6th International Symposium on Advances in Science and Technology
SASTech
Malaysia | Kuala Lumpur
24 - 25 March, 2012
Scope of the Symposium
Organised by:
Khavaran Institute of Higher Education
Hosted by:
Geospatial Association of South East Asia

Safety Management System; A Developed Measurement of Safety Factors in Construction Projects

Zubaidah Ismail, Samad Doostdar Somarin
Department of Civil Engineering, University of Malaya (UM)
zubaidahjk@gmail.com samaddoostdar@yahoo.com

Abstract

Accident on a construction projects, whether involving employees or the public, can impose an enormous burden on the construction contractors and other associated with project.
It is well known that construction projects have many work-related accidents and injuries, in recent year, to overcome such as safety problems. Safety program implementation has been given significant consideration as one of the effective methods. In order to effectively gain from safety functions, factors that affect its implementation need to be studied.
In this research the factors influencing safety on construction sites are discussed the impacts of the policy factors, technical factors, personal factors, organizational and the economical factor are considered in terms of how these factors are effected with the level of construction site safety.

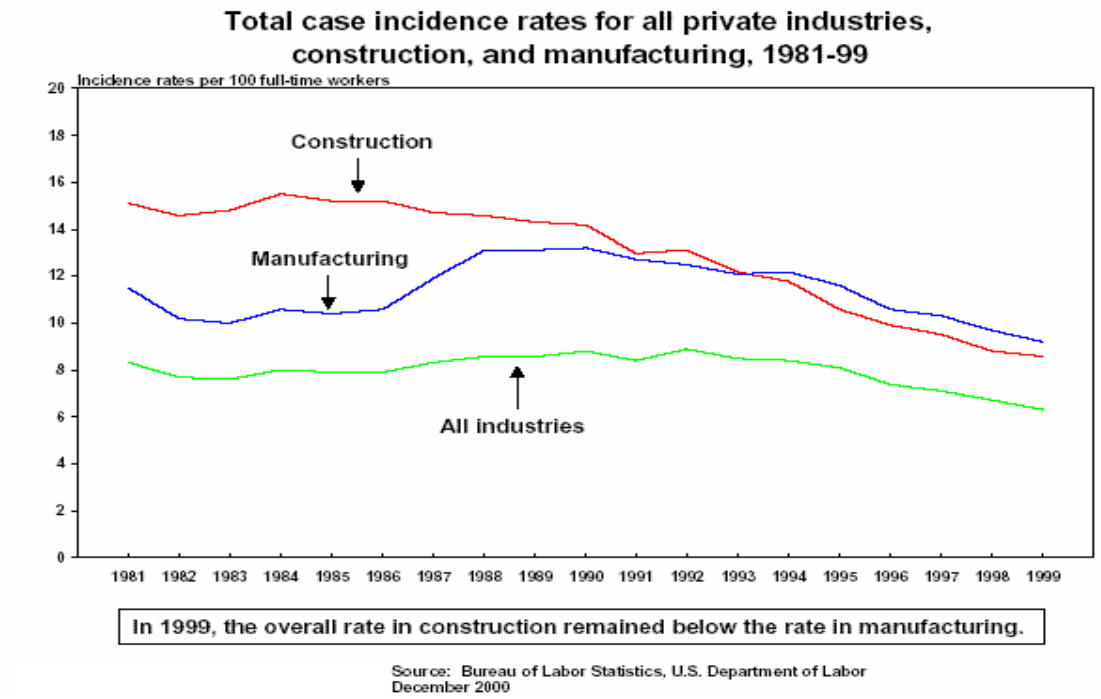
Key words: Safety Management System (SMS), Construction Safety index, effective safety factors, safety performance.

1. Introduction

The main goal of contractors in construction industry generally is increase of profiting which depends on the variables such as cost price of construction, period of construction and quality of the project execution, etc. and according to the researchers performed and statistics which is indicative of number of disaster and damages of this industry due to non observation of safety rules and the consequences there of, the concept of safety seems more serious.
In recent years, construction industries have significantly and rapidly risen. The construction industry continues to play a major role in World economic development, as many construction activities have been carried out to meet the high demands of expansive market. However, the construction industry has faced a wide range of challenges.

1.1.Research motivation

The number of fatalities at work in the construction sector remains a matter of serious concern for the Government, employers and employees alike (HSA,1999). Statistics on fatalities generally places the construction sector as the second highest industry, only surpassed by the agricultural sector. Among the most common sources of fatalities in construction, falls from heights is the category that accounts for the highest proportion of deaths. A brief comment of some statistics will be given below, especially for U.S. [Figure 1].



1.2.Research scope

This study focuses on the degree of the current level of utilization of Safety Management System (SMS) in construction techniques in the building sector of the Malaysian construction industry. The research scope includes the quality segments of single and multi-dimension safe works, commercial, institutional and industrial buildings in the Malaysia construction industry. Manufacture process, highway construction and other unrelated works were not included in the scope of this study.

1.3.Research limitation

The following limitations are inherent to this study due to the availability of funds, respondents, and research resources.

1) The population in this study limited in large size buildings,
2) Manufactured homes are not including in the study,

2. Accident

*2.1.*Accident analyses construction sites

In review of articles 43 accident cases reviewed at the construction sites, the most accident were caused by personal factor (%51), process factors (%14), policy factor (%9) and incentives (%5) [table 1].

Table [1], effect of factors in accident rate

Accident Factor	Average of day lost	Number of cases	%
Techniques & Resources Factor	21	6	14
Program & Training Factor	18	22	51
Management & Policy factor	9	4	9
System & Procedures Factor	7	2	5
Others	6	9	21
Total	61	43	100

The accident rate in research case study was: Working days lost / accident≃1.41

2.2.Accident analysis

The accidents were analyzed according to the company accident report made for insurance company. The reliability of the accident date is assessed to be high because all cases causing lost working days are based on personally statement. The company reports mean that the company in cure cost; moreover, the compensation paid by the insurance company depends to the closing of the site when the building was completed or to the date when the information collection phase of the study ended, were analyzed. The accident rate (accident per 1000000 hours worked) was calculated on the basis of the actual hours worked at every sit. Owing to this calculation method, the accident rates were higher than those of the national statistics (Markku Mattila, 1994).

3. Research Methodology

A variety of methodologies were adapted in order to reflect the different aspects of construction sites and to reflect overall project objectives. A pilot study was carried out and necessary amendments were made to the instruments before the main research started.

The safety compliance measure was tested with using several safely rating. The questionnaire and interview were designed and examined with samples of site manager, safety manager, construction consultant and workers. Adjustments to the procedure for administering these were made to ensure effective date collection.

The three methodologies used were:

- Interview with contractor & consultants & experts
- Evaluation of safety records
- Accident analysis

3.1.Questionnaire Survey:

A questionnaire survey was designed for this research that validated 50 questions,
This questionnaire designed in two parts, (i) getting information for project safety records, and (ii) finding effective factors on safety function. In this study, the survey was carried out on large-scale construction (High importance construction) projects. According to Civil Engineering Institute and ministry of housing definition, a project was differentiated as "High importance construction" when its more than 30000sf for building area with a workforce larger than 75 workers, that its focused in this survey.

4. Effect of safety factors

According to Rung Samy et al. (2002), effective or critical success factors are essential to the success of any program, in the sense that, if objectives associated with the factors are not achieved, the program will perhaps fail catastrophically, in general the success of safety program arises from desired events or activities that are required to be happen. According to top (1991) and Michaud (1995), a successful safety program can be measured in terms of no injury to people, no damage to equipment, machines and tools, no damage to environment, no loss the market competition, no damage to company image or brand-name and increased productivities. Based on previous safety researches, 20 factors were commonly proposed as essential to favorable outcome of safety program implementation. Table [2], summarized and discussed the potential factors affecting the success of safety function.

Table [2], Effects and description of safety factors

Dimension	*Sub- Factors*	*Factors weight*	*factors Discussion*
case study	Building Height Building Area number of workers	6.19 4.9 5.39	Up 15 stairs Up 30000sf Up 70 workers
Program & Training factors	Group Meeting Organization Safety Promotion Program evaluation arrangement Training	3.96 4.08 3.25 3.65 3.99 5.02	The safety personnel consist usually of the safety manager and safety representative. The safety manager's role is to act an expert who is aware of the health and safety legislation and other obligations concerning the company. Successful safety system can be achieved if the positive acts of employees toward safety are reinforced.[1]
Techniques & Resources Factors	Safe Practices Risk assessment Emergency planning Cost effectiveness Movement control Technique maintenance	4.88 5.02 3.8 4.36 4.28 5.83	Successful safety management system depend on employee involvement as workers tend to support the functions that they themselves help to create, workers should be given the opportunities to provide input into the design and implementation of safety programs such as being a member of the safety committee, reporting hazards and unsafe practices to supervisors, identifying training needs, investigating accidents, etc[2]
Management & Policy Factors	Safety culture Cost effective performance improve freedom in decision	6.31 3.8 3.98 3.97	A safety policy is the management expression of the direction to be followed in the organization. In successful safety program, a safety policy should commit the manager at the levels and it should indicate which takes, responsibilities and decisions are left to lower-level management.[3]
System & Procedure Factors	Operational process Safety Inspection additional response Incident Analysis	3.01 4.53 3.76 4.19	Safety inspection provides a motivate of meaning to project workers, not so much a set of actions for situations that arise, but a set of beliefs and values that provide workers with the function to carry out what function need to safety leaders who are able to planning for members motivation and report to safety management group mention further inspection programs.

[1] Levit and Samelson, 1993

[2] Peyton and Rubio (1991), Abudayyah et al (2006)

[3] Peterson, 1989

5. Determine effective factors: (questionnaire result)

Follow the research founds, frequency of applicants categorized in 3groups, Tables [3-4-5] summarized frequency result,

Table [3]. Frequency of Answers at effect of *Area* in Building Safety

No	Building Area	Very Good	Rather Good	Neither Poor	Rather Poor	Very Poor
1	Until 2000sf	3	4	7	12	10
2	2000-10000sf	3	5	7	12	9
3	10000-30000sf	4	8	8	9	7
4	Up 30000sf	7	12	7	6	4

Table [4]. Frequency of Answers at effect of *Height* in Building Safety

No	Building stairs	Very Good	Rather Good	Neither Poor	Rather Poor	Very Poor
1	Until 3 stairs	1	5	6	13	11
2	3-10 stairs	5	7	9	9	6
3	10-20 stairs	9	9	7	6	5
4	Up 20 stairs	13	15	4	3	0

Table [5]. Frequency of Answers at effect of *Workers* in Building Safety

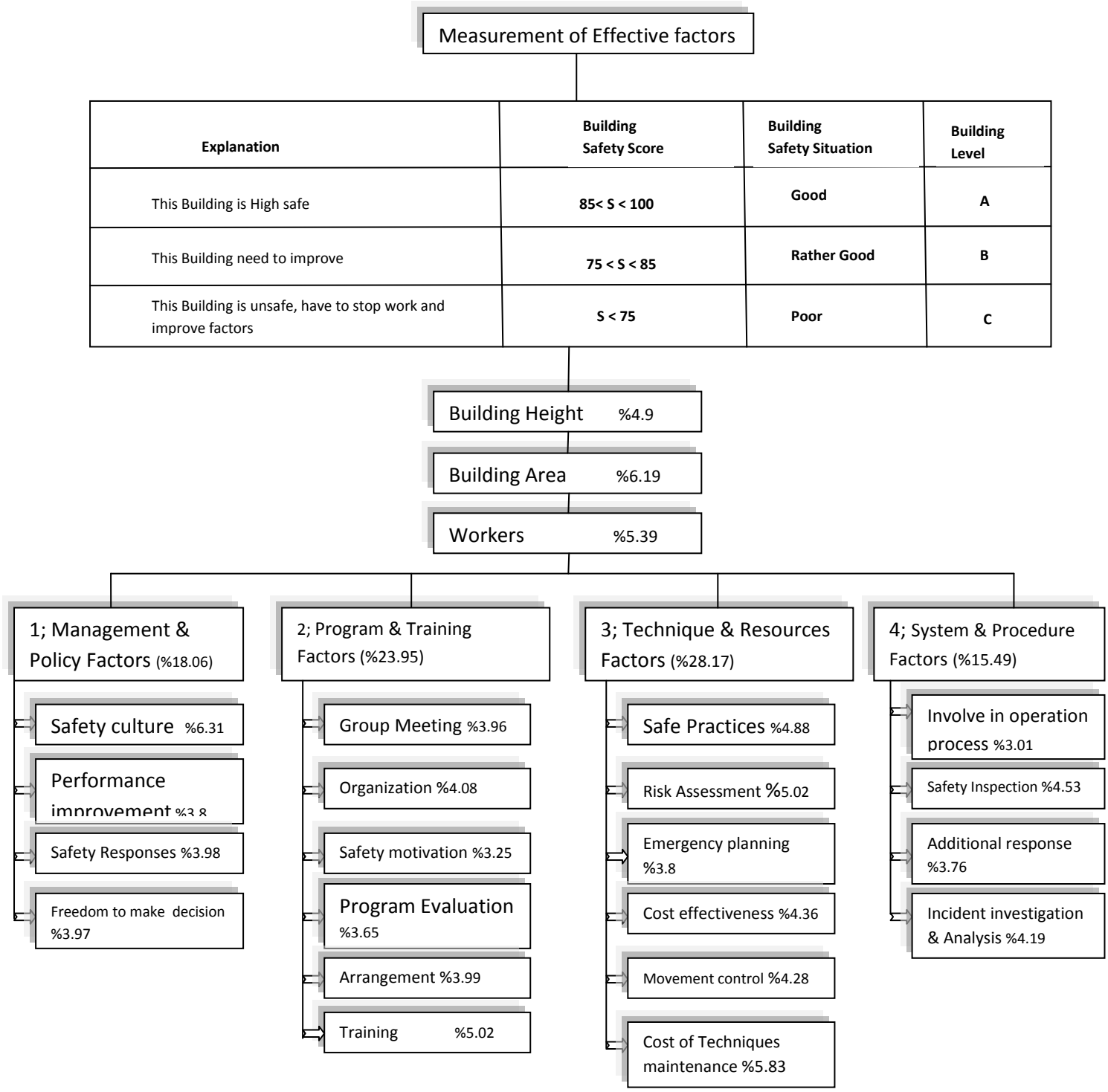
No	Workers No	Very Good	Rather Good	Neither Poor	Rather Poor	Very Poor
1	Until 30 workers	0	5	7	14	10
2	30-70 workers	3	6	11	9	7
3	Up 70 workers	14	15	5	2	0

6. Factor analysis

The factor analysis technique was utilized to help identifying the underlying cluster of factors that dominate safety performance. Figure [2] shows factor steps chart and the weight of each factor.

In order to give meaning to the result of the factor analysis and to relate them to the research framework, it is necessary to assign an identifiable name to the group of factors of high correlation coefficients. This is because the factors are an aggregation of individual variables. (Edvin Sawacha-1999).

Figure [2], Safety factors chart & factors weight



Most of the significant variables are discussed, follow the factors score, main category of variable are including Management & Policy factors, Program, Training, arrangement & organization factors, Technique & Resources Factors, System & Procedure & inspection Factors 0.75 to 1.00 (limitation of safety zone, acceptable zone). The result can be ranked as follows:

1) Safety Policy: (16.76%);

A safety policy should commit the management at the levels and its should indicate which tasks, responsibilities and a high level of safety performance is a good which is achieved by using the legal requirements as the minimum, and where the continual cost-effective improvement of performance is the way to things. (BS 8800).

2) Safety Training: (16.68%);

The experiences show that safety advisers and managers are an attractive way to analyze the role of their service in the company. Analysis of the flows to and from the tasks which they them selves perform clarifies the interdependencies in safety system, and enables them to concentrate on exploring and improving them.

3) Safety arrangement: (16.61%);

It's important to carry out consultation decision making on safety in construction projects, the committee have to prepare an activity plan, evaluate and prepare a plan for safety commitment training.

4) Safety organization: (16.67%);

Planning means that evaluation of the safety functions and essential, and preparing of the annual planning to achieve the project aims. There are different safety function according to the nature of the typical hazards, and follow BS 8800 (1996) Annex C, some common factor for safety function planning can be found. (Arto kussisto, 2000).

5) Safety additional response & Inspection: (16.65%);

Safety inspection is partly the fault of the incentive factors which is make motivation in workers for keeping safety at the workplace. There is turn means that safety inspection need to be safety leaders who are able to prepare a plan for staff motivation and able to make suggestion for how the staff and workers should be satisfy at workplace.

6) Safety Management and Responsibilities: (16.61%);

The safety manager is responsible for satisfy activities in project, It's main activities is to follow the status of safety at the project, and prepare weekly report to the top safety management group. Safety manager can stop a work that includes an obvious and immediate hazards danger, but otherwise safety manager's enforcement power is very limited.

7. Conclusion and Suggestion

In this study, an evaluation of effective factors in construction project was described. In order to facilitate a more objective to be developed, a range of effective factors in SMS were identified. A questionnaire survey was examined with contractors and construction consultants, in order to establish the importance of the factors.

There are different review having reviewed different exiting "safety factor evaluation" methods, a more comprehensive framework for evaluation construction safety performance was devolved. This provides a safety comprehensive analysis approach on contractor's safety performance at the both organizational and project levels that are not found in any existing systems.

The safety performance score can be used to form a league table of contractor's safety performance records, these records could help more for determining insurance premium and award in order to enhance contractor's inspection in construction site safety.
This research evaluated and rank 20 effective factors based on their degree of influence. It revealed that, techniques and resources, was the most influential factors for safety management program implementation in construction industry.
The result of the questionnaire frequency for effective factors in order of the degree of influence were: (1) safety culture, (2) cost of techniques maintenance, (3) training, (4) risk assessment, (5) safe practices, (6) safety inspection, (7) planning cost, (8) effectiveness cost, (9) incident investigation and analysis, (10) organization, (11) arrangement, (12) manager responsibilities, (13) involvement in operational process, (14) group meeting, (15) emergency planning, (16) cost effective improvement performance, (17) complain additional response, (18) program evaluation, (19) safety motivation, (20) safety monitoring. There were strong consensuses on the ranking of 20 effective factors that are influence in the construction industry.
The result of this study could help more informed decisions to be made on safety performance. It could also enable contractors to identify any potential hazard in project. Stage to ensure necessary measures be taken to minimize the loss in financial and social costs related to construction project.

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