

## **The Impact of Construction Supply Chain on the Implementation of Safety Management Systems**

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### **Abstract**

*The accident rate in the Malaysian construction industry is among the highest compared to other developing countries. The Malaysian government has recommended the self-regulation of safety management systems (SMS) for construction projects with the hope of improving the situation; however, the readiness of the local contractors to implement SMS is questionable. This research investigated the systemic issues of contractors in processing plants, during SMS development and implementation. Firstly, a literature review has surveyed the scenario of the construction supply chain as well as enabling an understanding of its impact on SMS implementation during project execution in the processing plants. Secondly, this paper has identified factors influencing SMS implementation through in-depth semi structured interview. Data were analyzed through grounded theory analysis method. The findings of this research appear to show that many obstacles encountered by contractors are interlinked, including cultural factors, working conditions and the organizational process.*

**Keyword:** Construction supply chain, project execution

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## INTRODUCTION

The growth of petrochemical processing plants (hereafter referred to as processing plants) has benefited various industries, especially the construction industry. The construction industry plays a major role in processing plants, as many construction activities are carry out to meet the high demands of development. One important role of the construction industry is to provide civil and mechanical maintenance tasks.

The use of contractors for maintenance tasks in processing plants is necessary to cope with the large scale of work and engineering problems (Mueller et al., 1996). Contractors play a significant role during maintenance tasks due to the amount of work to be accomplished in a short time (Duffuaa & Daya, 2004). Other reasons for using contractors include: experience and professionalism; specialization in certain areas; productivity, cost and efficiency (Lenahan, 2006 & Basri, & Kumar, 2006).

Despite its important contribution to processing plant development, the Malaysian construction industry is still saddled with serious safety problems. For instance, there have been 700 negligence cases in the construction industry since 2002, which include high-profile incidents (The Star, 2006 & Kong, 2001). The construction industry continues to contribute towards the high fatal accident rate in Malaysia (Kong, 2001; Berita Harian, 2007; Ministry of Human Resource, 2008 & Department of Occupational Safety and Health, 2011).

This research focuses on the exploration of the issues and problems related to SMS development and implementation faced by Malaysian contractors working in processing plants. The lack of sufficient theoretical understanding of SMS development and its implementation emphasises the requirement for a more grounded approach. This is achieved through the exploration of SMS from the perspective of those involved.

The research is intended to investigate the issues surrounding the successful and satisfactory delivery of SMS solely from Malaysian contractors' perspective and to develop a theory related to the reasons for those issues. It is intended that the results will assist various parties involved in construction projects in processing plants to understand what they need to do to address those issues.

## SAFETY MANAGEMENT SYSTEMS IN THE CONSTRUCTION INDUSTRY

Past studies have discovered that the successful implementation of SMS can help to prevent accidents in the construction industry (Baxendale, & Jones, 2000; Wilson, & Koehn, 2000; Tam et al., 2001 & & Gambatese, 2003). However, the use of SMS reached a plateau. Despite adopting SMS, contractors remain poor in the implementation of safety on worksites. As an organic type of organisation Wilson (1989), construction offers a flexible working environment. Construction involves human interaction and complex activity and aligns individual objectives into one process, which is always difficult in practice, especially for large projects. Projects are complex in nature, as they involve technical, procedural, organisational and human elements in an integrated manner (Ruuska & Vartiainen, 2003). The construction industry consists of various parties such as client/owner, designer, consultants, general contractor, subcontractors and suppliers which are known as multi-organization process.

Construction is also a multi-stage process as it includes conceptual, design, construction, maintenance, replacement and decommission. The multi-organization and multi-stage process is also known as construction supply chain (CSC). The CSC has been characterised with fragmentation and poor coordination among project participants in long time, and there are many inter-organization problems, such as interdependency, inaccurate information transfer and wrong deliveries which result in the dissatisfied performance (Xue, et al., 2007 & Vrijhoef, & Koskela, 1999). This complexity clearly demands SMS for the efficiency and effectiveness of accident prevention mechanisms. Therefore, many safety regulations have been enacted due to the distinctive nature of construction processes Kartam et al., 2000 & Fang et al., 2004).

The concepts of SMS are relatively new in Malaysia. The Occupational Safety and Health Act 1994 (OSHA 1994) is quite comprehensive and an improvement over earlier pieces of legislation, however, the level of awareness and practicability of such regulations within the construction industry are generally lower than expected (Rampal & Nizam, 2006). In addition, SMS in Malaysia is still under self-regulation without nationally applied models (Kogi, 2002). Hence the number of Malaysian companies subscribing to SMS is still small compared to the total number of industries in the country (Thye, 2001). A study by the Malaysian Trade Union Congress (MTUC) (2001), affirmed that the implementation of safety in Malaysia is poor in the workplace. Furthermore, there are currently no specific guidelines or a master plan for the implementation of SMS programmes to help the construction industry players to improve their performance (Construction Industry Development Board, 2008).

Industrial accidents happen mainly due to non-compliance of OSHA 1994 by employers (New Straits Times, 2002). However, in the case of contractors working in processing plants, safety is a requirement of the client. Many clients have introduced various safety approaches to improve the safety performance of contractors (Simon, & Piquard, 1991 & Ibrahim et al., 2002). It is compulsory to include a safety plan in the tender documentation during the bidding process (Kong, 2001). However, previous research Fitts, (1996), Smallwood, (1998), Yule & Mearns (2004) & Abraham et al., (2004), confirms that contractors adopt SMS just for the sake of the tender requirements and to satisfy the clients during the bidding process. Hence the implementation of safety is still lacking (Fitts, 1996). In the context of Malaysia, according to Husin et al., (2008), current SMS practice does have sound features and characteristics, but lacks mission, vision, objectives and awareness due to the over-emphasis on productivity. SMS is under self-regulation and it requires more constructive and practical ideas for implementation Husin et al., (2008). Furthermore, occupational safety is still in the early development stage in Malaysia Husin et al., (2008).

In the case of contractors working in processing plants, apart from the complexity of construction working condition, contractors face a greater risk during maintenance tasks Kim et al., (2002). Contractors could be exposed to a number of inevitable hazards: large numbers of workers, mostly employed by the contractors, who are unfamiliar with the plant in a confined space; the presence of hazardous materials; a large number of tasks performed under high pressure, in all weathers and often all the time (Ahmadun et al., 2003). The number of workers involved in a processing plant maintenance shutdown can be anywhere between 700 and 3000 at peak time (Ahmadun et al., 2003).

Due to the hazards and risks present in processing plants, the clients set high safety requirements and effective approaches to monitor and control the safety of contractors (Jannadi & Bu-Khamsin, 2002). However, accidents among contractors still happen (Kong, 2001; Mohd-Salleh, 2002; New Straits Times, 2002; Shaluf & Ahmadun, 2006 & Zainudin et al. 2006). Fatalities and injuries are commonplace among contractors due to the heavy physical activities necessary during maintenance tasks and the presence of a large number of workers (Hale, 1998; Ahmadun, 2003 & Duffuaa & Daya, 2004). The number of accidents involving contractors is often more than five times higher than those involving the processing plants' own personnel (Hale et al., 1998).

Some important examples of accidents in Malaysian processing plants are the Tiram Kimia Depot Chemical explosion (1992), the Shell Bintulu explosion (1997), the Petronas Gas Berhad fire and explosion (2002), the Petronas LNG Complex Bintulu fire incident (2003), the refinery fire in West Malaysia (1999) and the Fatty Chemicals methanol blast (2006). The latest accident is the Petronas LNG Complex Bintulu gas leakage (2009) (Mohd-Salleh, 2002; Shaluf & Ahmadun, 2006; Ismail, & Stuart, 2005 & Utusan Malaysia Online, 2009). Fatalities involving contractors is the worst consequences due to processing plants accidents. Some examples are three fatalities in the Petronas Gas Berhad explosion in 2002 (New Straits Times, 2002 & Shaluf & Ahmadun, 2006) and two fatalities in the Fatty Chemicals methanol blasts in 2006.

There are many issues involved in implementing SMS. Failures are still common despite advances in the SMS approach. Little has been written on the views of contractors in processing plants about the issue they have with SMS implementation. Therefore, an investigation of SMS

implementation can help to identify the problems encountered by contractors.

## RESEARCH METHODOLOGY

For this research, a literature review was undertaken to identify factors that influenced SMS implementation among contractors in processing plant. A literature review has surveyed the scenario of the construction supply chain as well as enabling an understanding of its impact on SMS implementation during project execution in the processing plants.

A series of in-depth semi-structured interviews were set up with Malaysian contractors working in processing plants. This is to commensurate with the aim of this study which is to develop a theory as a means of forming an understanding of how Malaysian contractors working in processing plants experience safety with regard to SMS implementation.

The target respondents for the interviews were Malaysian contractors working in processing plants. The sample was selected from Malaysian contractors in all categories (large, medium and small) of the Malaysian Contractor Industry Development Board (CIDB) registration and which specialize in civil and mechanical engineering for both maintenance services and project shutdown in processing plants. All local contractors are required to register with the CIDB in one of seven grades (g1 to g7). The categories reflect the size of the firms, with g7 being the largest and g1 the smallest. The categories are based on the tendering capacity or the project cost at which they are qualified to participate, the minimum capital available, the organization of resources and the level of experience. For the purpose of this study, purposive sampling was used to select the respondents because due to resource constraints, this was more practical. Invitations to participate in the interviews were made to 77 contractors working in processing plants. Only seven contractors, with total respondents are thirteen (13), were participated in the interviews.

The researcher developed the themes and questions to be covered. To prevent the interviewees and the researcher going off the point into irrelevant conversation, a detailed description of the interview questions was used as a reference. However, the actual interview process was managed as an open-ended interview to reveal unintended latent constructs. The order of the questions varied depending on the flow of the conversation. The areas of concern, which was divided into four sections, were used to help keep the interviews in focus without biasing the responses from interviewees.

Section 1 was designed to help the respondents feel more comfortable and relaxed with the conversation by engaging them in a discussion about their background and their current position within the organization. In Section 2, information about the safety practices in their company was gained. Section 3 investigated whether Malaysian contractors develop SMS and how they implement the system. Section 4 dealt with the issues raised during SMS implementation, specifically with regards to problems and barriers and the factors that contribute to successful SMS. Finally, the session ended with an expression of thanks and the offer of further discussion if the respondent so desired.

Before the researcher proceeded with the analysis, each interview was translated and transcribed into a word-processing document. The interviews were held in the Malaysian language, thus translation into English was needed. After completion of the transcription, the researcher read the transcript and made some revisions based on the notes taken during the interview.

The interview transcripts were analyzed according to the grounded theory approach, following recommendations in the grounded theory analysis literature (Strauss & Corbin, 1998; Goulding, 2002 & Heath & Cowley, 2004). Grounded theory has a well-defined process of data analysis for qualitative research (Walker & Myrick, 2006). The full transcriptions were analyzed line by line (Strauss & Corbin, 1998, Goulding, 2002 & Charmaz, 2006), to identify the full range of possible codes. The codes represent the interviewee and the number of the statement. To ensure the robustness of the analysis, data reduction was performed by the researcher independently inspecting the interview notes and transcripts.

The grounded theory method was developed by two American scholars, Barney G. Glaser and Anselm L. Strauss, during their sociological field investigation of the awareness of dying as a social problem (Glaser & Strauss, 1967). As they constructed their study of dying, they

developed more defined and systematic methodological strategies for collecting and analyzing qualitative data which researchers in various disciplines could adopt. Grounded theory was intended as a methodology for developing theory. It is grounded in data that are systematically gathered and analyzed. Glaser and Strauss's book *The Discovery of Grounded Theory*, which was published in 1967, first articulated these strategies and advocated developing theories which are eventually grounded in the behavior, words and actions of those under study (Goulding, 2002). With grounded theory, the researcher must work in the real environments in which the actions take place to analytically relate informants' perspectives to the environments through which they emerge (Goulding, 2002 & Douglas, 2004). Hence the emerging theory from grounded theory analysis is valid and reliable and does not require further proving or testing in the real environment because it comes directly from the real environment's data itself (Georgieva & Allan, 2008).

The method of presenting the emergent themes was adopted from Sharma and Vredenburg (1998) and Carruthers et al., (2006). The emerging themes were re-organised using FreeMind software version 0.8.0 to build up the connections between the significant themes and to categorise each theme into broad themes. The following sections address the broad themes in detail.

## **FINDING AND DISCUSSION**

The findings of this research appear to show that many obstacles encountered by contractors during SMS implementation are interlinked, including cultural factors, working conditions and the organizational process. These factors have formed the underlying root causes of ineffective SMS implementation: the misperception of safety responsibility. The misperception of safety responsibilities occurs by the parties involved in the construction supply chain. However, this study explains only relationship between clients and contractors, clients and contract workers and contractor and contract workers. Based on the research findings, the barriers to effective SMS implementation can be divided into external factors (clients) and internal factors (contractors and contract workers). Several distinct misperceptions of safety responsibility between clients, contractors and contract workers emerged from these barriers.

### **Reliance Culture of Safety Management Systems**

The results of the interviews indicate that a reliance culture does exist between contractors and client, and between contractors and parents company/headquarters. Several factors have contributed to this condition. Obviously, safety performance is being taken into consideration prior to contract approval. This has led to contractors disregarding safety measures in order to gain contract approval. Generally, SMS policy and procedure, which was drawn by the parents company/headquarters was included in the tender documents as a standard image of company's safety implementation.

Subsequently, contractors rely on headquarters in organizing the safety measures to be utilized. As a result, contractors are in a vulnerable situation as they need to work in environment, location and condition that they are not familiar with. To familiarize with the in-house safety requirements set by headquarters, contractors are required to collaborate with clients. However, the different levels of responsibilities between contractors and clients in the alliance have led to misperceptions in the process of implementing SMS. The reliance culture leaves the contractor in vulnerable position due to different environment, location and condition between the entities.

### **The Uncertainty of Organic Types of Organisation**

The implementation of SMS is highly influenced by the company's external environment such as the uncontrollable risk and uncertainty that is easily overlooked by contractor in the processing plant. Safety requirements and standards will vary based on client's requirements such as work

progress, datelines, and schedule. Consequently, safety enforcement is not standardized for contractors and clients when profit is placed as a higher priority compared to safety.

As contractors work under pressure to complete the task in a specified period, this study reveals the bureaucracy of safety procedures, which leads to ineffective SMS implementation, for example, the procedures for bringing in equipment; therefore contractors choose to take short cuts by using inappropriate equipment for the job.

Another issue, which relates to the working conditions, is the physical environment. In this case, the physical environment refers to the geographical location and climate of the workplace. Santos-Reyes & Beard (2002 & 2008), stated that the physical environment might affect some aspects of SMS. It is common that contractors will frequently change their working location, and therefore the working conditions also change Laukkanen, (1999). Safety requirements become more stringent and more demanding according to the project and client. SMS implementation becomes tougher due to this type of physical environment.

### **Disintegration and Inconsistency Organisational Process**

Organising is critical to ensure the effectiveness of SMS implementation and has a significant influence upon it (Fitts, 1996; Santos-Reyes & Beard, 2002; Rundmo et al., 1998; Dessler, 1976; Basso, 2004 & McDonald, 2000). Therefore, the development of safety department is crucial to cater safety issues in a company. However, contractors reluctant to do that as it can reduce the budget.

The main concern of a contractor is how to save money and reduce costs. Thus safety is usually considered a secondary priority in the company's plans. In this study, the interviewees' views indicate that it is common practice in Malaysia to discount safety purposely to win the tender. The clients who demand the lowest contract costs have influenced this scenario. As such, the contractors search for lower quality supplies and neglect safety issues. It is not surprising to find that the majority of contractors in this study do not allow for safety costs in their tenders. This seems to suggest that these contractors find it difficult to implement the most effective safety during the construction phase of their projects.

The SMS implementation was also affected according to project size and size of company. Safety attention is higher on bigger projects compare to small projects. For a small size of company, financial constrain is common which led to hiring temporary workers. This condition contributed to poor safety training and lack of qualified taskforce.

## **CONCLUSION**

From a theoretical standpoint, the development of empirical research in SMS has lagged far behind the fast growing acceptance of SMS as a management philosophy for improving organisational effectiveness. The problem is even more acute outside the developed world where knowledge of SMS is almost non-existent. The research described in this study has attempted to bridge the gap between the existing theories and knowledge and the approaches required for increased effectiveness of SMS implementation in a developing country like Malaysia.

The main study therefore investigated the root causes of ineffective SMS implementation from the perspective of those involved, providing a rich, grounded understanding of some of the key elements of SMS implementation and how they are experienced in the Malaysian context.

The results indicate that misperception of safety responsibility issues has a strong influence on contractors' SMS implementation. This finding is an interesting one, as previous studies of SMS give little or no attention to this issue. Addressing this issue is essential to create awareness by the parties involved to improve SMS implementation.

This research has contributed to furthering the understanding of the main factors influencing safety implementation by Malaysian contractors working in processing plants. It has identified factors that are peculiar to, or exacerbated by, the internal and external environment of

the companies. Factors such as financial constrictions, cultural dimensions and working conditions are prominent influences.

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