

# **Prioritization of Factors Influencing Safety Performance on Construction Sites: A Study Based on Grade Seven (G7) Main Contractors' Perspectives**

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**Abstract.** Construction industry is one of the major industries that propels Malaysia's economy. Although the construction industry itself highly contributes to our nation's GDP growth, yet the high fatality rates on construction sites have caused grave concern among safety practitioners and the stakeholders. The aim of this study was to identify and prioritize the degree of importance of the factors that influence the safety performance on construction sites as perceived by the contractors on sites. A survey which took the form of a questionnaire was administered to 110 major construction companies in Malaysia to implore the safety factors from Grade Seven (G-7) Main contractors. About 63 main contractors participated in this survey, which achieved a high response rate of 61%. This study prioritized the factors by using relative importance indices (I). The result revealed that the most important major factor was (1) Management Activities on Site, followed by (2) Personnel, (3) Process, (4) Policy, (5) Technical, and (6) Incentives.; while the top three most important factor elements were (1) Safety Inspection, (2) On site and HQ Management attitude towards safety, and (3) Safety Regulation Enforcement. Accordingly, this study prescribed several suggestions on the prioritized factor elements specifically as means of managing safety on sites proactively, taking the industry towards zero accident and strive for better improvements.

**Keywords:** Construction Sites, Safety Factors, Safety Management

## **1. Introduction**

Malaysian construction industry recorded a GDP growth of 1.6% in the fourth quarter of 2008 and continued to improve as it achieved a positive growth of 0.6% in the first quarter of 2009 (CIDB, 2010). Although this industry has contributed significantly to Malaysian's economy, this does not mean Malaysia can settle down comfortably. Often known as "dirty", "dangerous" and "difficult", this industry has been plagued by a high number of fatality rates on construction sites. Construction sites itself is commonly known as the most hazardous workplace. Current investigation from Department of Safety and Health (DOSH) has shown that construction sites have the highest death toll among all the industries (DOSH, 2012). Thus, construction industry became the most crucial industry in the need of effective safety measures and safety management system in the effort to achieve better safety performance (DOSH, 2011).

This paper aims to highlight and substantiate the important factors perceived by Grade Seven (G-7) Main-Contractors that work on sites. In Malaysia per-se, G7 Main-Contractors serve as the backbone on construction sites, executing projects more than RM 10 Million and above and having no limit in tender capacity. By capturing their perception on the factors that can influence the safety performance on construction sites, this study attempts to shed a light to the management into taking into account on these factors as means of managing safety on sites proactively, and effectively.

## **2. Literature Review**

Many researchers have studied the critical factors that influence safety program performance in construction projects. We have reviewed the literatures and pinpoint 6 major factors which entail Management, Incentives, Process, Policy, Technical, and Incentives related factors that are relevant to the governance of safety on construction sites per-se distinctively. Together with the factor elements (sub-factors), they are further illustrated in Table 1 below:

Table 1 Factors Influencing Safety Performance on Construction Sites

Major Factor	Factor Elements	Discussion
<b>Management Activities on Site</b>	Safety Inspection	Fang et al (2004) suggested 5 valid elements safety management activities, such as safety inspection, safety meeting, safety regulation enforcement, safety education and safety communication. Safety on sites can be improved effectively provided that safety inspection can function as a continuous improvement tool to benchmark safety at workplace (Fang et al., 2004; Mearns et al., 2003; Ng et al., 2005). Coupled with regular safety meeting on sites, safety issues can be properly reconciled (Ng et al., 2005; Aksorn and Hadikusumo., 2008; Saurin et al., 2008). Nevertheless, effective governance of safety on sites highly demands strict regulation enforcement. Workers will utterly comply with safety regulations if the management insists on issuing warnings and fines for safety non compliance. Failure of doing so will result in high accident rates as a result of non compliance of safety procedures on sites( Probst and Estrada, 2010). To ensure all personnel are aware with the safety matters and acquainted with the nature of working environment on sites, management should emphasize on giving adequate training and education that will equip them with appropriate safety knowledge to mitigate future accidents (Tam et al., 2004; Chan et al., 2010) . Propagation of safety information require management commitment in providing a robust channel of communication between workers to participate in joint problem solving processes that would enhance safety performance on sites (Michael et al., 2006; Kim et al., 2008; Kines et al., 2010).
	Safety Meeting	
	Safety Regulation	
	Enforcement	
	Safety Training and Education	
<b>Incentives</b>	Safety Communication	Incentives factor is one of the determinants that motivate workers to behave in a desired manner to safety regulations on site. It can be viewed a psychological approach that rewards workers for their adhered routine on site (Chan et al., 2010; Haines III et al., 2001). Teo et al (2005) suggested that incentives programs consists of 3 main elements such as monetary , non monetary, and disciplinary action. A reward system that utilizes money, coupled with non monetary incentives in the form of holidays, recognitions, promotions can encourage workers to monitor their own safety behaviour and performance is capable of improving safety behaviour. Workers on site tend to establish their behaviours consistent with the organizations goal, opting for both forms of rewards at the end of the specified compliance of rules. Disciplinary action on the other hand is a form of punishment to the personnel who violates established sets of safety rules and regulations on site. It can take the form of hefty fines and compounds for violators. Combination of reward and punishment can be regarded as a strategy that inculcates safe behaviours among workers on site.
	Monetary Incentives	
	Non Monetary Incentives	
	Disciplinary Action	
<b>Policy Factors</b>	Formulation of Safety Policies	Safety policy is an illustration of the organization’s expression in prioritizing safety in workplace ( Torner and Pousette, 2009). Depicted in Malaysia OSHA (1994) act, it is the duty of the employer to formulate safety policies to his employers in workplace. Notably, having high characteristics standard policies will harness positive management attitudes, formal conditions, collective values and individual attitudes that will foster better safety performance (Torner and Pousette, 2009). However, on another contention, if safety management systems on sites are complimented with a comprehensible policies that is well versed by all personnel on sites, employees will be able to execute any safety system in parallel with their nature of work (Teo and Ling, 2006). Clear cut policies are however inadequate without having a unified international standard to govern how the policies are carried out. OHSAS 18001 certification standards comes in handy when it is able to help organization to control risks related to occupational health and safety event. It is proven that companies with OHSAS 18001 certification in firms perform better in terms of safety than those who do not (Vinodkumar and Bhasi, 2011).
	Well-written and High standard Policies	
	Comprehensible and explicit policies	
<b>Personnel Factors</b>	OHSAS 18001 certification	Various studies have denoted personnel factors as any related issues concerning human aspects in workplace. Teo et al (2005) suggested that personnel factors consist of both management attitude towards safety, and supervisors and workers attitude towards safety, where both significantly shape the organization on sites. Direct support and involvement in safety by head quarter’s management is a sign
	HQ-Management Attitude towards Safety	
	Supervisors and	

	Workers attitude towards safety Constant Monitoring of Human Errors.	of management positive attitude towards safety (Ng et al., 2005). Similarly, a high safety attitude among supervisors will yield a positive safety culture on site. However, this can only be done with continuous safety competence training and seminars (Tam et al., 2004). Nevertheless, constant monitoring of human errors on construction sites can be a proactive way in improving personnel safety performance. Human errors on sites are commonly a result of faulty judgment and failure to follow safety rules and regulations (Hetherington et al., 2006). By taking this human touch into consideration, personnel errors can be assessed and modeled, preventing any future possibilities that will trigger accidents on site (Sorenson, 2002).
<b>Technical Factors</b>	Organized Technicalities  Risk Response and Risk Management System  Adequate PPE that is aligned with the nature of work	Technical aspects comprises layout of work, equipment, degree of automation, design of work environment, maintenance and also safety related systems such as risk control systems, personal protective equipment and emergency control system (Sgourou et al., 2010). Effective and organized technicalities should be employed on site that will ease the complexity of construction works to hinder any unsafe conditions and unsafe behaviours. To cope with hazards, risk effective risk response and risk management system are vital to manage, eliminate and enhance safety. When hazards cannot be completely eliminated, priorities must be given towards the effort of encouraging technical competence and hazards awareness through appropriate prevention methods such as the use of personal protective equipment (Olson et al., 2009). Adequate technicalities will gradually improve safety performance on site.
<b>Process Factors</b>	Identify Hazards  Assess Risks  Contingency Plans for Works  Safety Standard of Procedure for Work Processes	Process factors can be defined as the way of doing a particular task in the effort to achieve objective, goals or producing final product. The focal point in process factor is the effectiveness of control measure towards personnel due to the vast variation of construction activities (Teo et al., 2005). Hence, safe way of working has been the main priority on construction sites. DOSH (2008) in Malaysia has bring forth a standard guideline known as HIRARC(Hazard identification, Risk Assessment and Risk Control ) to assist safety personnel on sites to assess hazardous works, evaluate risks and develop a standard procedure for each and every detail of construction works on site.

### 3. Research Methodology

A questionnaire was developed and administered to 110 different well known major construction companies in Malaysia. Registered as Grade Seven (G7) in Construction Industry Development Board, these types of contractors handle projects worth more than 10 Million and above and have no limit in tender capacity. The questionnaire consists of two parts. The first part intends to obtain the demography of respondents; while the second part focused on the degree of importance of the factors in influencing safety performance on construction sites. To obtain the degree of importance of these factors in influencing safety performance, a five-point scale range from 1 (not important) to 5 (extremely important) was adopted to determine the relative importance of factors in influencing safety performance on sites. The relative importance (I) for each factor was calculated as follows:

$$I = \frac{\sum_{i=1}^5 W_i X_i}{\sum_{i=1}^5 X_i}, \text{ where}$$

$i$  = Response category index; whereby 1=not important, 2= slightly important, 3= moderately important ,4= very important, 5= extremely important

$W_i$  = Weight assigned to  $i$ th response =1, 2, 3, 4, 5 respectively.

$X_i$  = Frequency of the  $i$ th response given as percentage of the total responses for each cause.

The Index (I) had a range from 1 until 5, the higher value of index implies the higher degree of importance of each factor. The average index for the main factor is the average of the all the indexes of their respective factor elements. The computed index was then used to rank the different factor elements and the main factors as perceived by the contractors.

### 4. Analysis of Data

Of the 110 questionnaires that were sent out by hand, 63 contractors responded to the survey (61% of response rate). All of the questions were answered by the main contractors. Table 2 below presents the demographic characteristics of Contractors.

Table 2 Demographic Characteristics of Contractors

Demographic Details	Frequency	Percent
<b>Age</b>		
20-29	20	31.7
30-39	23	36.5
40-49	20	31.7
<b>Sex</b>		
Male	63	100.0
<b>Experience Working on Site</b>		
1-5	36	57.1
6-10	20	31.7
11-15	1	1.6
15-20	6	9.6
<b>Fields of Specialization</b>		
Civil engineering only	13	20.6
Building Construction only	40	63.5
Civil Engineering & Building Construction	5	7.9
Building Construction , Mechanical & Electrical	1	1.6
Civil Engineering, Building Construction, and Mechanical & Electrical	4	6.3

The Relative Important Index (I) for each factor element was computed, and ranked. Followed by that, the index of each factor element was averaged to constitute an overall index for their respective major factor. The major factors were ranked as well and displayed in Table 3. Based on the major factors ranking, the most important major factor as perceived is (1) Management Activities (I=4.35), followed by (2) Personnel (I=4.28), (3) Process (I= 4.25), (4) Policy (I=4.24), (5) Technical (I=4.23), and (6) Incentives (I=4.12). By sizing down to factor elements, top three most important factor elements are Safety Inspection (I=4.44), followed by On Site and HQ-Management Attitude towards Safety (I=4.38), and Safety Regulation Enforcement (I= 4.35); while the three most less favoured factor element was Non Monetary Incentive (I=4.06), OHSAS 18001 Certification ( I =4.11); and Monetary Incentives (I= 4.12)

Table 3 Relative Important Index (I) for Factors Influencing Safety Performance on Construction Sites

Factor	Factor Elements		Major Factors	
	Index (I)	Rank	Index (I)	Rank
<b>Management Activities</b>			<b>4.35</b>	<b>(1)</b>
Safety Inspection	4.44	1		
Safety Meeting	4.32	5		
Safety Regulation Enforcement	4.35	3		
Safety Training and Education	4.29	10		
Safety Communication	4.33	4		
<b>Incentives</b>			<b>4.12</b>	<b>(6)</b>
Monetary Incentives	4.12	20		
Non Monetary Incentives	4.06	22		
Disciplinary Action	4.19	17		
<b>Policy Factors</b>			<b>4.24</b>	<b>(4)</b>
Formulation of Safety Policies	4.22	15		
Well-written and High standard Policies	4.32	5		
Comprehensible and explicit policies	4.32	5		
OHSAS 18001 certification	4.11	21		
<b>Personnel Factors</b>			<b>4.28</b>	<b>(2)</b>

On Site and HQ-Management Attitude towards Safety	4.38	2		
Supervisors and Workers attitude towards safety	4.24	13		
Constant Monitoring of Human Errors	4.21	16		
<b>Technical Factors</b>			<b>4.23</b>	<b>(5)</b>
Organized Technicalities	4.24	13		
Risk Response and Risk Management System	4.14	18		
Adequate PPE that is aligned with the nature of work	4.30	9		
<b>Process Factors</b>			<b>4.25</b>	<b>(3)</b>
Identify Hazards	4.29	10		
Assess Risks	4.13	19		
Contingency Plans for Works	4.25	12		
Safety Standard of Procedure for Work Processes	4.32	5		

## 5. Conclusions and Recommendations

We have limitations to discuss in depth for all of the factors prioritized by the contractors. Hence, in this section, we only present a few prescriptions and thoughts for the contractors based on the three most prioritized factor elements; three most less preferred factor elements; and the most important major element that influence safety performance on sites .

Begin with the factor elements; safety inspection was ranked the most important factor that influences safety performance on sites. Safety inspection encompasses supervisor’s effort in instructing and monitoring safety on sites. Safety inspection can only function well if supervisors himself is put at the front line, doing vigorous inspections and bring out the supervisory aspects on both human and work. Site safety inspections and checking should serve as proactive governance on site by ensuring all personnel and job specification comply with governing safety regulations to hinder accidents. Next, HQ-Management Attitude towards Safety factor was ranked second most important factor. Head Quarters or known as “home office” should underpin any safety related management works. To show a significant support and involvement for safety, head office administrators should always set procedures for reporting accidents and near misses, in accordance with OSH (NADOPOD) Regulations 2004 and OHSAS 18001:2007 and ensure all documents such as accident data and safety analysis to be well organized and updated. Head Quarters should plan out short and long term safety budget to ensure the adequacy of safety implementation on site. Followed by that, “Safety Regulation Enforcement” was ranked the third highest important factor. To enforce regulation effectively, contractor himself should adhere to the regulations and impose any action stated out in OSHA (1994) act. For example, ensuring all workers to be protected with safety gears; or hiring safety and health officers for project worth more than RM 20 million; or even report any accidents on site to the authorities by following strict rules mention in any regulation and safety act. To show real discipline and strict adherence to the enforcement, contractors should impose heavy penalties and fines for violators; impose notice of prohibition (stop work order) and notice improvement for poor safety performance on site.

On the other hand, “Monetary”, “Non-monetary” and “OHSAS 18001 Certification” are perceived as less important in influencing safety performance on sites. We tend to agree with contractors’ contention and perception that these factors may have lesser influence on safety performance. Arguably, both monetary and non-monetary incentives do not necessarily achieve the safety record desired as individual’s expectations and response to incentives may vary, and it comes with both dismay and discouragement when their behaviour are not rewarded as perceived. Safety in fact is something that should be valued and harnessed, not to be paid for. Last but not least, OHSAS 18001 is only an obligation for contractors to achieve when the project comes with contractual requirement. Contractors may nevertheless see it as an option, rather than obligation.

Overall, our findings depicted “Management Activities on Site” as the most important major factor that influence safety performance on site. Undeniably, the responsibility of managing site activities heavily rests on the contractors, and site supervisors. To overhaul safety performance on site through effective on-site management activities, top management should constantly monitor and motivate supervisor’s work. Cooperative and motivated supervisors will ensure good housekeeping works on site, keeping accidents on site at bay. Notably, the factor elements under this major factor showed high rankings as well. (Safety

Inspection =1, Safety Regulation Enforcement = 3, Safety Communication = 4, Safety Meeting = 5, and Safety Training and Education=10).

Since the major liability on construction site falls on the contractor, we hope to shed a light to the contractors through our study on the perceived important factors that influence safety performance on sites. We believe the contractors can give a proper attention on the important factors and make dynamic efforts to reduce accidents on site. Optimistically, the Malaysian Construction Industry can opt for zero accidents on site and lift our industry's image for better improvements.

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