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Critical Success Factors for Safety Program Implementation among Construction Companies in Saudi Arabia

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Abstract

Saudi Arabia is considered one of the fastest growing countries in the Middle East. Despite this fact, the overall level of construction safety in Saudi Arabia has been relatively low. Many construction companies in Saudi Arabia have tried to control the rising costs of accidents and reduce projects delays due to the accidents; however, they do not know why the safety programs do not work efficiently, or where to start. This study has a main aim which is identifying the critical factors affecting the successful implementation of safety programs among construction companies in Saudi Arabia. Considering the current lack of understanding on these factors within this particular context, this study is the first and essential step to promoting comprehensive safety programs implementation within the Saudi Arabia construction industry. To achieve this aim, this study examined and synthesised numerous factors identified in past research studies on construction safety, whereby a set of factors was developed. Analytical Hierarchy Process (AHP) was then conducted to prioritise these factors, based on the input from a group of experts representing 18 construction companies in Saudi Arabia. Finally, Pareto principle was employed to develop seven most critical success factors, which represent the areas where companies should focus their attention and effort to achieve better safety levels through effective implementation programs.

Keywords: Analytical Hierarchy Process, Construction, Critical Success Factors, Safety, Saudi Arabia

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1. INTRODUCTION

Construction industry plays a fundamental role in increasing the economy of many countries. It provides the infrastructure required for other parts of the economy to grow, thus reflecting the level of economic development of the countries (Coble 1999). However, it is also documented that the construction industry has the highest rate of accidents among all industries (Sawacha et al. 1999) as well as the highest rate of disabling injuries and fatalities (Hinze 1997). For example, as reported by Bomel (2001), up to 40% of accidents occur in the construction industry in Japan, 50% in Ireland and 25% in the United Kingdom. Safety in developing countries in particular is often at much lower levels mainly due to an absence of strict safety regulations. In developing countries, safety rules hardly exist and can often not work appropriately and effectively. This problem is generally due to the lack of effectiveness of the authority in implementing safety rules and programs (Hinze 1997).

In Saudi Arabia, construction activities have increased rapidly during the past two decades, attracting construction companies from all over the world to participate in many development projects, with the employment rate in the Saudi construction sector accounting for 15% of the country's total workforce. Despite this, construction safety in Saudi Arabia has not been regulated by any government agency. A recent study on safety among many construction projects across Saudi Arabia shows that: 25% of contractors did not give new workers a safety orientation; 25% did not provide personal protective equipment; 25% did not provide first-aid on site and 38% had no trained safety personnel, which led to the conclusion that the concept of safety does not quite exist among construction contractors in Saudi Arabia (Berger 2008). In fact, many construction companies in Saudi Arabia have tried to control the rising costs of accidents and reduce projects delays due to the accidents; however, they do not know why the safety programs do not work efficiently or where to start.

The above situation suggested the need for the present study, which was aimed to identify the most critical factors affecting the implementation of safety programs among the construction companies in Saudi Arabia. Outcomes from this study provided a set of critical factors that can be used to guide a successful construction safety program implementation as well as safety policy development in the construction industry in Saudi Arabia.

2. THEORETICAL BACKGROUND

2.1. Construction safety programs

A number of definitions of safety programs are put forward by different researchers. Anton (1989) defined a safety program as ''the control of the working environment, equipment, processes, and the workers for the purpose of reducing accidental injuries and losses in the workplace.'' The objectives of safety programs in construction firms were identified by Rowlinson (2004) as to: (1) prevent unacceptable behaviour that may direct to accidents; (2) make sure the improper behaviour are discovered and reported; and (3) ensure accidents are reported and handled accordingly. Safety programs contain many elements such as safety policies, safety committees, safety training, accident investigations, in-house safety rules, safety incentives programs, control of subcontractors, personal attitude and perception, personal protection equipments, emergency planning, safety promotions, safety record keeping, and job hazard analysis (Anton 1989; Rowlinson 2004).

2.2. Critical success factors affecting safety programs implementation

The factors affecting the success of activities and projects, often named critical success factors (CSFs) can be defined as "areas in which results, if they are satisfactory, will ensure success within and of the organisation" (Rockart 1979). Within the construction context, a great deal of research has been conducted to identify critical factors associated with safety management. Following Aksorn and Hadikusumo (2008), these factors can be classified into four groups, namely: (1) worker participation; (2) safety prevention and control system; (3) safety arrangement; and (4) safety commitment. These are presented in Tables 1 through to 4. Despite these factors having been indentified in past research, their priority has not been fully examined under the context of Saudi Arabian construction industry to pinpoint the most critical areas where management can use as a starting point to developing and/or improving their safety program implementation strategy.

Table 1: Group 1 factors - worker participation

Factors	Description	References
Personal Attitude	Better safety attitudes mean better perception of the work atmosphere that leads to better safety performance.	Tam, et al.(2001) , Fang, et al. (2006)
Personal Motivation	To guarantee good safety records, all workers in the workplace should be motivated toward performing their jobs safely.	Johnson (2003)
Safety Meeting	To improve safety performance at the project, formal safety meeting must be held regularly to review the safety records.	El-Mashaleh, et al. (2009)

Table 2: Group 2 factors - safety prevention and control system

Factors	Description	References
Efficient Enforcement System	Efficient enforcement scheme should be developed and implemented to ensure workers follow the safety rules and regulation.	Fang, et al. (2004)
Suitable Supervision	Supervisors capable of allocating work that matches worker`s skill, identifying hazard conditions and making the environment safe by communicating with workers and listening to them and be sure all workers follow the safety rules and find solution for the occurring safety problem.	Fang, et al. (2004)
Safety Training	Training programs put in place to develop employees' knowledge and skills on safety at work that leads to improving their safety behaviours and attitudes.	Toole (2002), Tam, et al. (2004)
Equipment and Maintenance	Regular maintenance of equipment to ensure that they are always in safe working condition.	Toole (2002), Tam, et al. (2004)
Personal Competency	Ability of individual to carry out the right thing at the right time by using his/her sense, experience and skills to evaluate the hazard conditions and make a proper decision.	Mohamed (2002), Tam, et al. (2004), Fang, et al. (2006)
Program Evaluation	A safety program must be monitored and reviewed to make sure that the safety goals are met.	Abudayyeh, et al. (2006)

Table 3: Group 3 factors - safety arrangement

Factors	Description	References
Communication	Open communication between management and the middle-level and bottom-level staff to facilitate prompt report of and response to unsafe conditions.	Fang, et al. (2004), Abudayyeh, et al. (2006)
Allocation of Authority and Responsibility	Appropriate authority and responsibility assigned to workers in order to deal with safety incidents and carry out appropriate actions.	Abudayyeh, et al. (2006)
Adequate Resource Allocation	Sufficient resources (e.g. staff, time, money, information, facilities, tools, machines) to carry out day-to-day activities to accomplish both short-term and long-term goals.	Abudayyeh, et al. (2006)

Table 4: Group 4 factors - safety commitment

Factors	**Description**	**References**
Management Support	Management should ensure that sufficient resource is allocated for safety activities and that regular safety meetings and training are in place.	Abudayyeh, et al. (2006)
Teamwork	All levels of staff in the company must be engaged in the safety programs; improving safety should be seen as collective effort which requires cooperation from everyone involved.	Abudayyeh, et al. (2006)
Clear and Reasonable Objective	Clear and reasonable safety goals should be established to provide a clear direction for staff to work toward, and to serve as the target against which overall safety performance can be measured.	Abudayyeh, et al. (2006)

3. RESEARCH METHOD

Safety program implementation is a complicated practice because there are many factors and elements affecting the successful implementation. In this study, Analytical Hierarchy Process (AHP) technique was employed as it is considered a powerful technique for solving complex problems. Specifically, AHP was used to determine priorities among factors and sub-factors that are critical to making sound decisions for safety program implementation.

The methodology adopted to achieve the objectives of this study is described in four main stages. The first stage involved a review of safety in the construction industry to identify the importance of safety in construction projects. Moreover, an extensive literature review was carried out to explore the factors that affect the successful implementation of a safety program. The second stage was to develop a hierarchical model of factors affecting safety program implementation and a questionnaire to be used as part of the AHP technique. Data collection was conducted as the third stage to obtain input from experts in the area of construction safety management in Saudi Arabia. In the fourth stage, AHP, analysis for agreement of ranks and Pareto analysis were used to prioritise and refine the most critical factors. The following section provides details of data analysis and results.

4. ANALYSIS AND RESULTS

4.1. Ranking of critical success factors for safety program implementation

AHP technique requires the development of a hierarchical model which consists of three levels: Level 1 - the goal of the problem; Level 2 - the critical factors; and Level 3 - the sub-factors of individual critical factors. Based on the factors indentified from the literature review process (Section 2.2), a hierarchical model for critical factors affecting safety program implementation was developed, as illustrated in Figure 2.

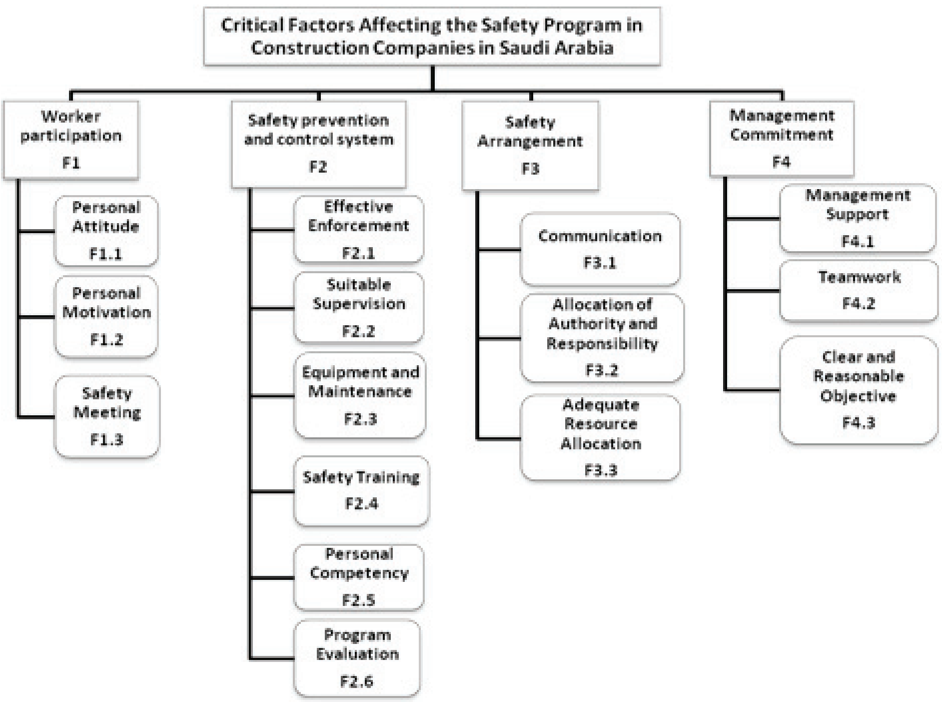

Figure 2: Hierarchical model of critical success factors for safety program implementation

The above model was used as basis for developing a questionnaire survey to seek input from experts in the field. In developing the questionnaire, a nine-point scale was used to assign relative scores to pair-wise comparisons amongst the factors and sub-factors. The identified experts were asked to determine the relative weights against a given list of critical factors and sub-factors affecting the implementation of a safety program. The experts would assign a score to each comparison using the provided scale. This process continued until all levels of the hierarchy were completed. In this study, the *Super Decisions* software (Saaty 2005) was used to assist in calculating the relative importance of the factors and sub-factors. The resulting AHP weights for each factor were then obtained and ranked to determine the priority of the factors. This afforded a list of key management areas on which organisations should concentrate their efforts throughout the process of safety program implementation.

In total, 31 experts from different construction firms in Saudi Arabia were invited to participate in the study. Out of these, 18 experts responded and completed the questionnaire thus achieving a response rate of 58%. For this group of experts, four (22%) had worked for 5 years or less, 11 (61%) for around ten years, and three (17%) for more than ten years. The majority of respondents held senior positions in their organisations, with 33% being project engineers, 28% supervisors, 22% project managers and 11% general managers. Only 6% of the experts were in the position of safety officer. In summary, the responses were considered to be a good representation of the target survey population. The results of the AHP process based on the input from these experts are presented in Table 5. The table presents ranking, average AHP weights, cumulative AHP weights and their percentage for each of the critical factors.

It should be noted that to justify the use of average AHP weights as the basis for prioritising factors, analysis of agreement of ranks was conducted to measure how good the agreement is among all the experts. To achieve this, a statistical method referred to as the Kendall coefficient of concordance (W) was used. The coefficient has a range from 0 to 1; meaning if (W) is close to 0, no agreements among the respondents is indicated and when (w) is close to 1, a strong agreement among the sample members is indicated. The Kendall coefficient of concordance is calculated using the formula below (Baig 2001):

$$W = \sum_{i=1}^{n} \frac{\left(R_i - \bar{R}\right)^2}{n\left(n^2 - 1\right)/12} \tag{1}$$

where: n: Number of factors, R_i = Mean ranks for each factor, and $\bar{R} =$ Average of mean ranks of all factors.

The coefficient of concordance calculated from the group of experts was 0.72, indicating a good agreement among the respondents (Baig 2001). Therefore, average AHP weights were used for the purpose of ranking the factors.

4.2. Pareto analysis

Pareto analysis is a statistical method in decision making that is used for the selection of a limited number of tasks that create important overall effects. In general, the Pareto analysis technique is used to help project managers identify a specific number of tasks that cause significant number of problems. In this way, project managers can be more efficient in rectifying problems by focusing their energy only on most significant root causes. The key technique to identifying these root causes is the 80/20 rule, which suggests that the focus should be on those tasks that cause 80% of the problems.

In the previous AHP analysis stage, the rank for all the 15 critical factors that affect the implementation of safety programs was determined. In this stage, it was aimed to obtain the most important critical safety factors from the list of the 15 ranked factors. This was carried out by adopting the 80/20 rule, whereby those factors accounting for 80% of cumulative AHP weights were identified. By inspecting the cumulative percentage of AHP weight column in Table 5, it can be seen that seven factors contribute to around 80% of cumulative AHP weight, which means that they were perceived to be the most significant for the successful implementation of safety programs. These seven factors, namely: (1) Management support; (2) Clear and reasonable objectives; (3) Personal attitude; (4) teamwork; (5) Effective enforcement; (6) Safety training; and (7) Suitable supervision, indicate the most significant areas where managers need to take into account when implementing safety programs in their organizations.

Table 5: AHP results

Rank	Critical Safety Factors	Avg. AHP Weight	Cumulative AHP Weight	Cumulative AHP Weight (%)
1	Management Support	0.3504	0.3504	35.04
2	Clear and reasonable objective	0.1449	0.4953	49.53
3	Personal Attitude	0.1060	0.6013	60.13
4	Teamwork	0.0666	0.6679	66.79
5	Effective enforcement	0.0550	0.7229	72.29
6	Safety Training	0.0451	0.7680	76.80
7	Suitable Supervision	0.0394	0.8074	80.74
8	Allocation of Authority and Responsibility	0.0379	0.8453	84.53
9	Adequate Resource Allocation	0.0307	0.8760	87.60
10	Safety Meeting	0.0277	0.9037	90.37
11	Program Evaluation	0.0258	0.9295	92.95
12	Equipment and maintenance	0.0228	0.9523	95.23
13	Personal Motivation	0.0224	0.9746	97.46
14	Personal Competency	0.0133	0.9880	98.80
15	Communication	0.0120	1.0000	100.00

5. CONCLUDING REMARKS

The aim of this paper is to examine and identify the most critical factors that have an impact on the successful implementation of construction safety programs within the context of Saudi Arabia's construction industry. Using AHP analysis technique, the rank of 15 critical success factors developed from extensive literature review was developed. Using Pareto principle, the cumulative average AHP weights of critical safety factors suggested seven critical factors that can account for 80% of the successful implementation of safety programs in construction companies. These factors are: (1) management support; (2) clear and reasonable objectives; (3) Personal attitude; (4) teamwork; (5) effective enforcement; (6) safety training; and (7) suitable supervision.

Based on the above findings, the study highlighted key areas for successful safety program implementation. It can be concluded that the top management has the most significant role in supporting the successful implementation of safety program in construction projects. This should be supported by having established clear goals and targets and teams of staff with the right attitude towards construction safety. Finally, successful safety programs implementation would need an effective enforcement plan, appropriate supervision and safety training and education. These findings can be used to help guide construction companies in Saudi Arabia to develop a strategy to implement safety program appropriately.

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