construction sites

CRITICAL SUCCESS FACTORS FOR THE SUCCESSFUL IMPLEMENTATION OF SAFETY PROGRAM

There are a set of factors that have a great impact on the success of safety program implementation. Those factors are known as Critical success factors. Critical success factors (CSFs) are the factors affecting the success of activities and projects, can be defined as "areas in which results, if they are satisfactory, will ensure success within and of the organisation" (Thanet Aksorn and B.H.W. Hadikusumo (2007)). Within the construction context, to identify critical factors associated with safety management, a great deal of research has been conducted. There are eleven critical success factors that has been identified from various safety literatures. They are; (S. Al Haadir and K. Panuwatwanich, 2011)

1. Communication
2. Continuing participation of employees
3. Personal competency
4. Safety education training
5. Clear and realistic objectives/ goals
6. Delegation of authority and responsibility
7. Adequate resource allocation
8. Management support
9. Safety meetings
10. Program evaluation
11. Efficient enforcement system/ schemes

Communication

The process of exchanging information between two or more people with regards to safety related issues is defined as safety communication. (Siu *et al.,* 2004). Communication is a medium through which useful exchanges between leaders and followers are structured, cultivated, and sustained. Another important aspect of organization is effective communication between a leader and the members. Effective safety communication according to (Vecchio-sadus (2007)) should include:

a) In an organization there should be an open and clear communication regarding safety among employees;
b) By providing feedback encourage safe behaviour;

c) Implement a lesson-learned programmed especially for safety.

Besides, (Cigularov *et al.,* 2010) stated that an effective communication plays an important role to engage workers in safety activities, to retain a positive culture, and to achieve support and cooperation.

Safety communication can be organised into two categories: formal and informal communication. Formal communication includes written formal communication, communication from upper management (superiors/supervisors), training and toolbox talk. In the meantime informal communication is communication among employees which at times referred to as ad-hoc communication (Alsamadani, 2013). In addition to that, Vecchio-sadus (2007) affirms that safety communication comes in various types, for example, workplace inductions, incident reports, safety performance, and policies and procedures. Downward communication, also called as upper management communication, is from upper to low level management. For example, communication between manager to immediate supervisor and from supervisor to subordinates. In this type of communication subordinates should receive information or instruction from their leader in order to do tasks or carry out daily work. A line of studies had considered and explored in the safety communication that takes place between supervisor and subordinates, as both of parties are the sets of people that are always involved in interactions on a frequent basis.

Continuing Participation of Employees

RESEARCH METHODOLOGY

This chapter discusses how the work was carried out in order to meet research aims and objectives. In the first section of the chapter philosophical assumptions and research strategy implemented for the study has been considered. It presents discussions of literature that inform about the different research strategies available which could be used as means of solving specific research problems. Data collection methods employed in the study are explained subsequently, followed by the research process adopted for the research study.

RESEARCH STRATEGY

There are two types of research strategies that has been used for questioning the research objectives. They are quantitative research and qualitative research. Quantitative research relies on the assumptions of an objectivist view of the social world. Therefore, objective methods ofmeasurements are used in the measurement in quantitative research which seeks out for data which are genuine or facts and to study the accordance of these facts and relationships with the theories and findings of any studies executed previously.There are two research methods which is been used in quantitative research, namely survey research and experimentation. Survey researchcomprises of either interviewing or

administering questionnaires to samples of researchrespondents which has been selected from a defined population by means of sampling procedures in whichthe phenomenon of interests occurs. In experimentation, under purposely controlled conditions created by the researcher, observations of the phenomenon of interest occur.

Qualitative research approach adopts a subjective view of knowledge of the real world.In practice, it adopts one of the two research methods or styles; field research (fieldwork or naturalistic inquiry) and nonreactive research.Field research includes observing and studying events and people firsthand in natural socialsettings.Whereas, nonreactive methods employ unobtrusive observational techniques, or studyarticles, archival records, official statistics and other by-products of past social life (Brewerand Hunter (2006)). Asignificantadvantage of qualitative research method is that it permits the investigator to interact with the research subjects in their language and on their own terms.The activities of the manager/ owner can be studied as required, the way management decisions are madeand how employees and persons are managed are agreeable to qualitative methods.

For collecting information from individuals about their activities and practices, beliefs, opinion etc. researchers used to employ interviews as the primary data gathering method. Interviews have a great power of tapping into the expert knowledge of an individual, depending upon the person who carries out the interview. It also helps to gather background information, present or past behaviours or experiences. On the other hand, some researchers go wrong on the side of not considering the gathering of background information or expert knowledge as an interview, hence do not pay close attention to the way questions are asked in such interviews, which in turn compromises the quality of data collected.

Questionnaires which are commonly used for data collection by interview are structured and semi-structured questionnaires. In structured interviews, the questions are arranged in a specific order and are fixed. That is, itconsists of closed or prompted questions with predefined answers. The researcher has to anticipate all possibleanswers with pre-coded responses. In this kind of survey, questionnaire will be read aloud, without being having any deviation from script. They are used in large interview programmes and may be carried out over the tele- phone, face-to-face or self-completion depending on the respondent type, the content of questionnaire and the budget.Major advantage of structured interviews over surveys includes lower levels of item nonresponse and the interviewer is able to alleviate inappropriate responses.But, in structured interview, if a respondent point out that they do not understand a question or a term in the question, the interviewer is normally limited to provide a previously scripted explanation. That is, beyond repeating the question, the interviewer is generally

unable to provide any explanation. The interviewer would read the questions and the response choices aloud to the respondent.

Semi-structured questionnaires consists of a combination of closed and open questions. They are usually used in business-to-business market research where there is a need is to accommodate a large range of different responses from companies. The use of semi-structured questionnaires facilitates us to gather a mix of qualitative and quantitative information. They can be managed over the telephone or face-to-face.

In this research semi-structured interviews have been conducted with experienced professionals working in construction projects.

FLOW CHART

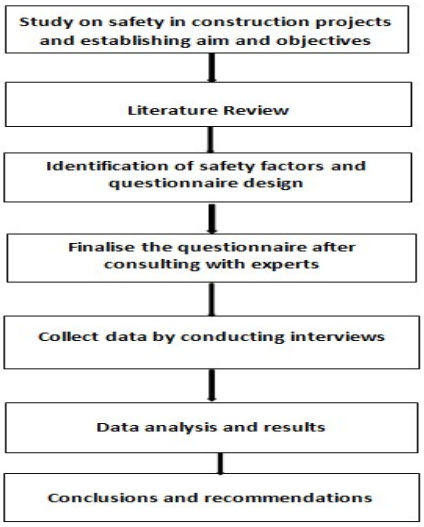

Fig 2. Research Methodology flowchart

GAP ANALYSIS APPROACH

Gap analysis is a business assessment technique used in order to compare the actual performance and prospective performance of a company. The term "gap analysis" comes from systems analysis and project management. This approach mainly refers to the analysis of gap between our today's statuses versus where you need to be in order to meet your project requirements.This enables the company an insight about the areas of improvement. Gap analysis comprises of defining the present state and the desired or target state, and henceforth the gap between them. Gap analysis is considered as problem-solving phase, which targets at finding ways to fill the gaps in order to reach the desired states. As it has mentioned in literature review, the success of a safety program depends largely on a set of factors, called as critical success factors. Therefore, it is necessary to investigate actual status of each of those factors and set a baseline which shows the degree of importance with respect to certain standards or recommendations for a successful safety program. Hence, gap analysis helps to pinpoint the barriers to successful implementation of a safety program by finding outthe gaps between degree of importance and actual status level. In practice, a questionnaire is the tool typically used for obtaining the required data for gap analysis in several researches. In this study, a questionnaire was therefore used for data collection. (Thanet Aksorn and B.H.W. Hadikusumo (2007)).

QUESTIONNAIRE SURVEY

A questionnaire has been designed by incorporating the applicable eleven factors or variables. A complete questionnaire comprises of two parts. First part is questions asking general information and project background of respondents, and second part is questions asking respondents to rate the level of influence of each success factors and to evaluate its actual status. The second part of the questionnaire is themain focus while conducting a survey. It intended to obtain the actual status of each factor based on the amount of care currently given to it in a successful safety program, as perceived by the respondents. Questionnaire was designed in such a way that corresponding to each critical factor identified, a question was designed by referring OHSAS 18001-2007 and a baseline was given to that factor according to the recommendations of the standard.

ANALYSIS METHOD

In this research,Questionnaire comprises of 4 maturity levels, and the baseline, which is considered as the degree of importance of these factors in construction sites was given in the fourth maturity level. Hence, while analysing the data, the responses obtained from various respondents, which is the actual status of corresponding factor will be subtracted from baseline, thereby obtain the gaps between the degree of importance of those factors with its actual status. This analysis is based on the fact that, large gaps between degree of importance with respect to the actual status of critical success factors indicates that those factors are most unsatisfactory as far as safety in construction industry is considered. Questionnaire has been circulated to various construction sites for responses, and face-to-face interviews was conducted in order increase the motivation of the respondents to provide right responses.

DATA ANALYSIS AND KEY FINDINGS

CHARACTERISTICS OF RESPONDENTS

Therespondents are categorised into two groups, viz. project managers and safety representatives. A construction project manager is the person who is having the highest authority in handling day-to-day activities and delivering the project, and is responsible for managing the implementation of the safety program, which aims to provide a safe and healthy environment on site. A safety representative in construction industry is defined as an individual, which includes a safety director, safety manager, or safety inspector, who is in charge of arranging safety for the construction company. The socio-economic information of the respondents is presented in Table 1.

Table 1. Socio-economic information of respondents

Socio-economic factors	Project managers	Safety representatives	Overall	%
Year of experience				
0-5 years	-	4	4	12.5
5-10 years	-	11	11	34.38
10-15 years	3	7	10	31.25
15-20 years	3	3	6	18.75
>20 years	1	-	1	3.13
TOTAL	7	25	32	100

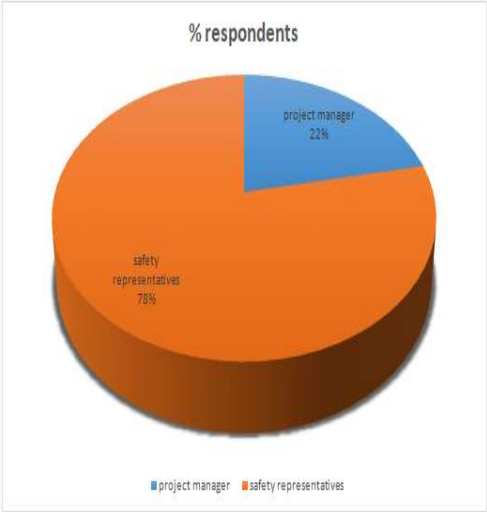

Chart 1. Socio-economic information of respondents

4.2 RANKINGS OF THE ACTUAL STATUS OF CSFS BY DIFFERENT RESPONDENT GROUPS

The breakdown of mean scores of actual status of eleven critical success factors as rated by the respondents from different occupations, namely project managers and safety representatives has been displayed in table 2. A panel of project managers gives a very high mean scores for actual status of five critical success factors namely, communication (mean=3.42) which has given top rating followed by safety education and training (mean=3.29), delegation of authority and responsibility (mean=3.14), safety meetings (mean=3) and clear and realistic objectives/ goals (mean=2.86). A panel of safety representatives rated communication (mean=3.56), safety education and training (mean=3.48), clear and realistic objectives/ goals (mean=3.36), delegation of authority and responsibility (mean=3.32) and personal competency (mean=3.24) with high mean scores. To examine the general similarity in the rankings of actual status between the panel of project managers and safety representatives, Spearman's rank correlation test was used to determine whether the similarity is significant or not. The Spearman correlation coefficient can take values from +1 to -1. +1 indicates a perfect association of ranks, 0 indicates no association between ranks and -1 indicates a perfect negative association of ranks. The closer is value of Spearman's coefficient to zero, the weaker the association between the ranks. The result showed that the Spearman's rank correlation coefficient was 0.918 and the correlation indicates a strong positive relationship between ranks given by both respondents is statistically significant at the 5% level. Therefore, it is inferred that the similarity of the rankings between project managers and safety representatives is very strong.

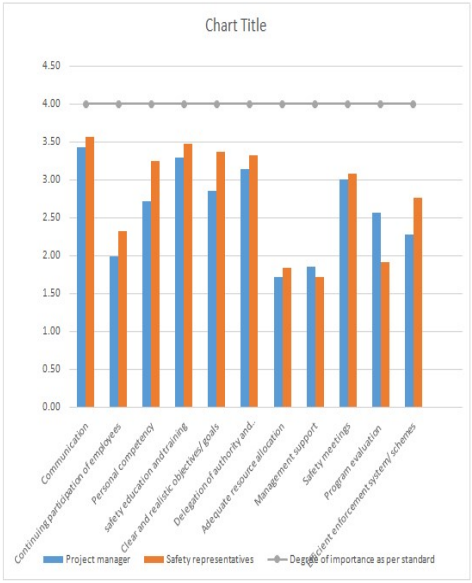

Chart 2. Gap between degree of importance and actual status CSFs by Different respondent groups

4.3 OVERALL RANKINGS OF THE ACTUAL STATUS OF CSFS

Table 2 illustrates the combined mean scores of actual status of critical success factors of every respondent's perceptions. According to the ratings given by them, five factors which are having best scores for actual status of CSFs are communication (mean=3.53), safety education and training (mean=3.44), delegation of authority and responsibility (mean=3.28), clear and realistic objectives/ goals (mean=3.25) and personal competency (mean=3.12).

Table 3. Overall Rankings of the Actual Status of CSFs

Sl. No.	Success factors	Degree of importance as per standard	Overall actual status			
			Mean	S.D	Gap	Rank
1	Communication	4	3.53	0.66	0.47	11
2	Continuing participation of employees	4	2.25	0.90	1.75	4
3	Personal competency	4	3.13	0.89	0.88	7
4	Safety education and training	4	3.44	0.66	0.56	10
5	Clear and realistic objectives/ goals	4	3.25	0.71	0.75	8
6	Delegation of authority and responsibility	4	3.28	0.72	0.72	9
7	Adequate resource allocation	4	1.81	0.77	2.19	2
8	Management support	4	1.75	0.79	2.25	1
9	Safety meetings	4	3.06	0.97	0.94	6
10	Program evaluation	4	2.06	0.86	1.94	3
11	Efficient enforcement system/ schemes	4	2.66	1.05	1.34	5

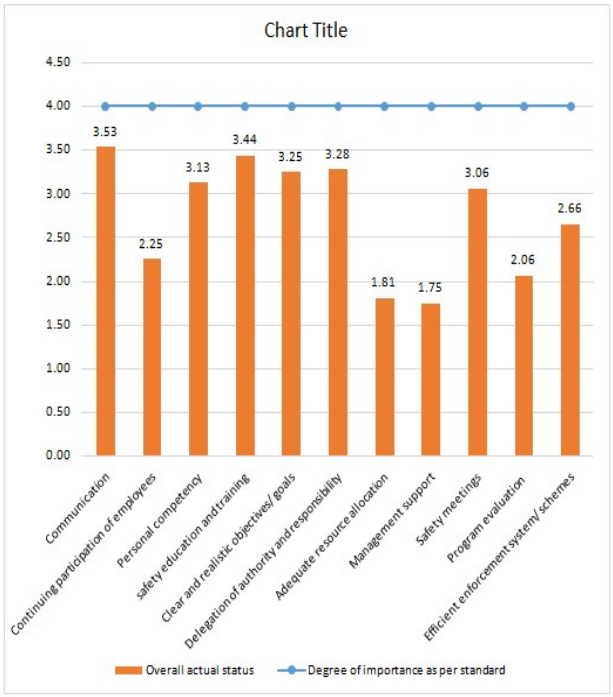

Chart 3. Gap between degree of importance and actual status of CSFs

GAP ANALYSIS BETWEEN DEGREE OF IMPORTANCE AS PER STANDARD AND THE ACTUAL STATUS OF CSFS

One of the major barrier to the success of a safety program in construction industry is insufficient attention to CSFs. Therefore, in this study gap analysis of the data has been done which shows the differences between the degree of importance of CSFs as per the recommendations in OHSAS 18001:2007 and actual status of each of these factors. Recommendations of OHSAS 18001:2007 has been set as a baseline for the evaluation. Gaps are found out by subtracting actual status from this baseline. That is for evaluation, the gaps are computed by subtracting the mean for actual status from the mean for the degree of importance as per standard. The gaps in the mean scores provided by the respondents can be a useful reference for construction managers when considering which all factors should be given the highest priorities for the improvement of safety in construction industry. Table 4 illustrates the rankings of the gaps between degree of importance as per standard and actual status for each of the 11 factors, as rated by the respondents. The results indicates that there are significant difference between the mean scores of actual status and degree of importance of these CSFs. Actual status of all the eleven factors are less than the degree of importance of same as per standard. Among these eleven factors, top five factors that have largest gap between their actual statuses from degree of importance are as follows;

a) Management support (gap=2.25)
b) Adequate resource allocation (gap=2.19)
c) Program evaluation (gap=1.94)
d) Continuing participation of employees (gap=1.75)
e) Efficient enforcement systems/ schemes (gap=1.34)

Management Support

While taking comments from respondents, most of them commented that management have no interest in taking safety under consideration, since it is a non-profit function according to them. So that, safety is given low priority in the case of giving sufficient attention and support. From the above analysis, we came to know that gap between the actual status of safety program and degree of importance is high. Most of the respondents believe that management carelessness is major cause of all construction accidents. Management is careless in many things such as; for the effective implementation of safety program, sufficient allocation of necessary resources is very important. Management shows a passive approach towards resource allocation. Most of the workers and officials does know that their company has a safety policy, but they are unaware about the policy since a written comprehensive safety policy has not been issued by the top management. Many respondents did have a complaint like, top management thinks that safety rules are established only for workers, not for them. So they won't

follow safety rules in most of the construction sites. Management used to give a vague reaction to safety suggestions and complaints most of the time and the frequency of their visit to the workplace in order to verify the safety performance in site.

Adequate Resource Allocation

According to respondents, sufficient allocation of necessary resources is a reflection of the level of management support. So that, lack of management support is said to be parallel to inadequate allocation resources for the implementation of safety program. For the successful implementation of a safety program, preferable resources specified by the respondents are safety budgets and safety personnel. Lack of these resources would affect the day-to-day activities very badly, in order to accomplish long term and short term safety goals. Along with safety budgets and safety personnel, resources which are important for the successful implementation of safety program includes time, information, methods and facilities for carrying out safety activities, tools and machines etc.

Program Evaluation

Considering responses obtained from the respondents, gap between degree of importance and actual status of this factor comes in the third rank in the list in which management support occupies the first position. It means that, periodic evaluation of the program is not taking place. It is very important to evaluate the program periodically in order make it a successful program. Since program evaluation is not done properly, any shortcomings that has happened during the implementation of safety program would not be noticed and so that improvement cannot be applied.

Continuing Participation of Employees

Another factor which is having highest gap next to program evaluation is continuing participation of employees. In most of the construction sites, employees whom are actually following these safety program would not be involved in the design of it. The major advantage of involving employees in the design and operation of safety program such as joining a safety committee, reporting hazards and unsafe practices to supervisors, investigating accidents, identifying training accidents, suggesting essential personal protective equipment etc. is that, the workers would have a tendency to support the program they create. Effectiveness of safety program is reduced, because workers are not getting opportunities to participate in any of the above functions.

Efficient Enforcement Systems/Schemes

The respondents stated that clear and efficient enforcement schemes or methods for non-compliant workers are not written or provided in job sites. According to them, the main reason for not having an enforcement system is that, to enforce safety on jobsite effectively, management should have a knowledge on relevant safety standards, they should be able to monitor the work on a frequent basis, and they should have the capability to control behaviour. Health and safety committees

which are very important for enforcement are not established in most of the construction sites. Also respondents pointed out that once in every 12 months safety audits should be carried out in construction sites as per OH&S Act, however a high percentage indicated that they do not carry out audits, this infringes the law. Thus the enforcement mechanism for health and safety in construction industry can be said to be weak and inadequate.

From table 3, it is clear that among these 11 factors, gap between degree of importance and actual status of above five factors are significantly higher than the rest of six factors. It's clearly been shown in the chart 2. That means among those remaining six factors communication, safety education and training and delegation of authority and responsibility have been be given appropriate consideration and implementation up to a satisfactory level in construction sites.

CONCLUSION

Safety is considered as one of the major problems that prevails inconstruction industry. As it continues to be a big issue, emphasis should be given for the effective implementation of safety program, so that, better site safety performance can be achieved. There are several factors that affects the implementation of safety program, and therefore, this study was mainly focussed on the identification of these factors called as critical success factors. There are eleven factors which are identified which contributes to the successful implementation of safety program and then based on OHSAS 18001:2007 standard degree of importance of each of these factors in construction sites has been set. Then actual status of these factors were evaluated based on the respondents' perception. Thereafter Gap between degree of importance and actual status of CSFs has been evaluated, and the result shows that management support has the highest gap and thereby it is the most important factor that has to be taken under consideration in construction sites followed by adequate resource allocation, program evaluation, continuing participation of employees and efficient enforcement systems/ schemes. On the other hand, communication is the factor which is having least gap between degree of importance and actual status, followed by safety education and training and delegation of authority and responsibility and are perceived as the least important factors that has to be taken care in construction sites. The study also showed that factors such as communication, safety education and training and delegation authority and responsibility have better actual status amongst all other factors. In other words, it is implied that these factors have been given appropriate attention in construction sites. On the contrary, management support, adequate resource allocation and program evaluation were considered the factors with poor actual status. Thus, more effort should be provided to improve the actual status of these factors.

In this research, Gap analysis was carried out to determine how to improve safety programs. In this analysis, it has been suggested thatlarger gaps between degree of importance and actual status of success factors indicate more unsatisfactory practices. Thus emphasis has to be given strongly to these factors in order to correct it. This study found out that the first five critical problems of safety program implementation are management support, adequate resource allocation, program evaluation, continuing participation of employees and effective enforcement systems/ schemes. These five factors must be given more attention in construction sites in order to achieve a satisfactory level. Meanwhile, there are three factors namely communication, safety education and training and delegation of authority and responsibility shown as satisfactory practices as it was characterized by very small gaps.

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