Industrial Engineering & Management
ISSN: 2169-0316
Al Tamimi et al., Ind Eng Manage 2017, 6:3
DOI: 10.4172/2169-0316.1000220
Research Article
OMICS International

# Application of "TQM" and "TSM" in UAE Construction Safety Management

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## Abstract

One of the chief goals of the construction industry is to maintain a safe environment at construction sites, a goal best achieved by implementing Quality Management. Deming's Total Quality Management (TQM) tools serve as an excellent option when it comes to efficiently using available resources to improve construction management at the site. Various accidents in the construction sites, however, may still occur, leading to loss of lives, delays and increasing project cost. Thus, an effective safety management system should be enforced to mitigate these accidents so as to reduce delay, cost and most importantly, prevent harmful accidents. A combination of TQM and Total Safety Management (TSM) ranks as one of the best available practices that establish a safe environment at the construction sites. In this paper, a survey has been designed, conducted and analyzed in order to solicit feedback from 61 engineers working in various construction companies and organizations in the UAE. Two construction processes that necessitate safety management are studied: safety of tower cranes and temporary formwork. The interrelationship between safety, quality, and reliability is also discussed along with the various causes of failure. The results of the survey reveal that the majority of the survey participants had implemented routine safety and health procedures to avoid accidents. The number of accidents, however, was still inordinately high due to top management pressurizing middle managers into completing construction goals within a designated time period.

**Keywords:** Safety management; Construction industry; Total safety management; Total quality management

## Introduction

Many Middle Eastern countries place more emphasis on flaunting their high-rise buildings; lengthy bridges and massive airports than the safety of their labor force. Fatal accidents and failures during different stages of construction are prevalent; leading to major injuries and death. Often times; the investors and government sectors continue developing construction projects even when all construction projects are not providing a safe area for their employees and end-users [1,2]. While investors and construction companies worldwide must concentrate on the cost and duration of the project to maximize their profits; they must also ensure the implementation of proper safety procedures for their workers; labor and engineers on site. Although all construction companies strive towards high quality products and services; they must also apply total quality safety management at their construction sites. A common problem at construction sites is the numerous objectives set by different departments in the project, with managers and engineers struggling with myriad deadlines and goals, thus neglecting the importance of safety. Implementing Deming's and Peterson's points might have a positive effect on the organization's work area since it reduces the number of accidents on site [3,4].

It is not uncommon for construction companies to underestimate the need of a safety plan prior to starting a project. To guarantee a positive safety performance through all stages of the project it is essential to plan exactly how a safe work area will be provided. Planning is critical for construction safety and setting a goal will help familiarize the safety management department with each project's strategic plan; thereby resulting in the identification of safety objectives [5-7]. In fact; the safety management department should have safety plans for all stages of construction so as to predict all potential failures that may occur during the entire project. TQM is a management philosophy and its goal is to align an organization's product and service quality with customer satisfaction through proper planning and continuous improvement [8]. TSM; on the other hand; aims to prevent accidents or near misses by planning for safety; providing clear lines for responsibilities; communicating properly between end-users and management channels; ensuring that hazards and risks are identified; and that the management is able to control them. The processes of TSM and TQM are very similar; as the focus on TSM result in several benefits; chief amongst them being the lower cost of services and a better understanding about TSM utilization [9]. If construction companies adapt TSM in their organization; it can result in increasing quality; reliability and competitiveness; while simultaneously establishing a safer work environment. According to Fotopoulos et al.; [10] safety manager on different projects can easily apply TQM tools such as Ishikawa diagrams; Pareto diagrams; and Statistical Process Control (SPC) to improve safety. Safety managers can identify an unsafe workplace and strive towards determining the causes of different failures in construction sites to avoid workplace injuries and deaths. This is the reason why so many different companies are employing TQM tools and techniques in an attempt to increase productivity; improve the quality of their services; obtain superior profit rates and most importantly; they are recognizing how much TQM contributes in providing a safer workplace environment. Since TQM allows the safety management department to effectively avoid failure and accidents during production; it also improves an organization's safety performance. In doing so; it results in a fluid relationship between labor and management groups which further leads to lower costs for the organization. Hence; planning is critical for construction safety

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**Received** July 03, 2017; **Accepted** July 07, 2017; **Published** July 17, 2017

**Citation:** Tamimi AA, Ansari AA, Kashwani G, Sajwani A (2017) Application of "TQM" and "TSM" in UAE Construction Safety Management. Ind Eng Manage 6: 220. doi:10.4172/2169-0316.1000220

because it helps the organization identify each project's strategic plans and safety objectives for different stages of construction in order to predict all possible failures [11].

## Problem statement

The construction business is one of the most dangerous fields. Fatal accidents and failures at any stage of construction are common all over the world; especially when the place of the project is dangerous or investors want to build high-rise buildings. While there can be numerous hazards at a construction site; failures of tower cranes; scaffolding and temporary formwork result in the highest number of deaths and injuries. Regardless of the scale of a construction project; there is always a need for scaffoldings; formwork and different types of cranes. Wrong scaffolding designs or an unsafe installation of tower cranes can be a real threat for labor and engineers on site which is why any responsible sector should be aware of the importance of safety designs for scaffolding; tower cranes and all other construction elements.

Although most investors and construction companies maintain that they are implementing the safety procedures in their organization; they ultimately concentrate more on the cost and duration of the project to maximize their profits; which is why; an increase in new construction projects is by no means a guarantee that these companies are providing a safe environment for their employees. Therefore; when the project is complicated and workers are required to perform dangerous tasks such as deep excavations or operate under tons of loads; management should prepare for potential failures and accidents. Two points are of vital importance here. Firstly; all accidents should be avoided at all costs via planning and training of the appropriate staff. Secondly; accountability in case an accident does occur. The latter is particularly important because there are many different organizations involved in any project. For example; in any construction project there is a main contractor; a consultant and municipality. With so many bodies involved; failures often result in consultants; contractors; engineers and site managers incriminating each other without anyone taking full responsibility for the issue. If responsibility for accidents is established from the outset; however; then that body is more likely to ensure that the project is completed safely and without any hurdles.

## Research Methodology

The survey in this research was designed based on questions covering the Deming's fourteen points on (TQM) and Peterson's theory on (TSM) concept. The information gathered from these pointes helped define the targeted respondents' objectives and goals of the study. The analysis of the survey will reveal who is more liable for fatal accidents in the construction sites. Implementing some of the Deming's fourteen points augments the quality of the work environment and provides a safer work area in any construction projects. The design of the survey is conducted to ascertain whether different companies are implementing these points to remain committed towards procedures that help define the safety roles and responsibilities for all the organization employees. The questionnaires posed seven questions designed as a rating scale where the strongly agree; agree; neither agree nor agree; disagree; and strongly disagree options were rated as 5; 4; 3; 2 and 1; respectively. The questionnaire was reviewed three times to make sure that all the questions are clear; straight forward; and easily answerable. Some respondents were concerned about the safety and reliability in case of accidents; and asked the researcher to provide them with the result of the study at its completion. The rating scale; sometimes referred to as Likert scale; was developed by Rensis Likert in the 1930s to assess people's attitudes. A rating scale was deemed more useful when behavior; attitude; or other phenomena of interest need to be evaluated on a continuum [12].

## Results and Discussion

Results include rating average; standard deviation and coefficient of variance. The survey has 7 questions designed to show rating scale of 5 (strongly agree); 4 (agree); 3 (neither agree nor disagree); 2 (disagree) and 1 (strongly disagree). Rating average and standard deviation were calculated using Microsoft Excel; and the coefficient of variance was calculated using Eq.1 as seen below:

$$\text{Coefficient of Variance} = \frac{StandardDeviation}{RatingAverage} \quad (1)$$

The questionnaire was distributed to more than 100 engineers in different positions. A Total of 61 responses were received which are displayed on Figure 1.

The first question asked in the survey was to specify the position of the respondents. As illustrated in the Figure 2; the most respondents were from 11 project engineers (18%) and 11 site engineers (18%). Other respondents were from 10 project managers (16.4%); 8 consultants (13.1%); 7 engineers from Sharjah Municipality (11.5%); 6 safety engineers (9.8%); and 5 contractors (8.2%). Finally; there were 3 "other" responses (4.9%) from other positions in the construction field.

The second question pertained to the responsibility for fatal accidents and failures during the construction stage. Figure 3 illustrates how 28 respondents (45.9%) admitted that the safety engineer is responsible for fatal accident and failures. 22 respondents (36.1%) opined that the site management is responsible. 7 respondents (11.5%) said that the site engineer is responsible. 3 respondents (4.9%) believed that unskilled labor are responsible. Finally; only one respondent (1.6%) said that the foreman is responsible for any fatal accidents on site. It is clear from Figure 2 that no one put the blame on the municipality and the consultants. While the municipality may not be responsible for any accidents on construction sites; the consultants are involved in different construction stages and should report any

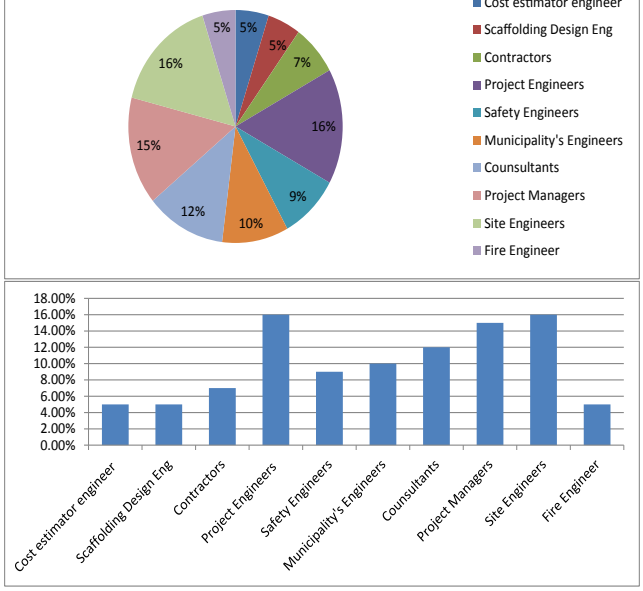


**Figure 1:** Questionnaire response.

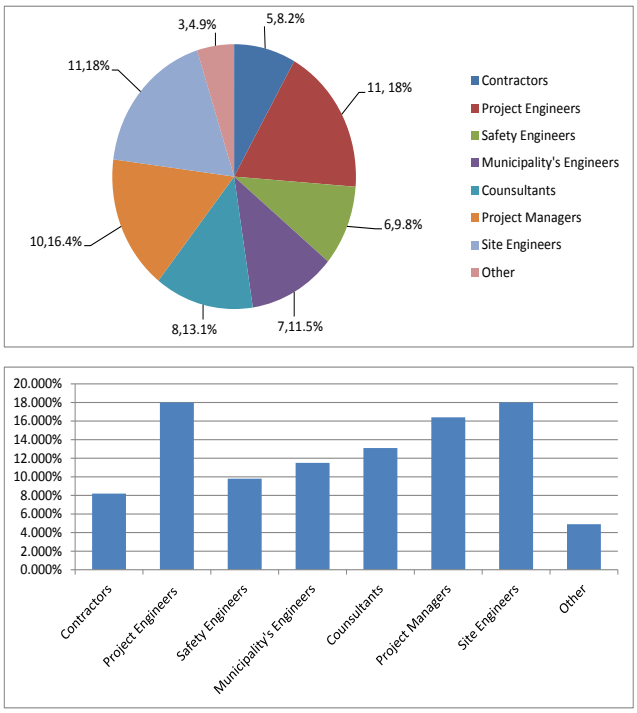


**Figure 2:** Position of respondents.

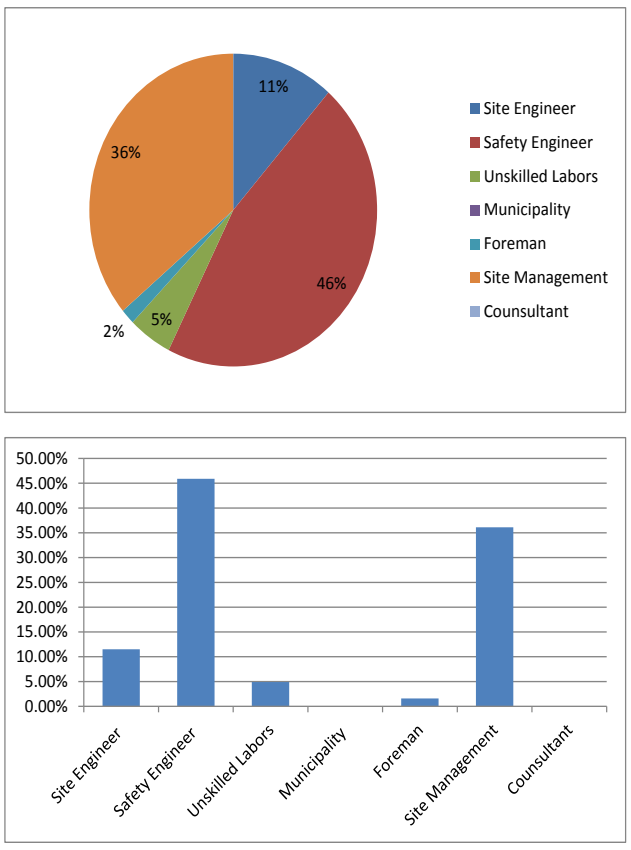


**Figure 3:** Responsibility for fatal accidents and failures during the construction.

unsafe practice seen on site. The consultant inspects the scaffolding and temporary formwork; whilst also providing the municipality with a guarantee letter confirming the safety and durability of the scaffolds and formwork before the concrete casting.

It is highly problematic that none of the respondents chose consultant as a responsible sector in case of fatal accidents on site. After all; during supervision; the consultant is also involved in all stages of the construction; especially since the main contractor will not be able to cast concrete for foundations; tie beams; and slabs before taking the consultant's permission. If the consultant and the contractor do not provide the municipality with a guarantee letter; ensuring the stability and durability of the temporary formwork for the slab; then the municipality will not grant permission to either the contractor or consultant to cast concrete.

Figure 3 reveals that 45.9% of the respondents believed that safety engineers are responsible for fatal accidents. In fact; upon visiting small to medium sized construction companies it is difficult to find any engineer called safety engineer; even if there are more than five appointed site engineers. While safety engineers are found in big construction companies; it seems each engineer or manager involved in the construction project holds others responsible for accidents.

The third question of the survey pertains to inspecting the stability and safety of the scaffoldings and tower cranes after installation. As illustrated in Figure 4; 57.4% of the respondents check the stability of the scaffolds and tower cranes every week; 14.8% check every month; 6.6% never check; and 4.9% check it only after accidents or upon windy

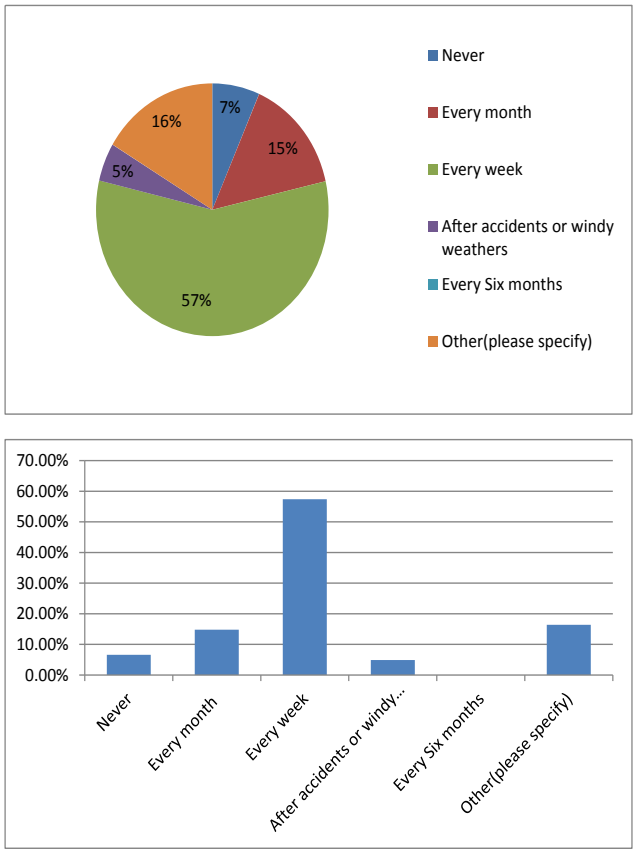


**Figure 4:** Stability and safety of the scaffoldings and tower cranes after installation.

weather. Additionally; 10 engineers (16.4%) noted the following in their response:

- One engineer said that he/she checks for stability and safety for tower crane every week but checks daily prior to usage.
- Three engineers said that they check every day for small size projects; like houses etc.
- Four engineers said that they check the scaffolds and tower cranes every time they visit the site.
- Two engineers said that they always check scaffolding prior to casting; and task the safety engineer to inspect the tower cranes immediately after every installation.

Peterson's first point was covered in the fourth question where it asks about the visibility of leadership in the construction activities that help to promote safety culture between employees and contractors in the construction site. It is evident from Figure 5 that 26 respondents (42.6%) agree; 23 respondents (37.7%) strongly agree; while 5 respondents (8.2%) disagree; 2 respondents (3.3%) strongly disagree and lastly; 5 respondents (8.2%) neither agree nor disagree. The rating average for this question is 4.03; with most respondents agreeing that visibility and activity of leadership in different activities in their sites results in a safer work environment. Standard deviation was calculated to be 1.048 with a coefficient of variance of 0.260.

The fifth question is about the safety and health communication level between the management and end-users in the organization. This question refers to Peterson's fourth point; which holds that communication about safety and health between management and workers should occur regularly. As can be discerned from Figure 6; 32 respondents (52.5%) agree; 14 respondents (23%) strongly agree; 8 respondents (13.1%) disagree; while 7 respondents (11.5%) neither agree nor disagree. Interestingly; none of the respondents strongly disagree. The rating average for this question is 3.85; which means that almost of the respondents agree that communication about safety and health between management and workers is carried out regularly in their organizations. Standard deviation was calculated as 0.928 with the coefficient of variance being 0.241.

The relationship between safety performance and professional competence was covered in Deming's sixth and Peterson's seventh point; respectively; maintaining that construction related accidents often occur due to a lack of frequent safety training. This leads to a decline in the competence level of labors' professional skills. As can be seen in Figure 7; 62.3% of respondents train their labor regularly; 32.8% do so at the beginning of a project; and finally 4.9% do it only after an accident or incurring municipality fines.

Lastly; question 7 explored the level of understanding of safety procedures and policies of the end-users in the construction site. In general; management should make sure that the labors possess a clear and thorough understanding of the required safety and health policies according to Peterson's ninth point. From Figure 8; it is evident that 30 respondents (49.2%) agree; 13 respondents (21.3%) strongly agree; 12 respondents (19.7%) neither agree nor disagree; 5 respondents (8.2%) disagree; and finally only 1 respondent (1.6%) strongly disagreed. The rating average for this question is 3.80; meaning that almost all

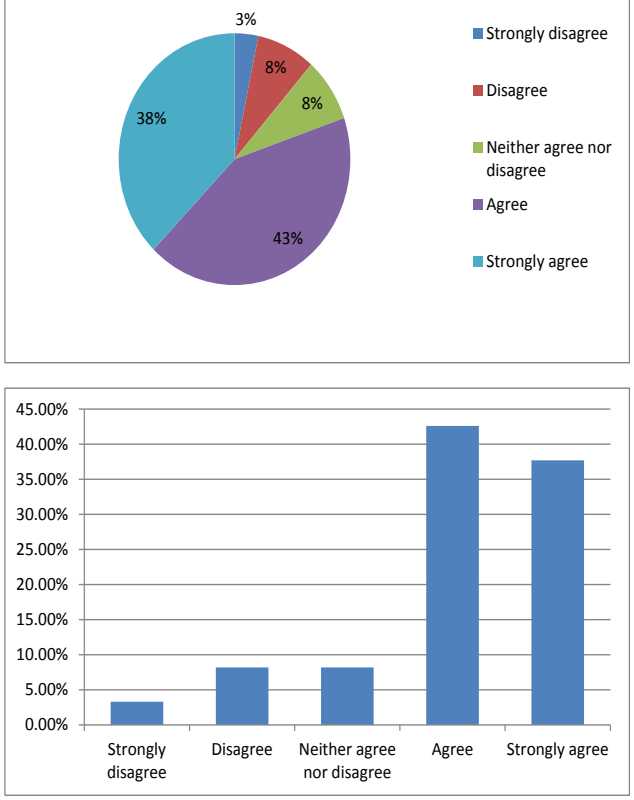


**Figure 5:** Visibility of leadership.

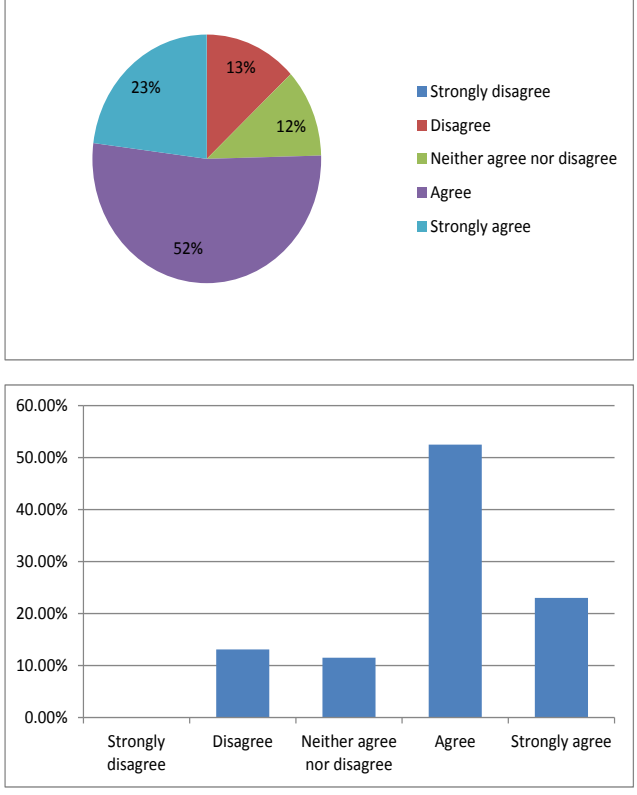


**Figure 6:** Safety and health communication level.

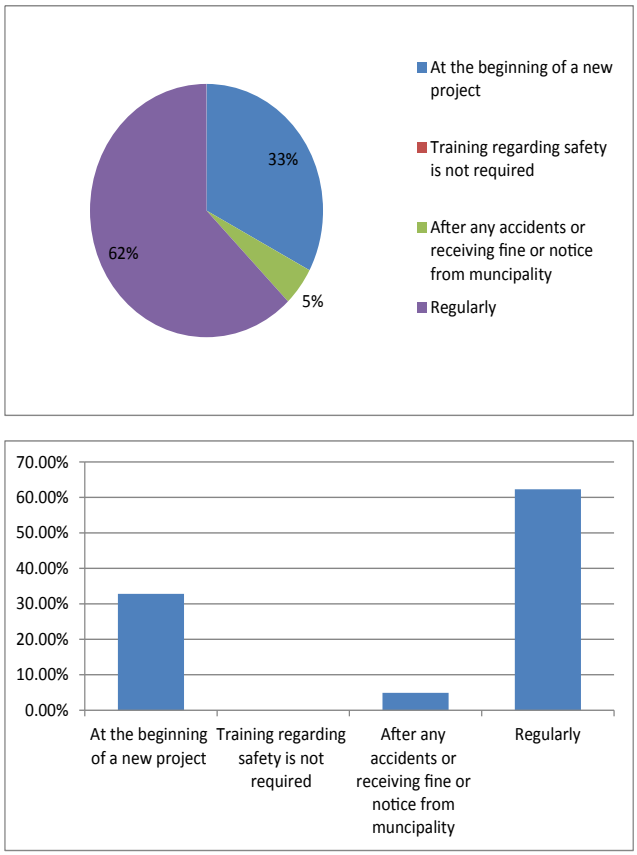


**Figure 7:** Safety training cycle.

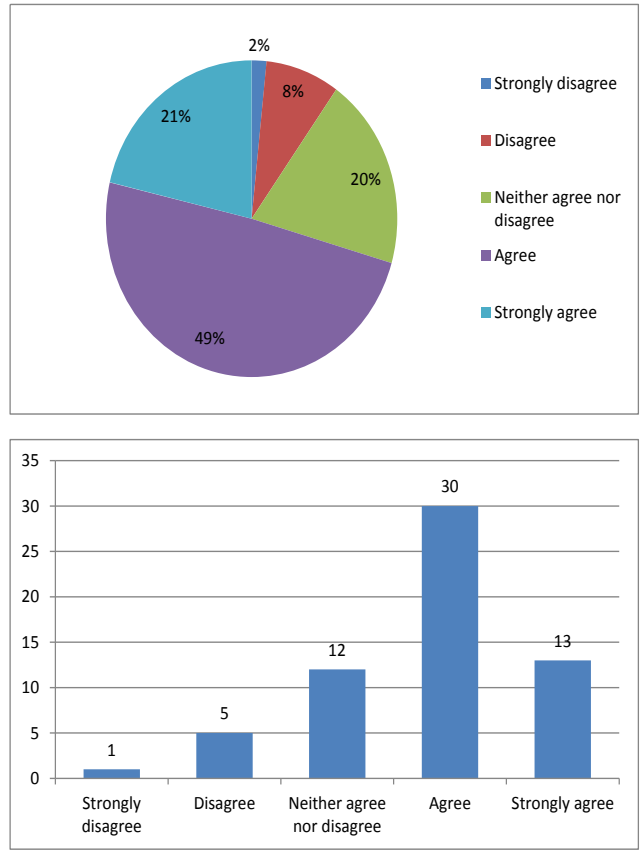


**Figure 8:** level of understanding of safety procedures and policies of labors.

respondents acknowledge explaining safety and health policies to all labor so as to avoid fatal accidents and injuries. Standard deviation was calculated to be 0.928; with a coefficient of variance of 0.244.

These results reveal obvious issues in the safety culture of the construction activities in the UAE. For example; the first question of the survey brings to light that senior management tends to avoid accountability when it comes to construction site safety; opting instead to transfer these responsibilities to the field safety engineer. This has a major effect on the safety communication in the organization whereby the present leadership visibility can be lost due to this unsafe attitude. Furthermore; if such unsafe attitudes are to become common then they are likely to become a standard culture inside the organization itself. This highlights the necessity of having a clear definition of roles and responsibilities with respect to safety. Respondents also indicate that both management and labors do not pay safety the required attention during the design stage of a project due to the performance mentality. The performance mentality in safety usually focuses at the reactive control tools and ignores the proactive safety role at the design phase that can be presented on various studies such as Hazard Analysis Identification (HAZID); Hazard and Operability Study (HAZOP); Environmental Impact Assessment (EIA); etc.

The second part of questions exposes a clear lack of safety competency for the end-user employees; something that results directly from an absence of effective training and adequate understanding of safety. It is vital for all operation employees; especially end-users; to have a strong theoretical and practical safety background in their construction activities. For instance; labors should possess an intimate knowledge of their company's Code of Practices (CoP) when it comes to first response plan in case of emergency; something that requires theoretical and practical skills.

Finally; from the gap analysis in the answers between senior management and operation employee; it can be inferred that there is an implementation problem. It is clear that managers believe they have an effective safety system in place in their organizations; however; this may be true only on paper. Safety systems need to be enforced regularly and emphatically if they are to be implemented properly at a construction site. As such; they highlight the need to have an integrated safety framework that addresses all technical and procedural challenges towards safety implementation. Applying (TQM) and (TSM) concepts can have a major role in filling the gaps and defects of safety; designing safety framework on the organization and integrating quality into safety and health management at construction sites.

## Conclusions

Based on this study; it can be argued that virtually all personnel avoid responsibility for accidents and failures; opting instead to blame others. The result of the survey demonstrates how people will react in the case of a real accident. Engineers try to blame each other and none of them will accept that it was his/her mistake. As such; there should be a clear statement identifying the responsibility of all engineers/managers involved in the project; thereby preventing such blame juggling. In addition; this would make the work site safer because accountability makes the staff thorough and responsible when undertaking an assigned task. A major point according to Peterson's

theory on Total Safety Management (TSM) is to provide and use Personal Protective Equipment (PPE). Results of the survey reveal that most of the respondents who filled the survey were implementing all safety and health procedures to avoid accidents. The number of accidents; however; is still high due to the fact that top managers often aim to finish the work within a time period and force the middle managers to get the work done as soon as possible.

## Acknowledgements

The authors are grateful to Eng. Waleed Nawaz for purveying his invaluable support in the experimental survey. The authors' thanks and appreciations go also to all construction companies that participated in the survey to promote and improve the safety culture in UAE's construction field.

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