

Suggestions for a Total Quality Management Based Safety Program for Construction Industry

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Today's construction projects are growing in complexity and in order to succeed on the global level, construction organizations must not approach construction safety and health as just another step in avoiding unwanted accidents or federal fines, but as a strategic tool, that if implemented effectively, will have the potential to maximize competitiveness and profit. This strategic approach to safety can be accomplished via a Total Safety management (TSM) philosophy which finds its roots from the Total Quality management (TQM) principles. This research proposes a TSM implementation model based on TQM principles and provides guidelines to industry players for model development and implementation in their organizations. The TSM implementation model consists of three phases; Phase 1: Planning and Preparation Phase, Phase 2: Identification and Assessment Phase, and Phase 3: Execution and Improvement Phase. For the TSM model development and implementation, the following is recommended: a risk-avoiding, long-term focused, action biased and facts oriented TSM policy; a TSM strategy considering suppliers' safety capability instead of their price only selection; a safety control system that does not rely on very frequent safety inspection; an effective communication system that enables the free communication of improvement ideas; an operational practice of using positive symbols and signals to boost safety morale and non-performance based safety competition for the promotion of safety culture; a normative TSM culture; a positive transformative leadership style and a comprehensive safety training program. It is also recommended that obtaining owner and top management commitment to safety is inevitable toward implementing a TSM program. In the final part of the research, existing safety management tools and systems are assessed as to their suitability and adaptability towards a TSM environment. Based on the assessment, an integrated ISO 9000 and OHSAS 18001 Management System is recommended.

Key Words: Total Safety Management, Total Quality Management, Construction Industry, OHSAS 18001, ISO 9000, Experience Modification Rating

Introduction

Although dramatic improvements have taken place in recent decades, the safety record in the construction industry continues to be one of the poorest (Huang and Hinze, 2006). Research shows that the major causes of accidents are related to the unique nature of the industry, human behavior, difficult work site conditions, and poor safety management, which result in unsafe work methods, equipment and procedures (Abdelhamid and Everett, 2000).

The loss or injury of trained and experienced workers, and the worker disruption to progress of work, undeniably represent reduction in the performance of construction. The cost of accidents which includes increased insurance cost, lost productivity and disruptions, provides an economic

motivation to try and prevent accidents from happening: safety culture can set the tone for implementation of safety in construction site environments.

Recent improvements in safety management have taken place as a combination of efforts of owners, contractors, subcontractors, and designers. The owner's involvement has shown to favorably influence project safety performance by setting safety objectives, selecting safe contractors, and participating in safety management during construction (Huang and Hinze, 2006). However, safety is implemented, in essence, by contractors on work sites who indeed need to adopt adequate safety related systems for the provision and control of work environment systems and human behavior. Hence presence of a safety culture in a contracting organization is immensely needed which should be concerned with the determinants of the ability to manage safety from top to bottom organizational attribute approach (Mohamed, 2003). This safety culture is largely dependent on a Total Safety management (TSM) philosophy which finds its roots from the Total Quality Management (TQM) principles. Although, the concept of TSM is relatively new in the construction industry; however, it is gaining popularity due to its ability to embrace all perceptual, psychological, behavioral and managerial factors.

Consequent to above, this research proposes a conceptual TSM model based on TQM principles for the construction industry. It also provides specific guidelines to industry players (owners, contractors, subcontractors, etc.) for model development and implementation in their organizations. Furthermore, the research delves into the existing safety management tools and systems used by organizations and assesses the suitability and adaptability of these tools and systems towards a TSM environment.

The research methodology is as follows. The paper first develops the rationale of the need of total safety management in the construction industry. This is done by critically evaluating the current safety statistics in the construction industry, assessing the cost consequences of poor safety performance to contractors, reviewing the role and impact of legislation on the safety scenario, and analyzing the criticism on safety regulations with respect to failure to act as a catalyst to incorporate TSM culture in an organization. Following this, the transition process from TQM to TSM is outlined, which is needed in order to interpret TQM principles in safety terms. Next, the conceptual TSM model is proposed based on the TQM principles and guidelines are provided to develop and implement the model. Finally, the existing safety management tools and systems are discussed with the perspective of assessing their suitability and adaptability towards a TSM environment.

Need for Total Safety Management in Construction Industry

The following discussion attempts to establish the need for total safety management in the construction industry. The authors have endeavored to discuss current safety scenario and safety related issues in order to justify the argument that today's construction industry, although thoroughly controlled by safety legislation and regulations, still demands an improved safety environment for at least two reasons: 1) reducing the number of fatal and non-fatal worker injuries, and 2) improving contractor EMR values in order to make them "safe" i.e. curtail the high cost associated with being "unsafe". The authors further argue that as today's construction

projects are growing in complexity, in order to succeed on the global level, construction organizations must not approach construction safety and health as just another step in avoiding unwanted accidents or federal fines, but as a strategic tool, that if implemented effectively, will have the potential to maximize competitiveness and profit. This strategic approach to safety can be accomplished via a Total Quality Management (TQM) based safety program i.e. a Total Safety Management (TSM) program for the construction industry.

Current Safety Statistics

In the past twenty years, construction jobsite injuries and fatalities have been on the rise and have gained widespread attention in the United States. According to the National Safety Council, occupational injuries cost United States organizations approximately fifty billion dollars annually (Karuppann et al., 1996). The Bureau of Labor Statistics (BLS) concludes that in the year 2006, the American construction sector was responsible for 21% (1226 in count) of all workplace fatalities across all industries, and 10.4% (412,900 in count) of all the country’s nonfatal occupational injuries and illnesses. Table 1 provides an overview of recent fatal occupational injuries and fatality rates (per 100,000 employees) over the period 2003-2006.

Table 1: Fatal occupational injuries and Fatality rate (per 100,000 employed), All U.S., all ownerships (2003 – 2006): Construction vs. All Industries

Year	Construction		All Industries	
	Fatal Occupational Injuries	Fatality rate (per 100,000 employed)	Fatal Occupational Injuries	Fatality rate (per 100,000 employed)
2006	1,282	10.8	5,703	3.9
2005	1,243	11.0	5,734	4.0
2004	1,278	11.9	5,703	4.1
2003	1,171	11.7	5,575	4.0

Source: U.S. Bureau of Labor Statistics, U.S. Department of Labor, 2007.

One of the major contributors to the increase of construction hazards is the fact that today’s construction sites are constantly changing environments utilizing a variety of new construction methods and complex machinery (Teo et al, 2005). In sharp contrast with the manufacturing sector, the construction industry does not build the same product repeatedly. Each project typically involves a new and unfamiliar site, with a unique design, and consists of a transient workforce that may not have worked with one another in the same setting. For this reason, it can be a very difficult challenge for a construction operation to initiate, manage, and improve proper health and safety protocol.

Cost of High EMRs to Contractors

Responding to this increased safety requirement generated by the construction industry occupational injury and fatality statistics, the industry control environment responded well by incorporating safety as an integral part in the regulatory framework. In the U.S., the workers compensation rates are a function of the loss experience of a contractor, and each labor hour is affected through the reflection of those losses in the experience modification rating (EMR).

Safety is implemented, in essence, by contractors on work sites who indeed need to adopt adequate safety related systems designed to respond to hazardous and potentially hazardous project conditions as well as designed to take the process to a safe state when predetermined conditions are violated. Hence regulating the safety performance of contractors was of immense essence. One measure of safety performance that is widely used is the EMR. As stated, this rating is used to adjust the cost of workers' compensation insurance premiums. EMR, derived from a company's recordable incident rate, in itself is essentially an incentive for firms to struggle for good safety records, as firms with poor safety records will pay higher premiums. The basic principles of EMRs are well-known by practitioners and are widely publicized in a variety of publications (such as Hinze et al., 1995; Everett and Thompson, 1995). On one hand, a safe contractor (with low EMR) can create a substantial competitive advantage through superior safe experience while, on the other hand, an unsafe contractor (with high EMR) can be liable to pay huge penalties in terms of insurance. Safety, therefore, and the effects of its absence – accidents – is now a key cost driver for construction firms in the U.S.

Well run and profitable construction firms typically also support effective safety management programs, regardless of the direction of the insurance market (McDonald and Haymark, 2001). This is because a safe contractor, with a lower Experience Modification Rating (EMR), can create a substantial competitive advantage through superior safe experience. Moreover, safe owners are reluctant to permit contractors to bid work without acceptable EMRs. Thus the most important step in controlling costs is to run safe construction projects, which require strategic implementation of safety as a business process, hence the need for total safety management.

OSHA – Role, Performance and Criticism

In the United States, all construction safety is legislated by the Occupational Safety & Health Administration (OSHA), a federal agency that is part of the U.S. Department of Labor. OSHA developed a series of specific construction standards, and policies for enforcing the standards to assist in the safety management process. The construction industry standards (29 CFR 1926) are not guidelines, but legal requirements that define the minimum protections construction organizations must provide their workforce on the job site. Table 2 lists the various topics covered in the OSHA construction standards.

OSHA periodically develops and publishes amendments to standards that through time may have become outdated or are in need of additional clarification. OSHA also develops a variety of safety related publications for construction organizations' reference. OSHA collaborated with the National Association of Home Builders (NAHB) to create a publication that specifically caters to meet residential construction needs (Koehn, 1983).

It is critical for American construction organizations to follow all applicable OSHA requirements, or they will be subject to OSHA fines and penalties. For that reason, construction organizations typically employ a safety manager or competent person, while other larger companies may employ outside consultants to develop and enforce safety management procedures. Outside safety consultants can become a valuable member of the team by visiting the jobsite to provide detailed safety advice, training, and other related safety knowledge as required. Whatever the solution, an effective construction safety and health program must be a core

element of a construction company's management strategy. The ultimate goal for a construction safety program must be to prevent workplace accidents and reduce occupational injuries. Companies that view this lightly may encounter increased accidents, strict OSHA fines, worker's compensation premium increases, and will ultimately have a negative impact on the company's ability to succeed in the global marketplace.

Table 2: OSHA Construction Standards 29 CFR 1926 (OSHA, 2006)

Subpart A: General	Subpart N: Cranes, Derricks, Hoists, Elevators, and Conveyors
Subpart B: General Interpretations	Subpart O: Motor Vehicles, Mechanized Equipment, & Marine Operations
Subpart C: General Safety and Health Provisions	Subpart P: Excavations
Subpart D: Occupational Health and Environmental Controls	Subpart Q: Concrete and Masonry Construction
Subpart E: Personal Protective and Life Saving Equipment	Subpart R: Steel Erection
Subpart F: Fire Protection and Prevention	Subpart S: Underground Construction, Caissons, Cofferdams, and Compressed Air
Subpart G: Signs, Signals, and Barricades	Subpart T: Demolition
Subpart H: Materials Handling, Storage, Use, and Disposal	Subpart U: Blasting and the Use of Explosives
Subpart I: Tools - Hand and Power	Subpart V: Power Transmission and Distribution
Subpart J: Welding and Cutting	Subpart W: Rollover Protective Structures; Overhead Protection
Subpart K: Electrical	Subpart X: Ladders
Subpart L: Scaffolds	Subpart Y: Commercial Diving Operations
Subpart M: Fall Protection	Subpart Z: Toxic and Hazardous Substances

OSHA offers a variety of occupational safety and health training programs to assist employers and employees in building the necessary skills and tools needed for effective safety management implementation. To expedite the process, OSHA has developed an internal training institute (ITI) that conducts ongoing safety courses for federal agencies and the private sector. OSHA also offers a more popular curriculum known as the Outreach Training Program where construction employers and employees can enroll in an accelerated one-week training course in construction health and safety.

Comprehensive safety training is not limited to safety managers or organization's safety person; safety training courses cater to all construction personnel such as project executives, project managers, job superintendents, carpenters, welders, and laborers. In addition to OSHA-based resources, many colleges and universities offer OSHA-certified training programs and comprehensive on-line web-based courses developed for all construction personnel.

There are credible statistics showing that, since its implementation by Congress in the early

seventies, OSHA has had a beneficial influence on US industries by significantly reducing workplace accidents. However, over the years, organizations have viewed OSHA and their numerous regulations, standards, and strict penalties in a negative light as well. One of the more common arguments against the agency is the fact that their heavy fines and guidelines deliver an overbearing and unwanted presence that greatly restricts an organizations ability to develop as well as compete. This places a heavy burden on organizations by forcing increased operational fees and the costs associated to retrofit outdated equipment rather than investing on improving the processes for achieving long-term safety objectives. A similar argument is that the agency is not actively participating in the necessary research to view and incorporate safety as an industrial development process, and hence their regulations do not support implementing safety as a total management process.

Transition from Total Quality Management to Total Safety Management

Total Safety Management (TSM) bears its roots from Total Quality Management (TQM), which is ingrained on Deming's Fourteen Points. In order to give a structured model of TSM, interpretation of TQM principles in safety terms is essential. The interpretation below follows a system model consisting of six management functions namely Policy, Strategy, Control, Audit, coordination, and Implementation.

1. Create constancy of purpose toward improvement of product and service.
 - A safety policy of highly risk-avoiding, long term preference over short term success;
 - A strategy of adapting to external changes such as new safety regulations and technologies.
2. Adopt the new philosophy.
 - A safety culture that drives the policy of rejecting long tolerated lapses and a new policy of continual improvement.
3. Cease dependence on mass inspection to achieve quality.
 - A safety control system that does not rely on very frequent safety inspection;
 - An effective safety inspection program that can identify underlying safety problems.
4. End the practice of awarding business on the basis of price tag alone
 - Considering the safety capability of prospective suppliers (sub-contractors) instead of their price only;
 - Using suppliers (subcontractors) with good safety capability.
5. Improve constantly and forever every process for planning, production, and service.
 - A leadership style that drives daily improvement to all processes at all levels;
 - An effective communication that enables the free communication of improvement ideas.
6. Institute training on the job.
 - The management in the safety requirements of various production processes;
 - Workers on the safe way of executing works.
7. Adopt and institute leadership.
 - A constructive safety leadership that resides in every functions and strives for the discrete safety policy instead of the targets of that function;
 - A proactive safety leadership that interacts effectively with other functions.

8. Drive out fear.
 - A culture of safety as value that is to be protected among other situational priorities;
 - A personnel policy that encourage peoples at all levels to participate in protecting and advancing safety;
 - A positive leadership style that founds on coaching and help but not fear.
9. Break down barriers between staff areas.
 - A truly systemic management system in which safety is taken seriously;
 - An effective safety coordination process;
 - An effective safety auditing process.
10. Eliminate slogans, exhortations, and targets for the work force.
 - A culture and leadership style of management by facts, not by empty exhortation;
 - An operational practice of using positive symbols and signals to boost safety morale.
11. Eliminate numerical quotas for the work force and goals for management.
 - Be free of unrealistic numerical targets;
 - Be managed by facts and effective leadership (principle 7 above);
 - Be driven by positive and constructive signals (principle 10 above).
12. Remove barriers that rob people of pride of workmanship.
 - Non-performance based safety competition for the promotion of safety culture;
 - An effective transformative leadership style that nurtures a safety culture and motivates workers to refine their safety behaviors.
13. Institute a vigorous program of education and self-improvement for everyone.
 - A comprehensive safety training program on both job related safety and safety management theories;
 - A transformative leadership style that creates a learning climate in constructing a learning organization.
14. Take action to accomplish the transformation.
 - A detailed plan for accomplishing the transformation;
 - A positive transformative leadership that encourage workers to revert unsafe behaviors to safe practices.

Proposed Total Safety Management Implementation Model

Based on the TQM principles, a TSM implementation model is proposed here (see Table 3) consisting of three phases; *Phase 1*: Planning and Preparation Phase, *Phase 2*: Identification and Assessment Phase, and *Phase 3*: Execution and Improvement Phase. Table 3 represents the model outlining the three TSM phases. A brief description of the proposed TSM implementation model together with recommendations for implementation follows.

Phase 1 - Planning and Preparation Phase: In this phase, construction organizations must first initiate the safety program through an effective pre-planning and resource development process. During this period, organizations must establish a vision, develop strong commitment from senior management, develop an employee-training plan, and must verify that all operational resources are in place to accommodate the program change.

Table 3: Total Safety Management (TSM) Implementation Model

PHASE 1 : PLANNING AND PREPARATION	PHASE 2 : IDENTIFICATION AND ASSESSMENT	PHASE 3 : EXECUTION AND IMPROVEMENT
<ol style="list-style-type: none"> 1. Gain Executive-level commitment 2. Establish the TSM committee 3. Mold the committee into a team 4. Give the committee safety and health awareness training 5. Develop the organization's safety and health vision and guiding principles 6. Develop the organization's safety and health mission and objectives 7. Communicate and inform 	<ol style="list-style-type: none"> 1. Identify the organization's safety and health strengths and weaknesses 2. Identify safety and health advocates and resisters 3. Benchmark initial employee perceptions concerning the work environment 4. Tailor implementation to the organization 5. Identify specific improvement projects 	<ol style="list-style-type: none"> 1. Establish, train, and activate improvement project teams 2. Activate the feedback loop 3. Establish a TSM culture

Phase 2 - Identification and Assessment Phase: This phase consists of developing safety goals and objectives, management training, and strategic decision making on safety management techniques.

Phase 3 - Execution and Improvement Phase: The final phase of the TSM implementation model is the execution and improvement phase. At this stage, the new culture must be incorporated in the mix, employee-training programs must be launched, and all safety performance closely monitored to promote continuous improvement.

Guidelines for Model Development and Implementation

The TSM policy should be one that is risk-avoiding, long-term focused, action biased and facts oriented. It strives for continual improvement. The policy nurtures a constructive safety leadership that resides in every function and strives for the safety values instead of achieving targets of that function.

The TSM strategy drives the company to adapt to external changes such as new safety regulations and technologies. In doing business with suppliers, TSM strategy considers suppliers' safety capability instead of their price only selection.

TSM favors a safety control system that does not rely on very frequent safety inspection. Instead, leadership and training are employed to render the system less dependent on control.

TSM requires effective safety inspection and auditing that can identify underlying safety problems and drive continual improvement. Statistical analysis on safety performance as

obtained through inspections and audits, in term of accident rate or frequency of observed unsafe behaviors, is for revealing the root causes of accidents for continual improvement. In no case should these figures be used to create a fear in work places.

TSM is a truly systemic management system in which effective safety coordination is enabled with an effective communication system that enables the free communication of improvement ideas. There is a proactive safety leadership that interacts effectively with other functions and a personnel policy that encourages people at all levels to participate in protecting and advancing safety.

In TSM, there is an operational practice of using positive symbols and signals to boost safety morale and non-performance based safety competition for the promotion of safety culture. Operations under TSM are free of unrealistic numerical targets and are managed by facts and effective leadership – a leadership style that drives daily improvement to all processes at all levels.

A normative TSM culture

Amid these functional characteristics, the interaction mediating among the functions is palpable; the interaction is manifested through leadership and training, both act to nurture a normative spectacular TSM culture as represented by the functional value system described above.

Leadership

A positive transformative leadership style that founds on coaching and help, but not fear, is to be instilled at all levels. Through this transformative leadership, workers are led to revert unsafe behaviors to safe practices.

Training

A comprehensive safety training program on both job related safety and safety management theories is to be implemented. It is crucial to train the management in the safety requirements of various production processes and workers on the safe way of executing works. And through transformative leadership, a learning climate is created for the pursuit of constructing a learning organization.

Owner Commitment

The very basic step in implementing TSM in construction projects is to obtain owner commitment to safety. Due to the complex nature and ever-changing environment of construction projects, project owners should move away from the usual practice of awarding tenders to the lowest price and advocate rewarding the best designers and suppliers who could provide the best value service. Moreover, in developing a total safety culture in construction, one important step is to develop a construction team of a main contractor, subcontractors and suppliers who would commit to the safety process and develop a true safety attitude. In this, the most important role is to be played by the project “top management” i.e. the project owner. This

is because TSM culture cannot exist until the project owner understands the significance, accepts the philosophy, nurtures the culture, demands the commitment as well as infiltrates the philosophy in the underlying layers of project execution support by initiating different systems and tools to propagate and facilitate TSM philosophy based culture in the construction project. Thus, the owner would require the main contractor to only select subcontractors who have demonstrated safety attitude and work performance on previous jobs, and so on.

Top Management Commitment

For a construction company to succeed, it is essential that senior management have the necessary will, leadership skills, and level of commitment to lead an organization. Just as in TQM, a TSM organization cannot maintain a high level of competitiveness and achieve short and long-term goals without the full cooperation of a strong upper management team. For a business initiative to succeed, it will be critical for management to act as a coach, demonstrate commitment, and actively participate in the training of subordinates. OSHA standards, guidelines, and enforcement may affect construction accidents on the smaller scale, but it is a company's management team that has the power to lead, educate, and empower employees toward taking preventative safety measures (Karuppann et al., 1996). Management must practice open communication and encourage dynamic information exchange down the chain of command. Management, interested in sustaining competitiveness in the global economy, must have the leadership ability to implement, maintain, and continuously improve a strategic safety management program. Management should encourage the employees by presenting self examples. It should stress the importance of safety "for the sake of safety" and not just "for the sake of competitiveness". This will demonstrate its strong commitment towards safety and in turn interest towards well-being of the employees.

Existing Tools and Systems Supporting Total Safety Management Implementation

In the following sub-sections, the more prominent safety management tools and systems are discussed with the perspective of assessing their suitability toward implementing total safety management in the construction industry.

CSHM Web-based System

Fortunately, for modern day construction companies, information technology is available as a valuable tool to help manage and monitor the construction health and safety management process. One such method is the web-based Construction Safety and Health Monitoring (CSHM) system. CSHM is a system composed of internet databases, designed to streamline a company's construction safety process via web-based technology. The primary objective of CSHM is to serve as a supplemental tool to the internal management process to minimize hazardous job conditions that can contribute to employee accidents, and to serve as a red flag to safety management to address certain job site conditions or procedures that may require immediate corrective action. It is important to note that CSHM is designed to assist and facilitate the safety management team process and not replace it (Cheung & Suen, 2004).

The CSHM has four main components that make up the interface. These include a web-based interface, knowledge base, output data, and benchmark groups. The web-based component, similar to a typical company intranet site, is the area that allows internet access to safety users and access to all pertinent project related or other safety data information. The knowledge base is the library of all construction-related safety parameters, guidelines, and practical solutions. In addition to supplying a wealth of safety related reference material, it acts as a smart solution center, offering practical solutions to common job-site safety problems. The output data section of the interface consists of a variety of project related data and statistics organized with the use of the graphical tables and figures, which cater towards management meetings where clear, accurate, graphical representation is essential. The benchmarking element of the program is designed to establish industry-wide benchmarks by comparing strategic output data from a variety of projects.

CSHM is a construction safety tool that fosters an effective TSM process through its automated procedure, high-speed data processing, error-free execution, and low cost of integration. Once implemented, the CSHM program may serve as a valuable element in aiding the construction safety manager to minimize occupational hazards and provide accurate safety solutions.

OSHA VPP

OSHA has created the Voluntary Protection Program (VPP) in an effort to reduce occupational work place accidents via an effective safety management process. The VPP management process stresses managerial accountability for employee health and safety, places strong emphasis on continuous monitoring and improvement, and strives to empower employees to take an active role and responsibility in the safety management process.

The VPP Construction Program is an alternate pilot program designed to address the needs of the construction sector. According to OSHA, the programs have received beneficial feedback from construction organizations for promoting effective safety management procedures. OSHA has developed the VPP to cater to the complexity of the transient construction workforce and the obvious challenges dealing with a constantly changing work environment, applying their focus to projects of all types, small or large, and to both general contractors and subcontractors.

VPP is a construction safety tool that fosters an effective TSM process by emphasizing on managerial accountability for employee health and safety, placing strong emphasis on continuous monitoring and improvement, and striving to empower employees to take an active role and responsibility in the safety management process.

OSHA Construction E-Tool

OSHA has developed a Construction E-tool, which is a series of web-based training tools used to educate construction employees on a variety of common construction related safety subjects. The web-based interface is highly interactive and provides graphs and drawings to graphically describe a variety of topics. One foreseeable benefit of this web-based tool is that the information is free, and readily available to any user at any location, provided they have an

internet connection. Construction workers can plug in their laptop and immediately find answers and seek advice on project relevant OSHA standards.

The OSHA E-tool is a valuable supplement to OSHA's construction industry standards (29 CFR 1926), but is no way a replacement. It fosters an effective TSM process by providing a means for all construction personnel at all levels to familiarize themselves with safety procedures. Construction personnel are encouraged to navigate through this system to familiarize themselves with safety procedures, but all companies should have an electronic or hard copy of the 29 CFR 1926 as their core resource.

OHSAS 18001 System

Similar to the quality management process, there are safety standards available to assist in the construction safety management process. The Occupational Health and Safety Assessment System (OHSAS) 18001, is an international specification standard created to address a variety of job-site health and safety issues commonly encountered in the construction and manufacturing sectors. Similar in structure to ISO 14001, OSHAS 18001 is a documentation intensive system that can be altered and customized to cater to an organization's particular needs. The primary rationale behind OSHAS 18001 is to continuously minimize occupational hazard risk in the workplace, which in turn improves company profitability. Construction organization striving for a zero injury job site must implement and embrace a rigorous OSHAS 18001 system, focused on minimizing risk while continuously improving health and safety performance (Pheng & Kwang, 2005).

Though widely accepted and implemented throughout the world, the European-based OSHAS 18001 system is not recognized or accepted as a certified standard by OSHA. It is interesting to note that despite the obvious benefit of integrating such a safety standard, OSHA does not collaborate with OSHAS 18001 committees and continues to enforce their Voluntary Protection Program (VPP) as a viable, certified approach toward promoting and enforcing appropriate safety and health performance measures.

Integrated ISO 9000 and OHSAS 18001 Management Systems

There are many similarities between the quality standards found in the ISO 9000 systems and the OHSAS 18001 safety management system. The two were created with the intent to be used in conjunction with one another. The two systems can be either partially integrated or totally integrated as one combined Integrated Management System (IMS).

The International Organization for Standardization developed the ISO 9000 system in the late eighties. It is a quality management tool designed to help an organization achieve its Total Quality Management (TQM) goals. ISO 9001:2000, the more recent version of ISO 9000, consists of a series of quality management standards aimed to standardize work processes and promote quality production throughout a variety of industries. ISO 9001:2000 regularly analyzes conformance to customer requirements, characteristics of planning, construction implementation processes, and supplier performance data. ISO 9001:2000 is set of organized tools and methods that may work in conjunction with a TQM approach to achieve quality milestones.

It is generally advised that an organization taking on a TQM role take the initiative to fully integrate the two systems to maximize process efficiency and minimize cumbersome documentation and unnecessary confusion that would result after using two separate systems. There are several benefits to incorporating an IMS system. Primarily, an organization will save valuable time and money managing one integrated system versus managing two systems. It would not be feasible for construction organizations with a tight schedule to take the time to manage both systems. In addition, the general system auditing process is much quicker and simpler, reducing unnecessary maintenance costs associated with quality control. A simpler system will require less audit staffing and the necessary operational costs associated with training and other requirements. Lastly, a fully integrated system will minimize excess paperwork, because of only having to manage one consolidated system. Recordkeeping and the work force needed to audit and control the documentation process is minimized, saving the company substantial operating expenses in the process. Whether or not an organization chooses to take this step will depend on their management structure, general philosophy, and style of operation as it relates to what industry they are in. Though integrating such systems can be an arduous and costly task, research studies point out that the long-term safety benefits outweigh the short-term investment (Pheng & Kwang., 2005).

Companies that choose to partially integrate the OHSAS 18001 and ISO 9000 systems may choose to keep particular manuals for specific tasks that do not share similarities but combine other shared tasks such as documentation standards. Organizations that go to the step to fully integrate these two systems do so by establishing one master manual that combines all pertinent procedures and guidelines. Table 4 provides a breakdown description for both systems. One can note the many similarities in structure.

Conclusions

Owing to increase in complexity of operations, the construction industry has become more dangerous than ever before. Construction organizations are faced with the challenge of having to closely monitor their safety management systems to minimize occupational hazards, while simultaneously trying to sustain profits in a competitive marketplace. In the United States, government agencies such as OSHA have done their part to promote a zero injury environment. However, the key to proper safety execution is not necessarily through strict guidelines and standards, but through an effective total safety management initiative, first supported by an organization's senior management, then integrated via specific safety management implementation tools/ systems, and finally by continuous follow up and monitoring to ensure quality and continuous improvement. Construction organizations interested in maximizing safety and competitiveness must look to TQM initiatives for inspiration. Quality focus, total commitment, and continual improvement must be the mantra of choice. Only those companies that take on an aggressive safety management approach will sustain profit margins and achieve world-class competitiveness.

The authors firmly believe that the TSM model presented in the paper is implementable if the guidelines provided are followed. In particular, it must be emphasized that implementing TSM requires a complete turnaround in corporate culture and management approach as compared to

the traditional way of top management giving orders and employees merely obeying them. As a catalyst for maintaining a safe project, contractor top management should formulate strategies and develop policies that nurture a safe culture. The authors would like to conclude that the single most important determinant of the success of an organization in implementing TSM is its ability to translate, integrate, and ultimately institutionalize TSM behaviors into everyday practice on the job. Ideas of continuous learning allied to concepts such as empowerment and partnership, which are facets derived from TQM, also imply that a change in behavior and culture is required if construction firms are to become safe organizations.

Table 4: ISO 9000:2001 versus OHSAS 18001:1999

ISO 9000:2001	OHSAS 18001:1999
Quality Management System	OH&S policy
<ul style="list-style-type: none"> ▪ General Requirements ▪ Documentation Requirements 	Planning <ul style="list-style-type: none"> ▪ Planning for hazard identification, risk assessment and risk control
Management Responsibility	<ul style="list-style-type: none"> ▪ Legal and other requirements ▪ Objectives ▪ OH&S management programs
<ul style="list-style-type: none"> ▪ Management Commitment ▪ Customer Focus ▪ Quality Policy ▪ Planning ▪ Responsibility, authority and Communication ▪ Management review 	Implementation and operation
Resource Management	<ul style="list-style-type: none"> ▪ Structure and responsibility ▪ Training, awareness, and competence ▪ Consultation and communication ▪ Documentation ▪ Document and data control ▪ Operational control ▪ Emergency preparedness and response
<ul style="list-style-type: none"> ▪ Provision of resources ▪ Human resources ▪ Infrastructure ▪ Work environment ▪ Product Realization ▪ Planning of product realization ▪ Customer related processes ▪ Design and development ▪ Purchasing ▪ Production and service provision ▪ Control of monitoring and measuring devices 	Checking and corrective action
Measurement, analysis, and improvement	<ul style="list-style-type: none"> ▪ Performance measurement and monitoring ▪ Accidents, incidents, non-conformances and corrective and preventive action ▪ Record and records management ▪ Audit ▪ Management review
<ul style="list-style-type: none"> ▪ General ▪ Monitoring and measurement ▪ Control of nonconforming product ▪ Analysis of data ▪ Improvement 	

In addition, a major need of the industry is to develop the attitude of project owners towards an active safety management implementation, since owners are usually the driving factor towards an active and mature safety management system. Construction companies that embrace TSM would prefer all repeat clients with the same cooperative design team and sole-source subcontractor and supplier partners. However, such is not the case due to prevalent bidding practices. In reality, most projects are like a new company being formed to produce one unique product. The "new company," if it embraces TSM philosophy, needs to define its mission, and success requires everyone to work together to accomplish that mission. In this, the most important role is to be played by the project "top management" i.e. the project owner. This is because TSM cannot exist without complete acceptance of its philosophy by at least the top management. Once the basic philosophy is accepted by the owner then different systems and tools can be initiated to propagate and facilitate TSM philosophy based culture in the construction project. Therefore, a change in the views and attitude of the owners through awareness programs can bring a prominent and distinctive change in the safety management status not only among contractors but also in the entire construction industry.

Coordination is needed from initial phase to end phase among all stakeholders for successful TSM implementation. However, most of the owners use the traditional design-bid-build delivery system, which, by nature, leads to lack of trust and confidence, adversarial relations, and increased arbitration and litigation, hence rendering the system devoid of effective communication and teamwork. This has led the owners to shift more of the risks to the contractors. The net outcome is that the construction industry has been bogged down with paperwork, defensive posturing, and generally tends to have a hostile attitude toward the other participants. TSM can help reverse this trend. Although, not a magic pill or panacea for all illnesses, it will, if properly implemented, help construction companies improve and will help all the parties come closer that would bring long-term benefits.

Successful implementation of TSM in the construction industry can be achieved through persistence, positive hands-on leadership, upfront preparation and continuous maintenance of a sensible plan. The following basic steps are identified:

- i. Obtain owner commitment to safety management. This is crucial to success.
- ii. Generate awareness, educate project staff and change attitude.
- iii. Develop and document approach to safety management to projects.
- iv. Prepare project safety management plans for all levels of work.
- v. Install organization and managing bodies.
- vi. Institute proper tools and techniques which may enable the participants perform formal safety management.
- vii. Promote staff participation and contribution by pre-task meetings and initiate brainstorming sessions.
- viii. Review safety management plans and measure performance.
- ix. Strive for continuous improvement.

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