

Improving Health and Safety Performance on Construction Projects by Using Total Quality Safety Management

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Abstract

Since more and more construction projects are about to be implemented in Myanmar now and in future, occupational health and safety (OHS) of the people involved in the Myanmar construction industry must be paid more attention to improve the existing poor OHS conditions of the industry. This paper gives a general review on the existing OHS conditions of the Myanmar construction industry through construction site visits, the opinions of top managers on OHS and the attitudes and behaviors of construction personnel for OHS. Based on the results from these three investigations and total quality management (TQM), an OHS management is proposed for construction projects.

Keywords: *Construction industry, OHS management, OHS performance, TQM.*

I. INTRODUCTION

The risk of people getting seriously hurt in the construction industry is notoriously much higher compared with other industries although several years of OHS reforms, researches and initiatives. For example, in the USA construction industry, there were 971 worker fatalities in 2017 [1] and in the Great Britain, there were 39 fatalities in 2017/2018 [2]. In China, the Ministry of Emergency Management (MEM) announced in July that during the first six months of 2018, there were 1,732 accidents and 1,752 deaths in the construction industry [3]. Therefore, it can be said that the existing occupational health and safety systems applied in these countries have many weaknesses and there are many areas needed to be improved.

In Myanmar, started in 2017, although Occupational Safety and Health Law (Draft) is published and being currently reviewed by the government, there is no legal framework, systems and standards to be specifically applied for OHS management in construction yet. Therefore, OHS conditions in Myanmar is in a bad condition with no doubt so far.

Since more and more construction projects are becoming complex and large thanks to increasing population, scarcity of land, overpopulation in urban areas and the help of latest construction technology, the more people are involving in the construction industry. These construction personnel have to face more risks and pressures put on them.

The traditional OHS management is no longer adequate for the construction industry. Therefore, an OHS management based on quality management can be a good solution to improve the occupation health and safety performance of

construction projects [4]. Although there are researches for applying TQM concepts to OHS management [4] [5] [6] [7] [8], there was no research for applying TQM based OHS management to be applied for construction projects yet. Therefore, this research can fill the gap of TQM and OHS knowledge area.

To implement a OHS management to a construction project effectively, surveying, discovering and analyzing employees' attitudes and behaviors towards to OHS plays an important part. There was no research and survey conducted to construction personnel in Myanmar to investigate their OHS attitudes and behaviors. Therefore, this research can give a general overview of OHS attitudes and behaviors of the Myanmar construction personnel.

By applying Total Quality Safety Management, OHS and other industrial operations are integrated into a 'total performance management system' and therefore, safety, quality and productivity can be improved in a jointed way during the life-cycle of a construction project.

II. LITERATURE REVIEW

For this research, literature review is performed for two areas. They are occupational health and safety management and Total Quality Safety Management [9] which is also known as Total Safety Management (TSM).

Since the existing traditional OHS management is no longer adequate for growing and complexing construction industry, certain researchers approach managing OHS in a new perspective. It agrees with the father of TQM, W. Edwards Deming's famous point – Adopt a new philosophy. In 2017, Sooyoung Choea and Fernanda Leiteb [10] propose a formalized framework by incorporating 3D and time for construction safety plan. By using their findings, OHS personnel will be able to analyze safety risks more specifically. They stated that OHS is no longer to be regarded as only the duty of OHS personnel appointed in a construction site. It becomes accepted as the duty of all and especially for construction site managers to show their leadership in managing OHS as a top management commitment. It also agrees with a Deming's point – Adopt and institute leadership. In 2019 research, the dark side of OHS leadership of construction site managers affects the OHS performance of employees [11]. However, the research is only based on the subjective answers from respondents. In this research, the training and coaching construction managers have a great impact on OHS performance. However, also in 2019 research, M. Loosemore and N. Malouf stated that mandatory OHS training is largely ineffective for improving OHS performance [12]. Although trainees will have more knowledge in OHS than others, they do not tend to give care to safety. For successful OHS leadership, main themes and sub-themes outlining factors for the successful application of safety leadership interventions are present by Shelley Stiles et al., [13]. Context, preparation, communication, leadership style and behavior and actions are key five themes for implementing OHS leadership. From these researches, it can be learnt that leadership as top management commitment and training as employee involvement plays important roles in managing OHS successfully.

In 2012, a model of total safety management (TSM) and its application to a certain company was presented by ZHI Xueyi et al., [4]. Although the model based on TQM differs from the traditional OHS management and emphasis on

active monitoring and continual improvement, the model is too general and the type of company in which the improvement obtained by the application of TSM model occurred was not described. In 2016, T. Kontogiannis et al., proposed principles, process and methods for TSM [6]. They describe a great deal of principles and theories which can be applied for managing OHS. Although their proposed TSM is mostly similar with previous OHS concepts, it modifies and arranges the existing OHS system with good points from TQM and simplifies the complex merged management system for a potential user. However, it is also general and not specified enough for construction project sites. In 2017, although there is a research presented a TSM framework for a major hazards plant producing pesticides [5], there was no research that apply TSM to modify and OHS management. Therefore, this knowledge area needs more researching to fill the gap.

III. METHODOLOGY

Research design involves construction site visits and using checklist to investigate the existing health and safety performance and practices of the Myanmar construction companies. Opinions of top managers on construction health and safety are obtained by one to one interviewing with each person on his/her construction project. Occupational health and safety attitudes and behaviors of construction personnel are collected through two survey forms – attitudes and behaviors. The analysis of these investigations are based on theories and researches of Total Quality Management.

3.1 Demographic Characteristics Construction Projects Used in This Study

For this study, six different construction sites from six different organizations were randomly chosen. All construction sites are located in Yangon region. The existing OHS conditions and performance of each company is determined based on one construction project the company performing. However, all construction sites chosen for this study can represent the general overall type and size of the projects mostly being performed in the Myanmar construction industry [14]. Size and type for each construction project are presented as Table 1.

Table 1 Size and Type of Construction Project

No.	Name	Size and type of construction Project	Number of projects	% of construction site in sample
1.	A	22 storied R.C.C residential project	1	16.67
2.	B	2 storied R.C.C. industrial project	1	16.67
3.	C	27 storied steel structure commercial project	1	16.67
4	D	23 storied R.C.C. commercial project	1	16.67
5.	E	2 storied R.C.C. government project	1	16.67
6.	F	3 – ½ storied R.C.C. Residential Project	1	16.67

All these construction sites had different procurement procedure and their organization culture are presented as follows.

The procurement procedure of Project A is design-bid-build. The owner is private and the project is constructed with a joint-venture foreign investment. Company A, which is the main contractor of the project, is a medium size company (number of employee between 101 and 150). They construct this project with seven sub-contracted companies which are specialised in civil work, HVAC, electrical work, scaffolding, elevator installation, finishing, painting and interior decoration, carpentry and floor work and masonry work respectively. A third-party company was also hired by the owner for QA/QC. The employees responsible for OHS management of this project were the project manager, one OHS officer, one OHS supervisor, one OHS coordinator and three senior project engineers

The procurement procedure of Project B is design-bid-build. The owner is private and the project is constructed with a joint-venture foreign investment. The project site is located in Thilawa SEZ. Company B, which is the main contractor of the project, is a large size company (number of employee above 200). They construct this project with two sub-contracted companies which are specialised in HVAC and electrical work respectively. A third-party company was also hired by the owner for QA/QC. The employees responsible for OHS management of this project were the project manager, the construction manager, one OHS supervisor and two senior project engineers.

The procurement procedure of Project C is design-bid-build. The owner is private and the project is constructed with a joint-venture foreign investment. The project site is located in one of the most crowded areas of Yangon. Company C, which is the main contractor of the project, is a large size company (number of employee above 200). They construct this project with four sub-contracted companies which are specialized in scaffolding, elevator and escalator installation, HVAC and electrical work respectively. A third-party company was also hired by the owner for QA/QC. The employees responsible for OHS management of this project were the project manager, two construction managers, one OHS officer, two OHS supervisors, one OHS coordinator, four senior project engineers and OHS representative person from each subcontracted company.

The procurement procedure of Project D is design-build. The owner is private and also the construction company D. It is a medium size local construction company (number of employee between 51 and 100). They construct this project with three sub-contracted companies which are specialised in elevator and escalator installation, HVAC and electrical work respectively. The company itself serves for QA/QC. Company D do not nominate and give responsibility for any person for OHS management of this project.

The procurement procedure of Project E is design-bid-build. The owner is public (the Myanmar government). It is a hospital project and located near the existing main hospital. Company E, which is the main contractor of the project, is a small size company (number of employee under 50). They construct this project with two sub-contracted companies which are specialised in HVAC and electrical work respectively. The government itself serve for QA/QC. Company E do not nominate and give responsibility for any person for the OHS management of this project.

The procurement procedure of Project F is design-bid-build. The owner is private. Company F, which is the main contractor of the project, is a small size local company (number of employee under 50). They construct this project with

two sub-contracted companies which are specialised in HVAC and electrical work respectively. Company F do not nominate and give responsibility for any person for QA/QC and OHS management of this project.

3.2 Demographic characteristics of top managers

For personal interview for top managers' opinions on OHS management in Myanmar, five people who were taking responsibility of top management in the private construction companies in Yangon were randomly selected. Four of them were the project managers and another was a construction manager. Four of them have oversea working experience. Only one of them is female. The 80 percent of interviewees had more than a decade experience in the construction industry.

3.3 Demographic characteristics of construction personnel

To investigate the occupational health and safety attitudes and behaviors of construction personnel of Myanmar, two surveys are conducted to 40 people. All people are working in construction projects in Yangon. Demographic characteristics of construction personnel are described in the following table.

Table 2 Demographic Characteristics of Construction Personnel

Item	Position	Number	% of people in sample
1	Project manager	5	12.5
3	OHS personnel	5	12.5
4	QA/QC engineer	2	5
5	M&E engineer	3	7.5
6	Project engineer	5	12.5
7	Senior assistant engineer	16	40
9	Junior engineer	4	10
	Total	40	100

IV. RESULTS FROM INVESTIGATIONS

4.1 Results Obtained from Construction Projects

To determine the existing OHS performance of surveyed construction project sites, seventeen areas are investigated. These areas investigated in six companies are summarized in the following table.

Table 3 Investigation Areas for OHS Performance of Construction Projects

Item	Investigation Area	Score	Percentage
1	Health and Safety Policy of the parent organization	1	5.88
2	Health and Safety Plan for the current project	1	5.88
3	Contractor Management	1	5.88
4	Emergency Plan	1	5.88
5	First Aid	1	5.88
6	Personal Protective Equipment (PPE)	1	5.88
7	Security and Public Safety	1	5.88
8	Electrical Safety	1	5.88
9	Working at Height	1	5.88
10	Scaffolding	1	5.88
11	Fire Prevention	1	5.88
12	Welfare Facilities	1	5.88
13	Health and Safety Training	1	5.88
14	Health and Safety Group Meeting	1	5.88
15	Housekeeping	1	5.88
16	Safe System of Work	1	5.88
17	Auditing	1	5.88
	Total	17	100

For Company A, the overall percentage of its OHS performance is 79 percent out of 100 which can be said 'Very Good'. For Company B, the overall percentage of its OHS performance is 67 percent out of 100 which can be said 'Good'. For Company C, the overall percentage of its OHS performance is 82 percent out of 100 which can be said 'Very Good'. For Company D, the overall percentage of its OHS performance is 21 percent out of 100 which can be said 'Bad'. For Company E, the overall percentage of its OHS performance is 5.5 percent out of 100 which can be said 'Very Bad'. For Company F, the overall percentage of its OHS performance is 3 percent out of 100 which can be said 'Very Bad'.

From these results, which can be concluded is that in Myanmar, occupational health and safety performance of construction projects with a joint-venture foreign investment is in a good condition such as Company A, B and C. However, these companies have some weaknesses in employee involvement, OHS training, public safety and auditing and reviewing of their existing OHS policy and plan.

The hospital project of the Myanmar government constructed by a local private construction company E do not implement any OHS system for the project. The reason for its very poor OHS conditions is competitive government building contracts which choose the bidder mainly based on the lowest price and there is no fixed sum proportioned budget for OHS in the bidding price.

The company D is building its own construction project. It is a high rise construction project and its only strongest point for OHS management is scaffolding system. Although it mainly emphasis on product quality over cost and time, the owner is not willing to provide any resources for OHS to its employees in the construction process. The Myanmar government do not enforce enough owners /clients to provide adequate OHS resources for the employees.

The local company F's small-sized residential project can represent the most common type of construction building of the whole Myanmar. These type of construction projects can be found easily in Yangon's suburb areas and in other cities. They are the worst in OHS performance and there is no enough law enforcement and there is still no problem until there is no fatally accidents happen to employees and workers.

4.2 Results Obtained from Top Managers

On-site one to one interview is conducted to five construction top managers to investigate occupational health and conditions of Myanmar and their opinions on OHS management in their construction projects. The six question asked are referenced form a research conducted to investigate the OHS conditions of Hong Kong [15]. These questions are presented in the following table.

Table 4 Questions for On-site One to One Interview to Top Managers

Item	Question
1	Do you satisfy with the present safety condition of the construction site in Myanmar? Do you think that further improvement on the safety condition is required?
2	In your project, what is the priority for the Time, Cost, Quality and Safety during your management? Is there any budget set for safety?
3	Do you agree that a good safety management could not affect the target on time, cost and quality?
4	Can you exactly follow the safety standard established by the Government on site? Why?
5	Why you follow the safety standard on site? In your opinion, what is the advantages for keeping construction site safety?
6	In your opinion, who should take the responsibility to improve safety condition? Or it is a duty of all?

All five construction top managers all stated that they do not really satisfied the preset safety condition of the construction project sites in Myanmar. Since four of them used to work in the construction industry of certain foreign countries such as Singapore, Thailand and Japan, the present OHS condition of the Myanmar construction industry is

much lower than that in these countries. Therefore, the further improvement and law enforcement for OHS is urgently needed to save the reputation of the Myanmar construction industry.

For these top managers' construction projects, their first priority is either cost and time which is the main factors can lead to the project failure. Planning for quality is rare in the Myanmar construction projects. OHS is not the first priority for all of them and they agreed that it is unrealistic to follow OHS rules and guidelines in tight schedule with a limited budget. Therefore, the popular motto which can be easily seen in front of almost every construction sites in Myanmar – 'Safety First' is just a written poster and does not represent a commitment of top management. In Myanmar, there has not been any law for a percentage of budget proportioned to the whole project budget to be set for occupational health and safety in construction projects.

The top managers believe that a good safety management could not affect the target on time, cost and quality in a theoretical perspective. In reality, they said that it is not always realistic to follow OHS rules and regulations in a construction project because it could affect the project time and cost.

The Myanmar government does not have standard OHS rules and regulations for construction industry yet. The existing OHS laws are very general and dated back to 1950s. In all interviewees' project sites, they use a mixed version of construction OHS rules and regulations adopted from a certain country such as UK, USA, Japan and Singapore.

Although the construction top managers do not give a great deal of emphasis on OHS over Time, Cost and Quality, they all could say at least three of advantages of applying OHS management in construction sites such as increase in the efficiency of work, the performance of work and improvement in the employee's morale.

They all agree that occupational health and safety is the duty of all and the most responsible party is the Myanmar government. The Myanmar government should enforce and monitor the construction industry to improve the OHS performance of the industry.

4.3 Results Obtained from Construction Personnel

To investigate the OHS attitudes and behaviors of people in the Myanmar construction industry, two survey forms are conducted forty people. For the attitude survey, there are eighteen questions are asked and for behavior survey, there are twenty-three questions are asked. All the questions asked are referenced from a national wide survey conducted for the New Zealand workforce in 2014 [16]. The key findings from some of these forty-one questions are presented in the following sections.

4.3.1 Occupational Health and Safety Attitudes of Construction Personnel

When the questionnaires were asked about the risk of people seriously getting hurt in construction compare with other industries, 97 percentage rated the risk is higher or much higher than that in other industries. They all aware that the field in which they work can put their health and safety on a greater risk. When asked the source of most of their OHS

knowledge comes from, nearly half of them said that it comes from their own experience and 32 percentage said that it comes from their immediate boss or supervisor. Only 15 percentages of 40 attended a particular health and safety course. Although all engineers attend a certain course for their career improvement, they do not attend any OHS short course unless their organizations provide them.

Sixty percentage of More than fifty percentages of them agree that it is not always realistic to follow OHS rules and regulations and tend to forget safety when they are really busy. They chose electrical shock and falling from height as the most common and serious accidents in the Myanmar construction industry.

Seventy percentage of them have to work 51 to 60 hours per a week. High working hours is accepted as normal for engineers in Myanmar. More than three quarter of them suffer work-related stress. Their work-life balance is not very high according to the survey.

4.3.2 Occupational Health and Safety Behaviors Construction Personnel

More than half of the questionnaires said that they do not be told everything to know to do job safely and do not always have a OHS decision for them. Sixty percentages of them take a risk or short cut on purpose.

Worker reporting hazard, near misses and accidents to bosses/supervisors and workmates at their workplace could not be found in about fifty percentage of respondents' workplace. Top management reporting hazard, near misses and accidents to workers can be found in 65 percentage of respondents' workplace.

The Frequency of discussion for OHS in an open and helpful way the workplace can be found rarely in 86 percentage of the respondents' workplace. The same percentage of these respondents said that they do not feel confident to approach the boss/site supervisor for OHS issue.

V. TOTAL QUALITY QUALITY MANAGEMENT BASED OCCUPATIONAL HEALTH AND SAFETY MANAGMENT

Based on the results obtained from three investigations performed and concepts and research on OHS and TQM, a health and safety management to be applied for a construction project will be presented as a part of the research.

The proposed construction project is a private residential building performed by a private medium-sized construction company located. The construction project is a medium-sized and high-rise reinforced concrete structure. It is built in a busy downtown area of Yangon. The procurement procedure for the construction project is design-build. The company performs as a main contractor. The company subcontract some kinds of work such as M&E and scaffold installation. These data are briefly described in Table 6 below.

Table 5 Profile of a Proposed Construction Project

1. Type of Organization	Private
2. Size of Organization	Medium
3. Type of Construction Project	(a) Private
	(b) High-rise
	(c) Residential
	(d) RC structure
4. Size of Construction Project	Medium
5. Location of Construction Project	Yangon Downtown Area
6. Procurement Procedure	Design-Build
7. Number of Sub-contractors	Two (one for scaffolding and one for HVAC and electrical work)

The OHS management for the proposed construction project is divided into four stages based on a famous TQM concept, Deming's Wheel. They are Plan, Do, Check and Act (PDCA) stages for improving continuously OHS performance of construction projects. The detailed stages in each plan is referenced from HSG 65 [17].

5.1 Plan for Occupational Health and Safety Management for a Proposed Construction Project

There are two parts in 'Plan' stage of the proposed health and safety management. They are determining the OHS policy and planning for OHS management. Each part is presented in the following sections.

5.1.1 Determining the OHS policy

To propose a OHS policy of the proposed construction company, there are six areas to be considered. They are the correct choice of OHS system, OHS policy statement of intent, organizations, organizational charts, general arrangements, roles and responsibilities for the OHS management. Of these six areas, the following three areas are described briefly.

5.1.1.1 Correct Choice of OHS system

There are five OHS system mainly used worldwide. They are Health and Safety Executive (HSE), Construction (Design and Management) – (CDM), OHSAS 18001, ISO 45001 and ILO-OHS 2001. For the proposed construction project site, OHSAS 18001 and ISO 45001 are used.

5.1.1.2 OHS Policy Statement of Intent

The OHS statement of intent is signed and dated by the chairman of the company. Under ISO 14001 standard, it is the highest manager's responsibility to make sure that OHS policy is developed and communicated to all employees at induction and refresher training sessions, during team briefing sessions and at toolbox talks.

The written OHS policy statement of intent will emphasis the role of behavior, applies to all people who come into contact with the company, pledge for a sustainable approach, pledge to become industry role models, recognize knowledge necessary for behavior change, pledge to go beyond raising awareness to secure commitment, recognition of the connection between health and safety and business performance, pledge for proactive two-way communication with the workforce/stakeholders, specify senior management behaviors that demonstrate commitment and so on [18].

5.1.1.3 Organizations for Occupational Health and Safety Management

For the proposed company and each construction project it is operating, there will be two organizations founded for OHS management. They are OHS committee of the company and OHS organization of the proposed construction project.

There are nine parties involved in the OHS committee of the company. Top management of the company such as company chairman, deputy chairman and board of directors are the most responsible people for occupational health and safety of their employees. The measurement of occupational health and safety performance and the attainment of health and safety targets are recognized as being as important as other measures of business performance and targets. Therefore, the department of occupational health and safety management has the full right as a kind of top management in managing the occupational health and safety management system and monitoring its implementation. Other departments such as human resource (HR) and admin, maintenance, QA/QC, operation and quantity surveying departments will consider the OHS as one of their priority work function and assist the OHS department in successful implementation of occupational health and safety in the company. The following chart describe OHS committee of the company.

The company's every construction site must have organizations for occupational health and safety management. It may be varied depending on the type and size of the construction projects performed by the company. For the proposed construction project, aligned with project manager and project consultant, there are three OHS personnel appointed by the organization to manage the occupational health and safety management system and monitor its implementation in the site. There will also be a safety supervisor appointed by major sub-contractor to assist the coordination with the main contractor and the detailed OHS management of employees from sub-contractor. Although the other minor sub-contractors do not have to appoint a safety person, they must have to nominate a competent senior employee who have experience and knowledge in occupational health and safety as a responsible OHS representative person of their company. Project engineers and supervisors both from main contractor and sub-contractors must monitor OHS performance of their workers, report OHS issues in sites to OHS personnel and help them to implement OHS system successfully in the construction project. The following chart describes the OHS organization of the proposed construction project.

5.1.2 Planning for Occupational Health and Safety Management

In order to prepare a OHS plan for a construction projects, there are many areas needed to be considered based on the risks and hazards involved in each construction activity. For the proposed construction project, eleven areas are to be planned based on the investigation findings. Since the Myanmar construction personnel regarded electrical shock, falling from height and mechanical hazards as the most common and serious hazards for them, OHS plans for electricity, working at height, workplace transport operation, mechanical handling and lifting equipment are considered in the research.

For manual workers, OHS plans for manual handling is also prepared. The psychological health of employees is the most neglected area while considering OHS plans in Myanmar and therefore how to deal with work-related stress is also considered. Welfare facilities and housekeeping Welfare facilities and housekeeping are also considered in OHS plan. In Myanmar construction sites, the public safety is in a bad condition and therefore protecting the public is included in the OHS plan. Fire safety and other emergency procedure are the essential part of the OHS plan and therefore they are considered in the proposed OHS plan.

5.2 Do for Occupational Health and Safety Management

There are two parts in the 'Do' stage of OHS management. They are organizing for occupational health and safety for the proposed project and implementing the plan effectively in the proposed project. Each part is presented briefly in the following sections.

5.2.1 Organizing for Occupational Health and Safety Management

For this section, there are five areas need to be considered. they are as follows [17];

- a. Controls within the organization: the role of supervisors
- b. Controls within the organization: managing sub-contractors
- c. Co-operation
- d. Communication
- e. Competence

5.2.2 Implementing OHS plan Effectively in the Proposed Construction Project

To implement OHS plan effectively in the proposed construction project, the following steps will be considered [17];

- a. Take positive steps to address human factors issues and to encourage safe behavior.
- b. Recognize that the prevailing health and safety culture is a major influence in shaping people's safety-related behavior.
- c. Make the necessary resources available to successfully implement OHS plan. Resources include human resources and specialized skills, organizational infrastructure, technology and financial resources.\
- d. Keep documentation on OHS proportionate to the complexity of the risks concerned.

Documentation health and safety should be functional and concise, with the emphasis on its effectiveness rather than sheer volume of paperwork.

5.3 Check for Occupational Health and Safety Management

There are two parts in the 'Check' stage of OHS management. They are accident/incident/near-miss investigations and measuring performance [17].

5.4 Act for Occupational Health and Safety Management

There are three parts in the 'Act' stage of OHS management. They are auditing, performance reviewing and taking actions from lessons learned [17].

After having done Act stage, the next one is Plan and the others followed. It is a continuous improvement circle. Therefore, it can find the weaknesses of the whole OHS management and correct them. The strengths are also recorded, analyzed and modified for further improvements. However, since the nature and type of construction sites are varied from sites to site and the procurement process is temporary and project based, the proposed OHS management is more suitable for long-term. The organizations should adopt PDCA circle to improve the whole OHS performance of their construction projects. TQM concept's benchmarking – the strong points of one construction project or one other organization can also be applied to construction projects which are weak in OHS management.

VI. CONCLUSION

The present OHS conditions of the Myanmar construction industry is in a terrible condition and construction companies use different types of OHS system or no OHS system. Although construction projects constructed with a foreign partner are better in OHS management than local ones, they also have many areas still left to be improved and considered. Therefore, the Myanmar government should make more law enforcement to improve OHS performance of the construction industry. The Myanmar construction personnel are all aware that they are working in an extremely high risk imposing industry. However, their actual attitudes and behaviors for OHS is not very satisfactory according to survey results.

By using the proposed OHS management based on TQM, it can show top management commitment and increase employee involvement in OHS management and also their morale. The OHS plans presented in this paper can help to improve the weakness areas of the six construction project surveyed. It can also improve the OHS attitudes and behaviors of the construction personnel. Since this OHS management is mainly based on continual improvement concept of TQM – PDCA, it will always be able to solve the challenges the construction industry worldwide faces in managing occupational health and safety no matter how large and complex a construction project could be in the future.



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REFERENCES

- [1] "Commonly Used Statistics | Occupational Safety and Health Administration." [Online]. Available: <https://www.osha.gov/oshstats/commonstats.html>. [Accessed: 02-Apr-2019].
- [2] "Health and safety statistics." [Online]. Available: <http://www.hse.gov.uk/statistics/index.htm>. [Accessed: 02-Apr-2019].
- [3] "China's most dangerous industry is getting more dangerous," *China Labour Bulletin*, 21-Aug-2018. [Online]. Available: <https://clb.org.hk/content/china%E2%80%99s-most-dangerous-industry-getting-more-dangerous>. [Accessed: 03-Apr-2019].
- [4] X. Zhi, L. Chunming, and C. Zhang, "Model of Total Safety Management(TSM) and its Application," *Procedia Eng.*, vol. 45, pp. 204–207, Jan. 2012.
- [5] O. N. Aneziris, Z. Nivolianitou, M. Konstandinidou, G. Mavridis, and E. Plot, "A Total Safety Management framework in case of a major hazards plant producing pesticides," *Saf. Sci.*, vol. 100, pp. 183–194, Dec. 2017.
- [6] T. Kontogiannis, M. C. Leva, and N. Balfé, "Total Safety Management: Principles, processes and methods," *Saf. Sci.*, vol. 100, pp. 128–142, Dec. 2017.
- [7] T. Kontogiannis, M. C. Leva, and O. Aneziris, "Special Issue: Total Safety Management," *Saf. Sci.*, vol. 100, pp. 125–127, Dec. 2017.
- [8] B. J. Ladewski and A. J. Al-Bayati, "Quality and safety management practices: The theory of quality management approach," *J. Safety Res.*, Mar. 2019.
- [9] OSHA, *OSHAcademy Course 700 Study Guide*. .
- [10] S. Choe and F. Leite, "Construction safety planning: Site-specific temporal and spatial information integration," *Autom. Constr.*, vol. 84, pp. 335–344, Dec. 2017.
- [11] M. Grill and K. Nielsen, "Promoting and impeding safety – A qualitative study into direct and indirect safety leadership practices of constructions site managers," *Saf. Sci.*, vol. 114, pp. 148–159, Apr. 2019.
- [12] M. Loosemore and N. Malouf, "Safety training and positive safety attitude formation in the Australian construction industry," *Saf. Sci.*, vol. 113, pp. 233–243, Mar. 2019.
- [13] S. Stiles, B. Ryan, and D. Golightly, "Evaluating attitudes to safety leadership within rail construction projects," *Saf. Sci.*, vol. 110, pp. 134–144, Dec. 2018.
- [14] Ipsos Business Consulting, *Construction in Myanmar*. 2013.
- [15] Ng, Tai-On, *Evaluating the Construction Safety Condition under Hong Kong Government Policies with Particular Reference to Total Safety Management System*. 1997.
- [16] "Nielsen. (2015). Health and safety attitudes and behaviours in the New Zealand workforce: A survey of workers and employers. 2014 baseline report. Construction report. (A report to WorkSafe New Zealand). Wellington, New Zealand: Author." .
- [17] *HSG65: Managing for Health and Safety*, Third Edition. HSE, 2013.
- [18] *Leadership and worker involvement toolkit*. HSE.