



## HSE MANAGEMENT SYSTEM AT HIGH ELEVATION IN SHIPBUILDING PROJECT

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### Abstract:

The Shipyard industry is one of the growing industry in Malaysia. There is still a lot of room for improvement with regards to the safety aspects within the industry. This study presents the finding of a survey on the safety management in shipyard operation of class C and D in Peninsular Malaysia as registered with Ministry of Finance Malaysia. Shipyard operation is considered a hazardous job. Most of the cases were due to fall from height, fire and explosion. The accidents were due to crane collapsed and explosion during welding works inside a hull of a Liquefied Petroleum Gas (LPG) carrier. The research aims to study the Health, Safety and Environment Management System (HSEMS) of shipyard operations in Malaysia particularly in Class C and Class D. This study was conducted using a survey method following the Glenn D's equation. The findings of this study shown that almost all the shipyards had HSEMS in placed but some were incomplete. Accidents still happen in the Malaysian shipyard industry from time to time. Nearly 10% of shipyards did not have clear HSE Policy due to low priority given to HSE matters.

**Keywords:** Shipyard; Safety; Accident; Health; Safety and Environment Management System (HSEMS).

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### 1. Introduction

HSE Management System model is well-known comprised of seven interrelated elements with underlying expectations [1]:

- Commitment and Leadership
- Policies and Objectives
- Organization, Resources and Documentation
- Risk Evaluation and Management
- Planning & Procedure
- Implementation, Recording and Monitoring
- Audit and Review

Each element must communicate these expectations to all employees, customers and third parties associated with organisation business. One of the hazardous operation is working in shipyard where ships are repaired and built [2] [3]. Usually, shipyards are built nearby the sea or river [4]. HSEMS should cover all these activities of shipyard. There are many studies performed on hotwork in confined space [5] [6] [7]. However, there aren't many studies on procedural of hotwork operation at high elevation compared to studies on risks, harms and incidents [7] [8] [9]. The safest working with the hot work environment at high elevation are designed based on managing, controlling and handling all aspects of health, safety and the environment in the shipyard industry [10] [11] [12].

### **The Safety Management**

The safety management role in the shipyard is managed by the operator. For example in the Daewoo Shipbuilding and Marine Engineering Co. Ltd. shipyard in Korea, the first stage to develop a HSEMS is by identifying the hazard, which known as Hazards Identification (HAZID). Then, it continues with determining the severity of potential hazards. However, most shipyard companies in Malaysia are still keeping their current SOP, and has no or less improvement made on it, as it is least enforced and not fully practiced [13]. The consequences of that, many incidents and accidents occurred in the shipyard such as firing, explosion and objects or human falling down.

### **Leadership**

Due to more recent foreign direct investments by Japanese and Westerners, the traditional patterns of business management and leadership have been modified [14]. They are still governed by their key cultural and religious values which underpin their behavior, beliefs and attitudes [15].

### **Cultural Approach towards Occupational Safety & Health (OSH)**

The key issue for employers, business managers and OSH professionals striving for excellence in the field of occupational safety and health is to ensure that occupational accidents and work-related ill health are prevented as much as possible. Furthermore, the safe and healthy behavior among all employees is also promoted. In order to achieve continuous improvement of workers' safety and health, a systematic, integrated, proactive, participative, and multiple-strategy approach towards OSH management is needed [16].

### **Policies**

The stages of the policy management process are: defining objectives, setting specific goals, implementing programs and actions, checking, validating, revising actions and goals. In the case of shipbuilding, because of the huge diversity of industrial organization models establishing specific performance targets is particularly difficult [17].

### **Organization, Resources and Documentation**

Surveys show that leaders and decision-makers are tending to follow the trend and search for best practices implemented. That happens sometimes without understanding their real organization's needs or assessing their actual requirements and that would put the organisations under a serious risk [18]. In addition, more than 300 injuries happen yearly in the marine industry during the operation. Most accidents occurred during working with hotwork environment at high elevation [19] [20] [21]. In addition, it has been found that the shipyards in Turkey, a huge number of accidents occurred due to falling from high elevations and followed by fire or explosion [19] [22].

## 2. Materials and Methods

This study attempts to fill in the gap by re-examining the HSEMS in shipbuilding industry in Malaysia. The findings provide an up to-date understanding towards the current conditions of the local HSEMS shipbuilding industry. The shipyard is class C and D which is registered with Malaysian Ministry of Finance (MoF). The findings of this study provide the up-to-date information in formulating appropriate strategies to address the challenges by human-related issue. The methods of the study as following below

### Questionnaire Survey

Questionnaire generally developed based on literature review and might have some modification and amendments [23]. The questionnaire were developed based on Likert Scale in order to scale which respondents choose one option that best aligns with their view. The respondents identified factors that perceived as being likely to contribute to the success of the construction project by responding on a scale from 1 (never) to 5 (always). The five-point Likert rating scale was 1 = Never, 2 = Seldom, 3 = Sometimes, 4 = Often and 5 = Always. The mean score (MS) for each factor was calculated using the following formula [24] [25].

$$MS = (\sum (f \times s)) / N \quad (1 \ll MS \ll 5)$$

Where  $f$  is the frequency of responses to each rating,  $s$  is the score given to each factor by the respondents and ranges from 1 to 5 and  $N$  is the total number of responses concerning that factor. Figure 3 shows the total selected response from responders for HSEMS questionnaire.

### Questionnaire Design

The questionnaire was divided into different sections, namely:

Section 1: General Information of the Agency/Organization

Section 2: Respondent Profile

Section 3: Success Factors for Successful Completion of Shipbuilding Projects.

In the research, the questionnaire were distributed to respondents that are familiar with shipyard building projects. It provides better information to be effective in meeting the objectives of the study [26] [27].

Despite the limitation of the sampling size, the firms surveyed represent a large proportion of the shipbuilding industry outputs and populations. The survey was sent to a total of 83 respondents in the shipbuilding industry which comprises of 11 clients, 7 consultants and 65 contractors. These respondents were selected systematic and randomly based on the lists of best performing companies from respective institution [28].

Based on the responses received, three (13.3 per cent) respondents were from clients, followed by four (8.4 per cent) from consultant and seven (78.3 per cent) from contractor companies. The response rate of 100 per cent is totally acceptable. Based on the literature review, the normal response rate in construction research for postal questionnaire is around 20-30 per cent [29]. On the other hand, Dulaimi ET Al. reported a 5.91 per cent respond rate for their research survey due to the lack of participation from the construction industry [30]. Based on the data obtained from the questionnaire, 3 of them or 3.6% are owner and project director each followed by 14 of them

which represent 16.9% are project manager. Besides that, 13 of the respondents with 15.7% are project engineer and 1 respondent or 1.2% are surveyor. While the supervisor showed 15 respondents or 18.1% and general worker are 34 respondents or 41%. Thus, it shows that the highest numbers of respondents are general workers and the lowest were surveyor.

3 respondents or 3.6% have between 1 to 3 years working experience. This was followed by 6 respondent or 7.2% between 3 to 5 years. Besides that, there have 14 respondents or 16.9% between 5 to 10 years and followed by 60 respondent or 72.3% more than 10 years. This represented the highest number of respondents for working experience is more than 10 years and the lowest are between 4 to 6 years. No respondents between 1 to 3 years. It was followed by 6 respondents or 7.2% between 4 to 6 years. Then, the respondents more than 10 years comprised of 71 respondents with 85.5%. This illustrated that the highest number of respondents more than 10 years and the lowest allocated by the respondents between 4 to 6 years and 7 to 9 years.

### 3. Results and Discussions

#### The Normality Test

In statistics, normality test are used to determine if a data set is well-modeled by a normal distribution and to compute how likely it is for a random variable underlying the data set to be normally distributed. Normality is an important concept in statistics because before start the analyses, the researcher should check a dataset for normality before performing an analysis that relies on normally distributes data. When the data is normal, the test should be conducted using parametric. Mean and median are very similar for all factors as shown on Table 1. Based on the test, each factor showed significant level of  $p < 0.05$ . This showed that it was not normal distribution and suitable for this study. This means that the test should be conducted using non-parametric although all items were shaped Likert scale. The all factors show positive skewness where the mean value is greater than the median value.

Table 1: Test of Normality for Each Factor

| Factor                                    | Mean  | Median | Standard Deviation | Skewness |
|---|-------|--------|--------------------|----------|
| Leadership and Commitment                 | 3.251 | 3.200  | 0.599              | 1.235    |
| Policy and Strategic Objectives           | 3.200 | 3.000  | 0.671              | 1.057    |
| Organization, Resources and Documentation | 3.077 | 2.888  | 0.699              | 1.146    |
| Evaluation and Risk Management            | 3.551 | 3.400  | 0.585              | 0.877    |
| Planning and Procedures                   | 3.167 | 3.000  | 0.616              | 0.855    |
| Implementation and Monitoring             | 3.097 | 2.909  | 0.560              | 1.315    |
| Auditing and Reviewing                    | 3.494 | 3.333  | 0.705              | 0.509    |

Figure 1 showed the distribution of elements reviewing. The result showed, shape of auditing and reviewing were leptokurtic and negative skewness. That means the results were higher kurtosis or higher peak in a normal distribution.

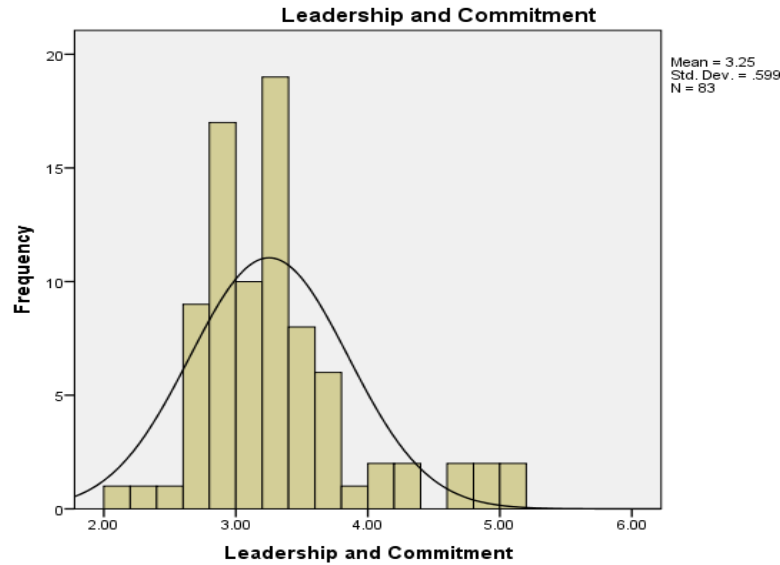


Figure 1: Distribution of Leadership and Commitment

**Reliability**

Cranach’s alpha is the tool to investigate the internal consistency (i.e. reliability) of the measures, and Cranach’s alpha reliability coefficient normally ranges between 0 and 1. According to Saharan & Boogie, the closer the reliability coefficient to 1.00 is the better. They further proposed that reliability less than 0.6 were considered to be poor. Those in the range 0.7 was acceptable and those over 0.8 was good [31].

In this study, 83 respondents were used in the pilot study. As seen in Table 2, all factors showed the result is acceptable. The result was range from 0.810 to 0.922. Based on success factors for successful completion of construction projects, Cronbach’s alpha for leadership and commitment is 0.917, policy and strategic objectives was 0.917, organization, resources and documentation was 0.922, evaluation and risk management was 0.848, planning and procedures was 0.865, implementation and monitoring was 0.81 and auditing and reviewing was 0.911. The overall questionnaire showed Cronbach’s alpha was 0.981. Every questionnaire items was valid because the Cronbach’s alpha greater than 6. So, the data in this study can be classified as good and adequate for this research means.

Table 2: Test of Reliability

| Factor                                    | Cronbach Alpha | No of Item |
|---|----------------|------------|
| Leadership and Commitment                 | 0.910          | 10         |
| Policy and Strategic Objectives           | 0.919          | 9          |
| Organization, Resources and Documentation | 0.923          | 9          |
| Evaluation and Risk Management            | 0.848          | 10         |
| Planning and Procedures                   | 0.865          | 11         |
| Implementation and Monitoring             | 0.810          | 11         |
| Auditing and Reviewing                    | 0.911          | 9          |
| Overall                                   | 0.981          | 71         |

**Relative Important Index****Leadership and Commitment**

Table 3 showed the perspectives of Leadership and Commitment from client, consultant and contractor on relative importance of HSE Management System for Hotwork Operation at High Elevation in Shipbuilding Project in a single table. From the comparative view in Table 6, “Managers at all levels ensure that decisions/practices were consistent with HSE policy and objectives” had been ranked as the most important factor by the groups (combining the views of client, consultant and contractor) followed by “Organization employ staff who possess HSE qualification that aim to provide training in more than the basic requirements” and “Organization ensure HSE advisors were competent person”.

Table 3: RII of Leadership and Commitment

| Statement  | RII   | Rank |
|--|-------|------|
| Top management actively promote positive HSE culture in the business   | 0.636 | 6.5  |
| Organization promote a positive culture towards HSE matters  | 0.636 | 6.5  |
| Organization regularly arranges meetings for promoting HSE aspects   | 0.631 | 8    |
| Organization ensure HSE advisors are competent person  | 0.699 | 2.5  |
| The organization’s superintendent discuss HSE matter at workplace  | 0.653 | 5    |
| Safety is priority mention during toolbox meeting  | 0.67  | 4    |
| Senior management do HSE inspections frequently  | 0.564 | 10   |
| Organization involved in HSE activities, objective-setting and monitoring  | 0.61  | 9    |
| Organization employ staff who possess HSE qualification that aim to provide training in more than the basic requirements | 0.699 | 2.5  |
| Managers at all levels ensure that decisions/practices are consistent with HSE policy and objectives                     | 0.706 | 1    |

**Policy and Strategic Objectiveness**

Table 4 showed the perspectives of Policy and Strategic Objectiveness from client, consultant and contractor on relative importance of HSE Management System for Hotwork Operation at High Elevation in Shipbuilding Project in a single table. From the comparative view in Table 4, “Organization really cares about my well-being” had been ranked as the most important factor by the groups (combining the views of client, consultant and contractor) followed by “Organization arranges to ensure new employees have knowledge of basic HSE” and “Organization encourages open communication about safety”.

Table 4: RII of Policy and Strategic Objectiveness

| Statement  | RII   | Rank |
|--|-------|------|
| Organization has a HSE Policy document   | 0.619 | 8    |
| Organization manage and communicate changes in HSE policy to all employees                       | 0.639 | 6    |
| Organization structured to manage and communicate HSE effectively                                | 0.634 | 7    |
| Organization ensure new employees have knowledge, practices and requirements with respect to HSE | 0.646 | 4    |
| There is a positive culture of HSE issues in organization  | 0.593 | 9    |
| Organization openly accepts ideas for improving safety   | 0.641 | 5    |
| Organization encourages open communication about safety  | 0.651 | 3    |
| Organization arranges to ensure new employees have knowledge of basic HSE                        | 0.655 | 2    |
| Organization really cares about my well-being  | 0.684 | 1    |



### Organization, Resources and Documentation

Table 5 showed the perspectives of Organization, resources and Documentation from client, consultant and contractor on relative importance of HSE Management System for Hotwork Operation at High Elevation in Shipbuilding Project in a single table. From the comparative view in Table 5, “Organization normally conduct incident/accident investigations” had been ranked as the most important factor by the groups (combining the views of client, consultant and contractor) followed by “Organization advise employees about PPE requirements at workplace” and “Organization provide Health and Safety training to employees”.

Table 5: RII of Organization, resources and Documentation

| Statement   | RII   | Rank |
|---|-------|------|
| Organization provide training needs                                 | 0.619 | 5    |
| Organization provide Health and Safety training to employees        | 0.634 | 3    |
| Organization advise employees about HSE signage, use and compliance | 0.59  | 8    |
| Organization advise employees to find Project Safety Plan &OHS      | 0.612 | 7    |
| Organization advise employees about PPE requirements at workplace   | 0.648 | 2    |
| Organization have made provision for HSE communication meetings     | 0.614 | 6    |
| HSE system are in place to monitor and prevent worker from accident | 0.622 | 4    |
| Organization manage PPE requirements                                | 0.508 | 9    |
| Organization normally conduct incident/accident investigations      | 0.696 | 1    |

### Evaluation and Risk Management

Table 6 showed the perspectives of Evaluation and Risk Management from client, consultant and contractor on relative importance of HSE Management System for Hot Work Operation at High Elevation in Shipbuilding Project in a single table. From the comparative view in Table 6, “Personally I feel that safety issues are the most important aspects of my job” had been ranked as the most important factor by the groups (combining the views of client, consultant and contractor) followed by “Employees feel confident when they have all the training before perform at workplace” and “I can influence health and safety performance in this organization”.

Table 6: RII of Evaluation and Risk Management

| Statement  | RII   | Rank |
|--|-------|------|
| Safety is the number one priority in the organization when completing a job  | 0.704 | 4    |
| Organization identify hazards, assess risks, control and mitigation consequences, to a level as low as reasonable practicable. | 0.667 | 6    |
| Organization provide identification, assessment, control and recovery of hazards and effects                                   | 0.634 | 7    |
| The project area plan been reviewed (including hazards associated with utilities, excavations and restricted areas etc)        | 0.571 | 10   |
| Immediate Manager/Supervisor show interest in my safety at workplace   | 0.687 | 5    |
| Organization send employees for risk assessment training before they are allowed to perform their work                         | 0.610 | 8    |
| Organization is advice of type environmental hazards are associated with the scope of services                                 | 0.588 | 9    |
| I can influence health and safety performance in this organization   | 0.776 | 3    |

|  |       |   |
|--|-------|---|
| Employees feel confident when they have all the training before perform at workplace | 0.916 | 2 |
| Personally I feel that safety issues are the most important aspects of my job        | 0.918 | 1 |

### Planning and Procedures

Table 7 showed the perspectives of Evaluation and Risk Management from client, consultant and contractor on relative importance of HSE Management System for Hot Work Operation at High Elevation in Shipbuilding Project in a single table. From the comparative view in Table 7, “Organization ensure that work instructions and procedures are aligned with its HSE” had been ranked as the most important factor by the groups (combining the views of client, consultant and contractor) followed by “My immediate Managers/Supervisor express concern if safety procedures are not followed” and “Corrective action is always taken when management is aware about unsafe practices”.

Table 7: RII of Planning and Procedures

| Statement   | RII   | Rank |
|---|-------|------|
| Safety rules and procedures are carefully followed in this organization   | 0.658 | 4    |
| Health, safety rules and procedures are really practical  | 0.655 | 5    |
| Organization advise employees on the procedures to refuse unsafe work   | 0.610 | 9    |
| My immediate Managers/Supervisor express concern if safety procedures are not followed  | 0.670 | 2    |
| Corrective action is always taken when management is aware about unsafe practices   | 0.667 | 3    |
| Organization advised employee about changes of procedures and tasks, and employee properly prepared with complete safety training | 0.636 | 7    |
| Organization ensure that work instructions and procedures are aligned with its HSE  | 0.672 | 1    |
| Organization explained to employee about unsafe act and inappropriate behavior at workplace                                       | 0.653 | 6    |
| Procedures of scaffold inspection and tagging been explained to employee  | 0.545 | 11   |
| The site's incident report procedures (including near misses) been explained to employee  | 0.624 | 8    |
| I feel some of safety rules and procedures do not need to be followed to get the job done   | 0.578 | 10   |

### Implementation and Monitoring

Table 8 showed the perspectives of Evaluation and Risk Management from client, consultant and contractor on relative importance of HSE Management System for Hot Work Operation at High Elevation in Shipbuilding Project in a single table. From the comparative view in Table 8, “Organization ensure employees are competent to perform a job that involves hazards and risks” had been ranked as the most important factor by the groups (combining the views of client, consultant and contractor) followed by “Organization ensure that infrastructure and equipment used within operations are correctly certified, registered, controlled and maintained” and “Organization frequently monitor HSE performance in the workplace”.



Table 8: RII of Implementation and Monitoring

| Statement   | RII   | Rank |
|---|-------|------|
| Organization frequently monitor HSE performance   | 0.619 | 6    |
| Many accident and near misses have occurred while working for this organization   | 0.612 | 7    |
| Organization frequently monitor HSE performance in the workplace  | 0.639 | 3    |
| Organization ensure all employees have received appropriate HSE training and it is recorded and monitored                                   | 0.622 | 5    |
| Organization ensure employees are competent to perform a job that involves hazards and risks  | 0.740 | 1    |
| Sometimes I have to neglect some procedures/tasks to complete the job   | 0.561 | 9    |
| Conditions at workplace hinder my ability to work safety  | 0.602 | 8    |
| Organization ensure that infrastructure and equipment used within operations are correctly certified, registered, controlled and maintained | 0.733 | 2    |
| Organization frequently in place to control hazards and monitor the effectiveness of these controls   | 0.636 | 4    |
| Organization frequently communicate with employees about waste plan, a policy or guidelines on waste management                             | 0.557 | 10   |
| Organization had sent employees for training before they are allowed to erect, alter and dismantle scaffolding or mobile towers             | 0.494 | 11   |

#### 4. Conclusions and Recommendations

The present condition of HSE Management System for Hotwork Operation at High Elevation in Shipbuilding Project in Malaysia was reviewed. This gives all the combination of factors contributed to accidents in shipbuilding projects. The questionnaire survey and subsequent analysis gave different ranks for the factors from the perspective of client, consultant and contractor. There are 77 factors for HSE Management System for Hotwork Operation at High Elevation in Shipbuilding Project identified from the literature review, which were also ranked from the perspective of client; consultant and contractor based the results of the questionnaire survey and subsequent analysis.

The relative important index RII was calculated to rank the HSE Management System for Hot Work Operation at High Elevation in Shipbuilding Project. The statistical validity of the data collected using the questionnaire were tested by determining the normality. The reliability of the data was tested using non-parametric testing methods namely the Pearson correlation and Cronbach's coefficient alpha. The responses were classified into three categories (client/owner, consultant, contractor) to facilitate the investigation in different viewpoints of the Malaysian shipbuilding industry. The statistical analysis was conducted using SPSS ver.22 for window to rank factors for three categories of respondents namely client/owner, consultant and contractor.

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