Priority in Safety Management System Using Decision-Tree Technique

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Abstract

Safety Management System (SMS) is part of a company's safety management program and it's a way of managing Occupational Safety and Health (OSH). It helps reduce safety risks and improve overall OSH performance. This study was conducted to prioritize the SMS variables using the Decision-Tree technique. Questionnaires were administered to assess the current practice of SMS from a selected manufacturing industry. The study examined 7 independent variables which are Management Commitment, Employee's Attitude, Work Related Stress, Colleague Encouragement, 3 Sub Factors namely Recognition, Fear and Self-awareness that was adopted from previous studies. These variables were prioritized using the Decision Tree technique and overall efficiency of the present SMS were established for further improvements.

Keywords
Safety Management System; Decision-Tree; OSH Hazards

1. Introduction
The objective of this study is to investigate the application of Decision-Tree technique in prioritizing Safety Management System (SMS) variables. The data is evaluated, and improvements based on prioritize data using the Decision-Tree technique is then proposed.

The complexity of industrial processes and the use of hazardous substances make future injury risks uncertain and frightening (Gholizadeh & Esmaeili, 2015). A good SMS is critical to success, good governance, and overall business

sustainability (Muthusamy et al., 2021). The desire for economic growth sometimes blinds the manufacturer to societal demands for good OSH practices, particularly from industrial threats. Technical risks can be intentional or unintentional. Determining potential risks based on reliability concept is often difficult due to rapid technological advancement (Lam, Halim and Muthusamy, 2010).

A Safety Management System (SMS) is part of a company's safety management program. It's a standard way of managing its OSH. It helps reduce OSH risks and improve overall OSH performance. The requirements for SMS incorporate many elements of the ISO 9000 QMS and ISO 14000 EMS standards. Occupational Safety and Health Management Systems (OSHMS) - Guidelines provides a general guidance on how to apply OSHMS (MS1722:2011) (DOSH, 2011).

In this study, Decision-Tree technique is adopted to investigate the relationship between independent variables and a dependent variable (performance measure). Creating a Decision-Tree is a visual representation of all possible solutions to a problem (Song and Lu, 2015). It is structured like a tree, with each branch representing a possible path of events. Each stage weighs the cost and likelihood of occurrence. It can also prioritize the SMS variables and provide a pathway for corrective action plan to mitigate, avoid, transfer of OSH risks.

This study aims to prioritize the SMS variables described in Act 514 in Malaysia. Questionnaires were administered in a chosen manufacturing industry based on their SMS practices. The collected data is then analyzed, summarized, and proposed action plans to strengthen its OSH practices.

2. Literature Review

A literature review is the compilation and review of evidence on project-related issues which has been studied by researchers in scholarly papers, articles, publications, and research papers.

2.1 Department of Occupational Safety and Health (DOSH)

The Malaysian Ministry of Human Resources has a division called the Department of Occupational Safety and Health (DOSH). As a government agency, DOSH enforces national health and safety legislation. The function of DOSH is to conduct investigations as well as technical analyses on employee OSH matters. It began with steam boiler safety in the 1960s and worked its way up to OSH in the 1990s as the Occupational Safety and Health (OSH) Act 1994 or Act 514. The Act 514 adopted the Safety Management System framework as outlined in the following section.

2.2 Safety Management System (SMS)

Whether issued by a product/service supplier or a safety authority, the fundamental objective of a Safety Management System (SMS) is to offer a systematic approach to attaining acceptable levels of safety risk. As shown in Figure 1, a SMS is composed of four functional components as stated by the US Federal Aviation Administration (FAA, n.d.).

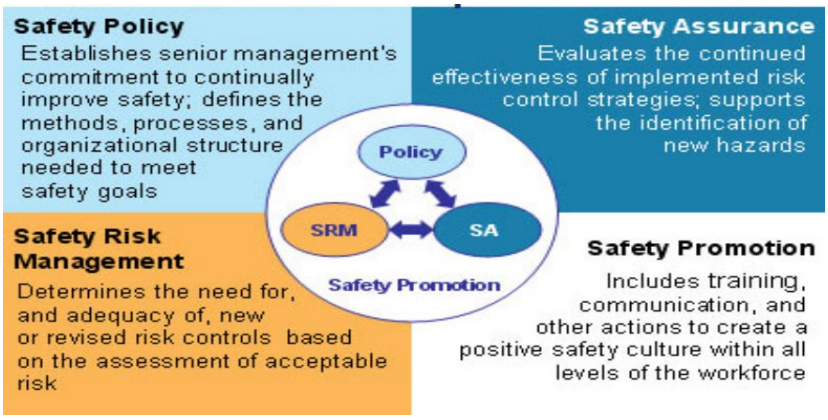

Figure 1 Four SMS Components

A Safety Policy underlines top management's commitment to continuous improvement in safety; specifies the methods, processes, and organizational structure required to achieve safety objectives. Whereas a Safety Risk Management (SRM) evaluates the need for and appropriateness of new or updated risk controls based on assessing risk. On the other hand, Safety Assurance assesses the effectiveness of risk control techniques that have been applied and the discovery of new dangers. Finally, Safety Promotion consists of training, communication, and other activities aimed at fostering a positive safety culture throughout the workforce.

Among these four SMS components, Culture plays an important role in the management of OSH. It includes four main elements which can be summarized as Management Commitment, Employee's Attitude, Work Related Stress, Colleague Encouragement, and 3 sub-elements namely Recognition, Fear and Self-awareness (Sulaie & Park, 2018). These seven main and sub-elements can be grouped as the Independent Variables that influences the Dependent Variable, i.e., Safety Incident Rate.

3. Methodology

The flow chart as shown in Figure 2 depicts the flow of the study conducted and how the result was analyzed.

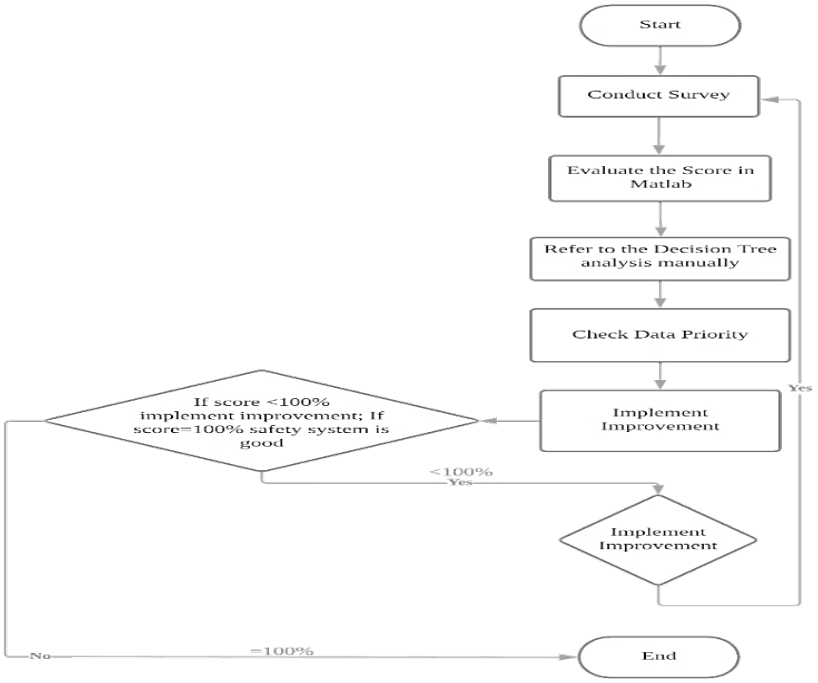

Figure 2 Study Flow Chart

Quantitative survey method was adopted in this research. Questionnaires were created to collect the independent variables data as outlined in the OSH Act 514 from a selected manufacturing industry. These independent variables are then divided into three priority categories: high priority, medium priority, and low priority based on Pareto's rule considering total cumulative score from the questionnaires original score (UTM, 2014; McGonagle et al., 2016).

The variable's obtained score is then converted into percentage to employ the Decision Tree technique starting from High to low priority variables. If a high-priority variable did not meet 100% score, immediate action is required. If medium priority variable is less than 100%, an action will be taken as soon as possible. On the low priority variables which have little impact on the system, the management can initiate actions when resources are made available.

The decision tree suggests primary improvement actions based on the company's survey choice, and the researcher suggests secondary improvement plans for the company's OSH Committee.

4. Data Collection

Survey questionnaires are designed to obtain the variables data from the OSH Committee and other employees such as managers, operators, and all other workers in the facility. From this survey, the researcher received 50 questionnaires from the respondents out of 75 questionnaires administered. The success rate is 66.7%.

4.1 The Calculation:

Each answer to the survey will contribute to a predetermined score. The scores will be added up for each independent variable and divided by the total score of the variables as shown in Table 2. If the score is 100%, the independent variable is still in good practice; else, action should be taken based on action priority level as shown in Table 1.

5. Results and Discussion

The final score and the Decision Tree are shown in Table 2 and Figure 3 respectively. The full score showed a high priority for Management Commitment and Employee Attitude where both scored less than 100%, and medium priority for Work-Related Stress and low priority for Colleague Encouragement. It demonstrated that only two sub-independent variables, i.e., Fear and Self-Awareness with high and medium priority have scored 100% and need no intervention. Whereas Recognition variable which has a high priority requires attention since the obtained score is below 100%. (Table 1)

Table 1 Action Priority Level

Obtained Score percentage	**Priority Level**		
	High	**Medium**	**Low**
0% - 50%	IMM	ASAP	KIV
51% - 80%	IMM	ASAP	KIV
81% - 99%	IMM	ASAP	KIV

Legend: IMM – IMMEDIATE
ASAP – AS SOON AS POSSIBLE
KIV – KEEP IN VIEW

Table 2 Independent Variable Score

No.	**Main Category Independent Variables**	**Full Score**	**Full Score Percentage**	**Priority Based on Pareto**	**Score Obtained**	**Obtained Score Percentage**	**Action Priority**
1	Management Commitment	551	53.3	High	201	36.5	IMM
2	Employee Attitude	328	31.7	High	250	76.2	IMM
3	Work-related stress	115	11.1	Medium	31	27	ASAP
4	Colleague Encouragement	40	3.9	Low	3	7.5	KIV
	Cumulative Full Score	**1034**					
	Subcategory Independent Variables	**Full Score**	**Full Score Percentage**	**Priority Based on Pareto**	**Score Obtained**	**Obtained Score Percentage**	**Action Priority**
1	Recognition	59	44	High	28	47.5	IMM
2	Self-Awareness	50	37.3	High	50	100	-
3	Fear	25	18.7	Medium	25	100	-
	Cumulative Full Score	**134**					

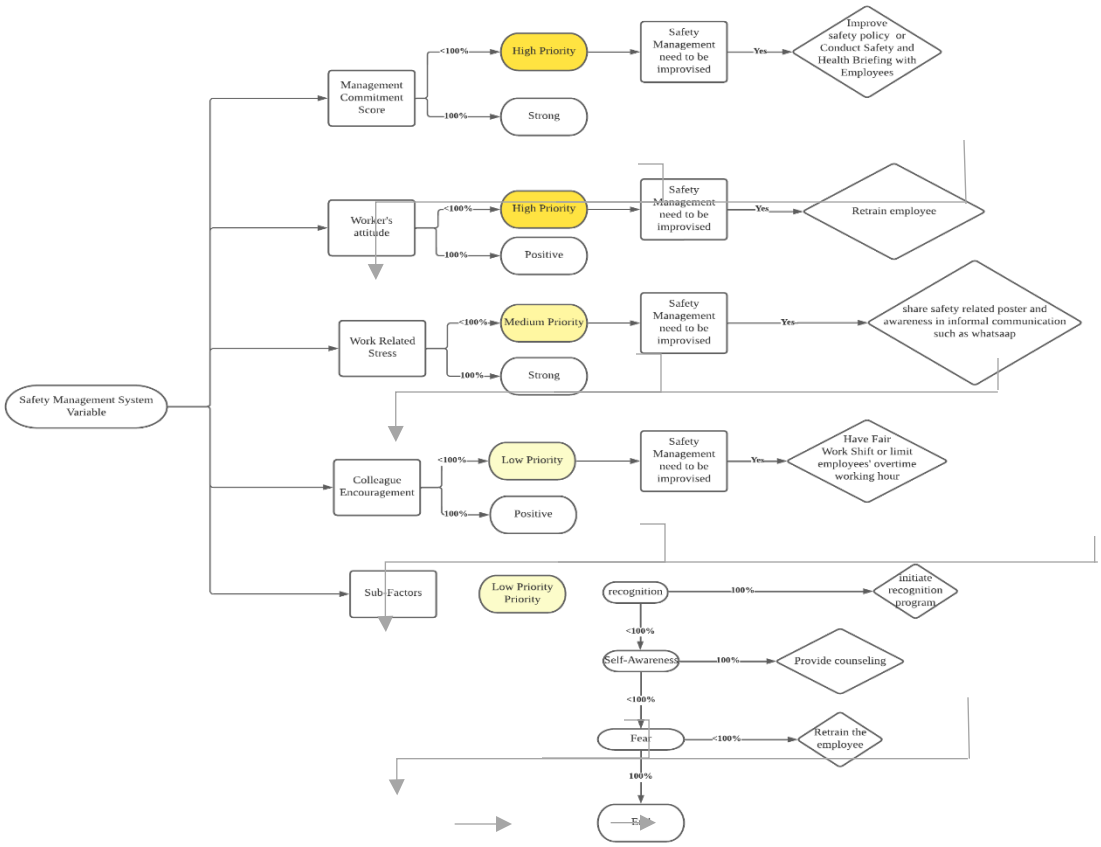

Figure 3 Decision Tree Diagram

Management Commitment is critical to the SMS, and it requires immediate corrective action from the OSH committee and management. This study reaffirm that the selected manufacturing company meets the Malaysian DOSH's minimum safety standards. The organization prefers to increase management commitment by continually upgrading safety policies and training of staff.

To improve worker safety, the selected manufacturing industry committed to provide Personal Protective Equipment's (PPEs) such as earplugs, safety helmets, safety shoes, goggles and so on. The industry can also enhance safety assessments from current once a year to twice a year to detect any non-compliance in safety practices. Post-training evaluation is not given to the staffs. It is suggested to conduct post-training assessments to ensure personnel are well-versed in good OSH practices.

Attitude of employee is given second highest priority. The employee's attitude is still high, but not high enough to be ignored. Employees prefer to ignore safety procedures to finish their jobs faster. Management is encouraged to retrain staffs who lacks safety knowledge, ensure they are wearing adequate PPEs as required, and operating machinery or equipment as directed (McGonagle, et al., 2016).

Stress at work is falls under medium priority, where the actions must be taken to improve this variable otherwise it may affect the OSH systems in a long-term run. To alleviate work-related stress, management assigns employees' reasonable workloads, limits overtime, conducting stress assessments and organizing non-work-related activities after

the work hours such as sports and social activities. This variable refers to management's commitment to keep-up employees mental wellbeing (Corporate Wellness Magazine, 2022).

In this study's, Colleague Encouragement variable is least valued. The survey indicated that least interactions among employees in OSH related discussion and sharing information. To increase the Colleague Encouragement, management should hold regular OSH related meetings, discussions, forums involving employees (Shangareev, 2018; Ashford, 1997).

The OSH committee and management should consider giving recognition to employees who complies with OSH policies diligently. Management should encourage and recognize employees publicly, so encouraging and strengthening the company's good safety culture and practices among employees.

6. Conclusion

The study investigated the application of Decision Tree technique in safety management system prioritizing as outlined in the Occupational Safety and Health Act 1994. The independent and dependent variables have been identified, and the decision tree diagram has been constructed. Management commitment is the highest priority variable as management commitment to safety is a distinct and crucial component in an effective OSH management. The employee's attitude is the second highest prioritized data, while positive attitudes will support to strengthen the importance of safety procedures and equipment. Many successful companies have built strong safety cultures that have led to excellent and efficient work units. Research has shown that one way to build that kind of culture is to get the management and workers actively engaged and involved in safety related discussions, forums, employee suggestions etc. Recognition, fear, and self-awareness are the least prioritized variable in this study, but still, they are vital to an organizations OSH management system.

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Biography

Kanesan Muthusamy received the Ph.D. Degree in Information Engineering (Operations Research) from the Graduate School of Engineering, Osaka University, Osaka, Japan. In the past, he has held various engineering and management positions with Robert Bosch, Motorola, and Panasonic. Currently, he is an Asst. Professor in Department of Mechanical and Mechatronic Engineering, UCSI University, Kuala Lumpur, Malaysia. His research interest includes OR/OM, OSH, TQM and Project Management. Dr. Muthusamy is a Professional Engineer registered with the Board of Engineers, Malaysia.

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