

How TQM has Impacted the Industry

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ABSTRACT: Total Quality Management (TQM) needs true believers who translate its principles into practices that drive the organization to excellent performance and to be a successful entity in the industry. A model in the paper illustrates TQM in terms of the processes according to the literature review summary of several authors' ideas with an enlargement view. The TQM has parts that are interrelated to build a foundation of QM principles, QM Core, and QM Infrastructure. Putting TQM into practice, a survey was collected from Oil and Gas Drilling Industry field for safety practices which translates the TQM process. In the end, a proposal was discussed in the paper to improve the safety process within TQM and how some factors have impacted the role of risk assessment and root cause analysis methods outcomes under TQM radar.

Keywords: Quality Management, TQM, Total Quality Management, Industry Quality, ISO, Performance.

Received January 1, 2023; **In final form** March 31, 2023; **Published** June 2023

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1. INTRODUCTION

In general, industry performance and monitoring practices have to be understood through Total Quality Management (TQM) concept. This paper reviews literature papers that focus on TQM and analyze the survey that was collected from Oil and Gas (O&G) Drilling Industry experts. The literature review intends to understand TQM measuring performance and develop empirical works on Drilling Industry in O&G for safety practices. The backbone of the discussion is the primary data collection; the survey, which will clarify the weakness and strengths of safety practices under specific indicators used in TQM. In addition, connect the literature review to real examples. Many papers have discussed TQM to apply new ideas, approaches, and methods of applications for technical and academic aspects. The interrelationship of TQM processes from authors' reviews and discussions is summarized in the following sections of this paper with a broader picture. The interrelationship elements formed the basis of TQM for QM Principles, QM Core, and QM Infrastructure. The structure of this paper is as follows: Literature Review Search Method, TQM from Literature Review, Survey Analysis, Discussion, and Summary and Conclusion.

2. LITERATURE REVIEW SEARCH METHOD

A mapping tool was used to filter related papers and tap on, precisely, the industrial impact from QM and ISO to narrow the search. Among several search and mapping tools available for scholars, Connectedpapers website (Papers, 2023) has been selected, a tool that can map key papers by clustering the prior and derivative works. The keywords "quality management models and methods" was used to show suggested papers, as in Figure 1.

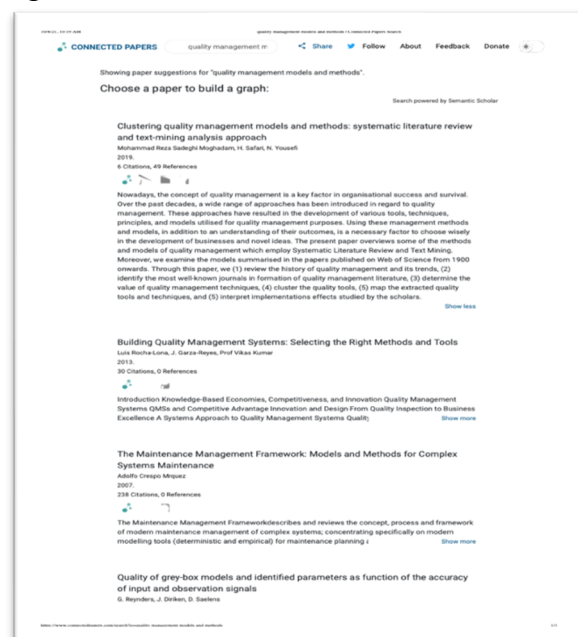


Figure 1. Connectpapers.com search suggestions.

The selected paper is “Clustering quality management models and methods: systematic literature review and text-mining analysis approach.” It is the core paper to build a graph for related papers, as in Figure 2.

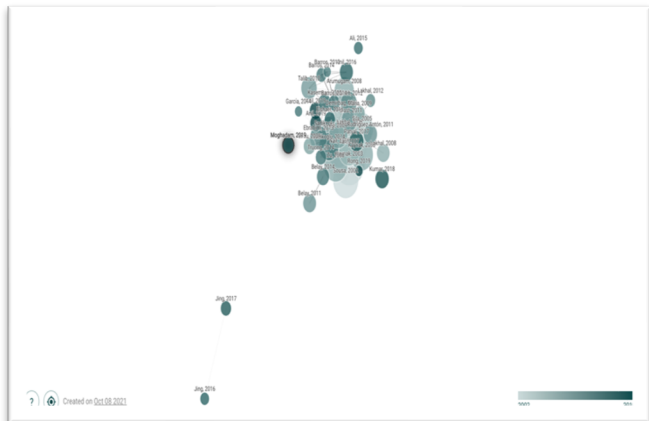


Figure 2. Connectedpapers.com clustering graph.

Below are the criteria used to refine the generated list from the core paper which mapped papers that connected to QM:

- Most fitting abstract that has QM focus
- Most appropriate paper with higher citations and references

As a result, 41 papers emerged from the core paper, as shown in Figure 3.

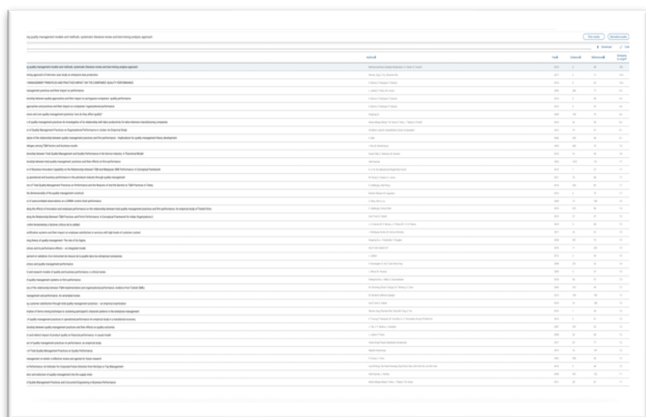


Figure 3. Connectedpapers.com papers connected to the core paper.

Nine papers, including a key paper, were selected for analysis with an 8+ “similarity ranking score,” which connectedpapers.com uses in its ranking option, as in Figure 4

Title	Authors	Year	Citations	References	Similarity to target
Clustering quality management models and methods: systematic literature review and text-mining analysis approach	Mohammad Reza Sadeghi Moghadam, H. Safari, N. Yousefi	2019	6	49	100
term mining approach of interview case study on enterprise lean production	Shawei, Jing, Z. Ho, Zhanwen Niu	2017	6	11	10.9
QUALITY MANAGEMENT PRINCIPLES AND PRACTICES IMPACT ON THE COMPANIES' QUALITY PERFORMANCE	S. Barros, P. Sampaio, P. Saraiva	2014	8	42	10.6
quality management practices and their impact on performance	L. Lailah, F. Pinar, M. Liman	2006	286	77	9.4
the relationship between quality approaches and their impact on portuguese companies' quality performance	S. Barros, P. Sampaio, P. Saraiva	2014	4	49	9.4
quality approaches and practices and their impact on companies' organizational performance	S. Barros, P. Sampaio, P. Saraiva	2013	0	47	9.4
infrastructure and core quality management practices: how do they affect quality?	Xingqiong Qi	2009	158	70	8.6
adoption of quality management practices: An investigation of its relationship with labor productivity for labor-intensive manufacturing companies	Alkhu, Magesh Balraj, F. M. Kasim, P. Hala, J. Takala, O. Pinarli	2014	20	95	8.2
the Effect of Quality Management Practices on Organizational Performance in Jordan: An Empirical Study	Ali BAKHIT Jaafar, Abedalrhman Zuhair Al-Abiedallah	2012	79	41	8.1
meta-analysis of the relationship between quality management practices and firm performance - implications for quality management theory development	A. Naz	2006	105	94	8.1

Figure 4. Connectedpapers.com ranking papers.

Those selected papers have a year range in as Table 1, with a mix of method approaches as in Table 2.

Table 1. Papers Ranged by Year

Range	Year
Oldest	2006
Newest	2019
Average	2013

Table 2. Papers Method Approaches

Methodology	Number	Percentage
Qualitative	3	33%
Quantitative	1	11%
Mixed	5	56%

Two of those nine ranked papers were excluded because they have a low relationship to the topic and need more citations. An additional paper has been added for QM's historical review purpose, “Theory of Quality Management: Its Origins and History.”

3. TQM FROM LITERATURE REVIEW

According to Síría Alves Barros, Sampaio and Saraiva (2014a) TQM definition is “Total quality management (TQM) described as a collective, interlinked system of quality management practices (QMPs) that is associated with organizational performance. An understanding of quality management principles is the foundation of any improvement activity.” which draws a meaning of literature review in terms of TQM industrial impact. Historically, in Japan, the quality movement evolved from just inspection techniques to total

quality control. The idea in Japan followed the epistemology proposed by Shewhart and then was given to the scientific experimentation for PDCA (Plan-Do-Check-Act cycle). This epistemological of TQM is a mixed phenomenon, and scientists sought improvement in the PDCA cycle, (Koskela, Tezel and Patel, 2019). Along with other broad historical discussions, the authors criticized insufficient references for established ideas and techniques that play a fundamental role in TQM. On the other hand, the International Organization for Standardization (ISO) established principles of TQM as the foundation of ISO standards; for example: “Customer focus, Leadership, Engagement of people, Process approach, Improvement, Evidence-based decision-making, Relationship Management (International Organization for Standardization, 2015)”. The definition and history of TQM draw brief lines for the next section, the selected papers that focus on TQM's industrial impact.

3.1. TQM's Industrial Impact

The authors from the selected papers discussed new ideas, approaches, and analysis results that reach out to the concept and definition of the TQM and its impact scale on industrial. In relation to the aforementioned TQM definition, its core meaning is relying on practices performed by the organizations which impact organizations' performance ends. This concept unlatches ideas and interrogates for academic and industrial practitioners to examine TQM, measuring its actual impact.

In the beginning, the objective of the key paper “Clustering quality management models and methods: systematic literature review and text-mining analysis approach” was to examine the models used in QM through a historical perspective, (Sadeghi Moghadam, Safari and Yousefi, 2019). This key paper's literature review search method was about extracting and reviewing the quality management techniques from collected documents (text mining). Because of their study limitations, they introduced only three QM tools (FTA, FMEA & RCA). According to their review, emerging trends for QM are primarily focused on corporate social responsibility, supply chain, knowledge management, and sustainable development. Still,

from several other studies, additional works have been discussed, such as leadership, customer focus, employee involvement, HR management, continuous improvement and innovation, and other QM practitioner tools, such as PDCA and the fishbone diagram. This knocks the door for the subsequent seven papers regarding quality management impact from a practical side.

These seven papers have a different approach to analyzing the impact of QM on the industry. They have a variety of research methods and theory applications to measure the performance results from the adopted QM practices. The most highlighted argument about QM's origin is the conceptual model by Barros, Sampaio, and Saraiva, (2014b). They identified ten QM principles and thirteen QM indicators, as in Figure 5.



Figure 5. A Model for the Relationship of QMPPs and Quality Performance (S`ria Alves Barros, Sampaio and Saraiva (2014b)).

In their study, the ground-breaking comprehensively identified a model that includes practices for QM, which translate the principles into performance. They could prove the relationship between principles and indicators through their research method (survey). However, the study would have been more interesting if they had included the results from implementing QM practices from the company performance indicators end.

Further exploring the relationship between QM practices and the impact on performance, Lakhali, Pasin and Limam (2006) have proposed a model that explains the direct effects of management practice (to the left-hand side) and three performances indicators; financial performance, operational performance, and product quality (to the right-hand side), where both are linked to around infrastructure practices and core practices (in the middle), Figure 6. They claimed that the path analysis approach in

the conceptual model showed an association between management practice, infrastructure and core practices, and performance. Their findings showed interesting positive effects of QM practices on organizational performance if companies' manager implements TQM. However, their argument relies heavily on qualitative analysis only for implementing the model with associated aspects of QM, with no quantitative analysis.

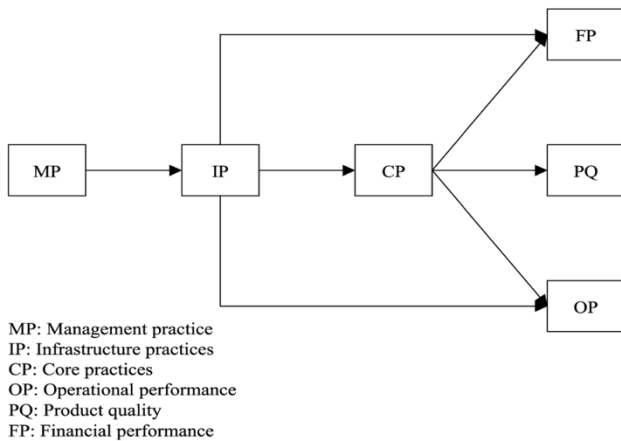


Figure 6. A Model for the Relationship of four Dimensions “Management Practice, Infrastructure Practices, Core Practices, and Performance” (Lakhal, Pasin and Limam, 2006).

Also, a conceptual model developed by Síría Alves Barros, Sampaio and Saraiva (2014a) (in their second paper), Figure 7, identified approaches to QMPs that have a significant impact on QM performance in Portuguese companies, but this may not apply to other organizations because of local regulation or business cultural. Their literature reviews generated nine generic QM performances “Leadership, customer focus, employee involvement, and commitment, HR management (incentive and recognition), strategic planning management, process management, supply chain management, continuous improvement innovation, and Quality tools and Business Excellence Models.” They identified indicators for measuring organizational performance, proofing consistency outcomes and results. In their comprehensive qualitative analysis research, an investigation is needed to explain the efficiency of QM when implementing the proposed model.

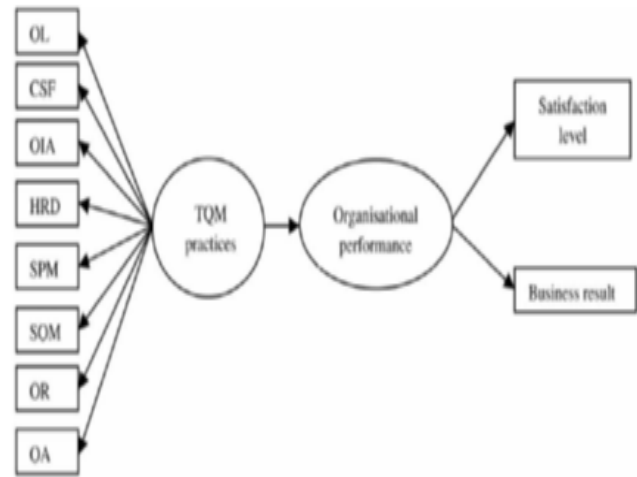


Figure 7. A conceptual proposal model of TQM practices Síría Alves Barros, Sampaio and Saraiva (2014a).

Moges Belay *et al.* (2014) made tremendous attempts to study the relationship between TQM practices and labor productivity. The measuring method is the revenue per employee and asset per employee to determine the QM adaptation level. The findings from this study, statistically, the correlation coefficient of TQM practice level and total asset per employee is 0.639 with a significance level of 0.05. The r-value is not less than 0.05, which shows a positive relationship between revenues per employee and TQM practice and adoption level. Since they focused this study on labor-intensive manufacturing companies, findings can't be extrapolated to other sectors, i.e., oil and gas, where technology has a significant portion of their operational activities. Though, observation suggested a strong influence from TQM on the organization's performance.

On the same momentum, Jaafreh (2012) had a similar approach; his six hypotheses were statistically tested, with QM practices as independent variables and organizational performances as dependent variables. Leadership, strategic planning, customer focus, and employee relation have a significant direct impact, while supplier quality and process management have no significant. It reveals that quantitative and qualitative analysis prove a relation between TQM and its effect on performance.

The last paper has heightened the need for meta-analysis of the relationship between QM practices and the performance (Nair, 2006). After the author’s assessment using the published empirical studies data between 1995 and 2004, he followed seven determined hypotheses for QM methods and overall performance. He revealed an aggregate positive correlation between several QM practices and performance, but low on the plant level. However, the author believes an investigation is needed to assess the indirect link between management/leadership and operational performance and the direct/indirect links between supplier QM and financial performance, customer service, and product quality.

4. SURVEY ANALYSIS

The concept behind the survey is to analyze current practices in the drilling industry and learn from the real practice in the field which would lead to exploring TQM pitfalls in safety monitoring and performance. The method is survey-based through Qualtrics.com online software application. It is about collecting primary data from field subject matter experts who hold positions in health, safety, environmental, QA, Operation, and Maintenance. It is targeting specific drilling contractors who are working in the O&G drilling industry in Saudi Arabia. The questions were designed to evaluate the QM system in assisting safety management systems by applying risk assessment (RA) and root cause analysis (RCA) methods. A safety control can be systematically actionable by measuring control and corrective action, which are important in Quality Management System (Tashi, Mbuya and Gangadharappa, 2016).

Although, in the survey, assessing the experts’ opinion is often difficult but a subjective judgment is often practiced, for instance, using the weight technique to clear the blurry opinions (Jiskani *et al.*, 2022). These methods (RA and RCA) are widely used applications for problem correction and uncovering symptoms or signs, which will help to develop prevention practices to stop incidents from reoccurrence. Figures 8 and 9 represent the RA and RCA feedback from the field experts with the following rating scale type:

- No contribution
- Low contribution
- Moderate contribution
- High contribution
- Extreme contribution

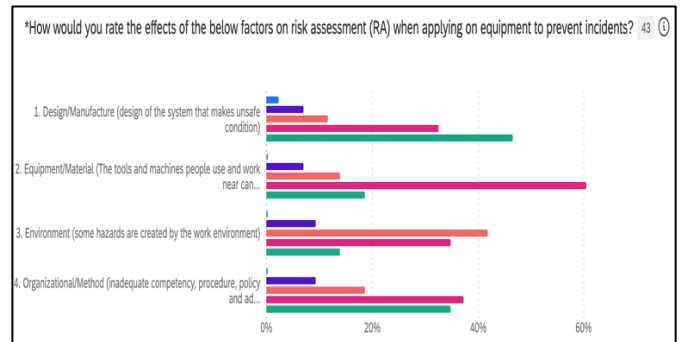


Figure 8. Factors that affect RA.

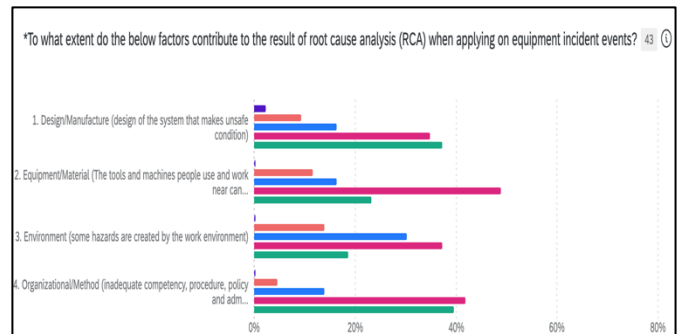


Figure 9. Factors that affect RCA.

Both questions show that a majority of responses identify Design/Manufacturer and Organizational/Method factors as having an extreme level of contribution for RA and RCA. The other two factors, Equipment/Material and Environment, have a second level of contribution. The highlight from the field survey shows an extreme impact on the quality of conducting RA and RCA on drilling incident events from those factors. This led to revisiting TQM processes and applications to manage indicators and practices, which will be discussed in the next section.

5. DISCUSSIONS

First, the model in Figure 10 shows TQM in terms of the procedures in accordance with the literature review summary of the ideas of various authors with the enclosing cycle. Leaders who adhere to TQM view it as a crucial philosophy and benefit from a higher output from their staff in terms of efficiency and profitability because it inspires them to find solutions to issues. TQM components are linked to form the QM principles, QM Core, and QM Infrastructure, which form the basis of TQM. All of these are consistent with the central idea or value used by the majority of authors to define high-level principles, which are: 1) Leadership, 3) Strategic Planning, 3) Supplier Quality, 4) People Management, 5 Organizational) 6) Process Management 7) Customer Focus 8) Product 9) Information and Analysis.

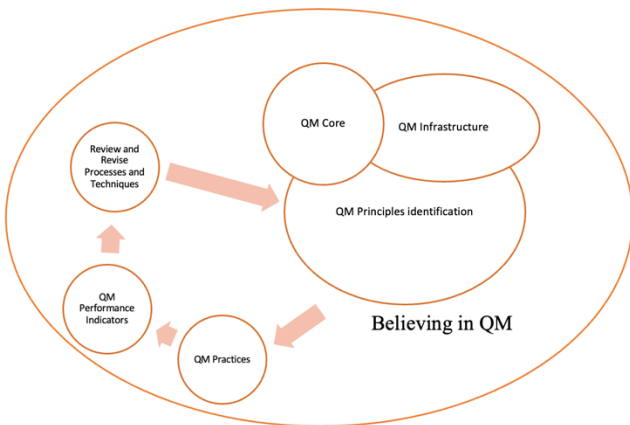


Figure 10. literature review summary of authors’ ideas for QM.

QM practices are the third step in the cycle. It is the implementation stage of the QM and tests the return from it. Authors have identified several practices (top management support, customer relationship, supplier relationship, workforce management, quality information, Product/service design, and process management), and they prove of relationship to performance as statistically presented in many papers. Those practices connected the central concept to performance indicators. A summary in Table 3 from Síría Alves Barros, Sampaio and Saraiva (2014a) mentioned the most important indicators that QM could be measured.

Table 3. Performance measures proposed by different authors (Síría Alves Barros, Sampaio and Saraiva (2014a)

Author(s)	Measure	Indicators
Prajogo and Sohal (2004)	Organization performance	<ul style="list-style-type: none"> Quality performance Innovation performance
Lakhal <i>et al.</i> (2006)	Organization performance	<ul style="list-style-type: none"> Financial performance Operational performance Product Quality
Lin <i>et al.</i> (2005)	Organization performance	<ul style="list-style-type: none"> Satisfaction level Business results
Fuentes <i>et al.</i> (2006)	Organization performance	<ul style="list-style-type: none"> Operational performance Market and financial performance Employee performance
Sila <i>et al.</i> (2007)	Performance measure	<ul style="list-style-type: none"> Organizational effectiveness Financial results Market results
Sit <i>et al.</i> (2009)	Organization performance	<ul style="list-style-type: none"> Customer satisfaction
Shieh and Wu (2002)	Organization performance	<ul style="list-style-type: none"> Project performance
Feng <i>et al.</i> (2006)	Organization performance	<ul style="list-style-type: none"> Quality performance Innovation performance
Ooi <i>et al.</i> (2008)	Organization performance	<ul style="list-style-type: none"> Job satisfaction
Zakuan <i>et al.</i> (2010)	Organization performance	<ul style="list-style-type: none"> Employee performance Customer satisfaction Business results

The last step is to review and revise processes and techniques for implementing QM in the organizations. Although “review and revise processes and techniques” is sometimes included in principles. However, the control cycle PDCA model was added as a standalone element to revisit the central concept (QM principles, QM Core and QM Infrastructure) to identify gaps and follow the control cycle again.

The industry has a significant portion of this paper. It is a steppingstone to identifying the impact of the TQM on the industry. In conjunction with survey results, field feedback has implied that the most affected factors from the survey are big concerns about safety practices that the drilling industry demonstrates in their QM processes for safety practices, in terms of RA and RCA methods.

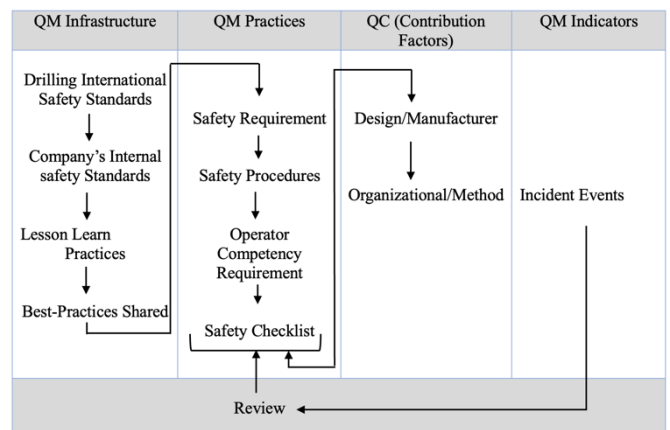


Figure 11. Drilling Industry TQM with Survey Outcomes

Within the approach that was discussed previously, TQM should have the Infrastructure, Practices, Indicators and Review processes to improve the drilling safety process. The survey feedback incorporates this approach with specific QM performance and monitoring indicators. Figure 11 demonstrates the approach: The first column is the several standards to build the QM Infrastructure, which has already been adopted by drilling companies. In the following column QM Practices, which is putting QM Infrastructure into motion mode, consists of safety procedures to run drilling operations and machines, that must be in compliance with safety requirements. These QM Practices also have already been adopted by drilling companies. The next move of the TQM process is the Quality Check (QC) for the factors that have an extreme contribution to safety control methods (RA and RCA). The two factors (Design/Manufacturer and Organizational/Method) have to meet the requirements and criteria from the previous columns. In design/manufacturer factors, QC will review and verify if suppliers provide equipment specification that meets safety standards for drilling operations. Also, for organizational/method, if the supplier provides enough manuals and procedures to run equipment and associated activities in a safe manner. The last column is the QM Indicators, which has an incident event indicator. This indicator shows the quality of previous processes. When incidents indicate causality related to contribution factors, then a review process will go back to improve procedures to avoid such pitfalls in the quality process.

Most authors have proof of the relationship of the QM to the organizations' performance, which to a certain degree, they show evidence either by higher returns or by gaining a higher reputation and customer loyalty. This paper is a foundation for the next TQM dilemma in the industry operations performance gauging. TQM is one of the methodologies that improve performance and monitoring systems for safety.

6. CONCLUSIONS

If a business is to succeed and assume the lead in its sector, it needs a true believer to put QM's principles into action. First of all, executives who believe in quality management see it as a basic sense

that will increase worker productivity and profitability. The cornerstone of TQM under the "Believe in QM" umbrella is a mix of the three components: QM Infrastructure, QM Core, and QM Principles. Which all adhere to the definitions of basic concepts and tenets that are consistent with the ways in which the majority of authors have described them.

The QM is implemented through QM practices, which evaluate its effectiveness. Numerous papers have statistically demonstrated the connection between various practices and performance. These practices include top management support, customer and supplier relationships, workforce management, quality information, product and service design, and process management. These procedures linked the main idea to success metrics. However, when necessary, this has to be reviewed; the methods and procedures used to apply QM in the organizations. Review and revise practices and techniques presented as stand-alone components for cycle control to reiterate the central concept, search for gaps, and repeat the control cycle.

The literature review serves as a foundation for knowing how the QM will affect the industry. Drilling Industry in Oil and Gas serve as an example in this paper. Data was collected through a survey to evaluate factors that impact the quality of safety performance. Risk Assessment (RA) and Root Cause Analysis (RCA) methods which indicate the quality of safety outcomes to prevent incidents. In the survey, experts show an extreme contribution of two factors that impact RA and RCA quality, Design/Manufacturer and Organizational/Method.

A proposal process for TQM was demonstrated in this paper under columns for each component of TQM, with the survey results. The process gives a mean to review the impacts of the factors on the safety practices and enhances performance and monitoring systems for safety management systems.

ACKNOWLEDGEMENT

I am grateful to Prof. Matthew Revie and Dr. Steve Paton, who provided extensive personal and professional guidance during my doctoral career. And nobody has been more important to me in pursuing this paper and learning journey than my

parents, wife, sons, and daughters, whose love and guidance are with me in whatever I pursue.

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