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ORIGINAL ARTICLES

Investigating the causal relationships between quality management activities and performance measures: an application of interpretive structural modeling

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ABSTRACT

Increase in the competitiveness and the new economic challenges force the organizations to implement the advanced management systems such as quality management systems. Successful implementation of such systems requires many efforts and an integrated planning is required for this purpose. The quality management consists of the necessary activities that lead the precise attention and perception of the organizations to the excellence. The present study seeks to identify and examine the causal relationships between quality management activities and performance measures in cement industries and also offer an interpretive structural model from the quality management activities and performance measures. This model can be used as a guideline by managers, because not only it is indicated in this study that how the research variables influence each other, but also the most important and the weightiest factors were identified.

Key words: Quality Management, Performance Measures, Interpretive Structural Modeling

Introduction

Quality management is one of the modern managerial approaches that have high potential in the organizations empowerment (Yeung *et al*., 2006). Kanji introduced quality management as the second industrial revolution (Kanji, 1990). Quality management provides the backgrounds of the organizational improvement by concentration on designing, technology and appropriate production processes selection, quality education, employees' more and more participation, and attention to the customers' needs. Quality management not only considers the products, but also has a comprehensive perspective toward the organization and includes all of the work processes and activities (Yeung *et al*., 2006). Quality is the result of more concentration on all resources such as individuals, processes, materials, and equipment and finally will results in customers' satisfaction (Ahire *et al*., 2000). Many authors have offered different definitions of the quality management. For example, Flynn *et al* (1994) stated that quality management is an integrated approach for achieving the outputs with high quality through concentration on the retention and continuous processes improvement in the different organizational levels and functions and satisfies the customers' needs and wants through it. Dean and Bowen (1994) introduced quality management in the frame of principles, activities, and techniques sets. From their perspective, the principles include attention to the customer, continuous improvement, and team working. In this perspective, every principle consists of several activities such as direct communications with the customer, processes analysis, education, and cooperation with the suppliers. Realization of these activities is possible through some of the quality management techniques such as quality function development, control diagrams, cause-effect diagrams, and six-sigma.

Since now, many authors have examined and analyzed the quality management activities, but some of these studies have been conducted in terms of the effects of quality management activities on the performance measures. Therefore, this study seeks to identify the quality management activities in Iranian cement industries and then examines the effects of these activities on the performance measures. Regarding the importance of the study, the main goals of this study are indicated in the following section.

- Identifying the quality management activities in Iranian cement industries
- Identifying the relationships among the quality management activates
- Examining the effects of quality management activities on the performance measures
- Offering an interpretive structural model from quality management activities and their effects on the performance measures

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- Classifying the identified quality management activities and the performance measures based on the influence power and the dependency level

In the following section, research frameworks in terms of the quality management activities and the performance measures have been indicated concisely and after research methodology, the dependency-influence power analysis and the conclusion have been offered.

Literature review:

Quality management activities:

Different studies have been conducted in terms of quality management activities and principles by different experts and authors (Nair, 2006, Sila and Ebrahimpour, 2005). Based on the ISO 9000, quality management includes the coordinated activities for directing and controlling the quality. In this study after examining the previous studies and receiving the experts' viewpoints, seven quality management activities have been identified. The identified activities include the following cases.

Management leadership:

One of the fundamental quality management activities is responsibility of the senior management. This is management leadership (Black and Porter, 1996). Top management should have the responsibility of quality in the organization and supports the high level quality through appropriate planning and also provides the backgrounds of continuous improvement culture (Criteria for Performance Excellence, 2002).

Education:

A proper educational planning in terms of quality can changes the employees' perspective toward quality. Quality management attends and values the human resource considerably and suggests the quality-related statistical educations to the employees (Criteria for Performance Excellence, 2002).

Employees' participation:

It is impossible to conduct quality improvement efforts without employees' participation. The senior managers should provide the backgrounds of their employees' participation and encourage team working among them (Black and Porter, 1996). The employees should use the benefits of quality improvement. For this purpose, the quality awards can be useful and encourage them for participating (Criteria for Performance Excellence, 2002).

Quality reports and data:

A feedback in any quality management system is necessary. The senior management should receive the quality reports and data from its subordinates. The managers' precise reports help them to identify the problems. These reports and data also can be used in quality function evaluation (Sila, 2007).

The suppliers' quality management:

The suppliers influence the output quality continuously. Selecting a good supplier based on the modern decision making techniques will result in quality improvement. The supplier management is not the only choice of the supplier, but it has the responsibility of creating strategic relationship and participate them in product management (Sila, 2007).

Product-service designing:

Precise product and service designing is infrastructure of the quality development. In the product designing, the organizations' power, product development methods, and also its development vision should be identified. Other important point is considering the departments participation designing that is a preventative from error in the future (Criteria for Performance Excellence, 2002, Sila, 2007).

J. Appl. Sci. Res., 9(4): 2639-2645, 2013

Customer-orientation:

Every organization's survive and growth depends on the customers' satisfaction. In the nowadays competitive world, lack of the attention to customers will results in its failure. Identifying the customers' needs can influence the customer's attention and their loyalty (Black and Porter, 1996).

Process management:

One of the activities that can provide backgrounds of the organizations' competitiveness is the process management. This considers the control rarely, but suggests attention to the precise designing. The fundamental role of process management is clear in this step (Black and Porter, 1996, Sila, 2007, Criteria for Performance Excellence, 2002).

Performance measures:

Performance is the measureable results of the organizational decisions and activities that indicate the extent of the organizational successfulness and the achieved outputs (Marr and Schiuma, 2003). The organizations performance measurement should be performed based on the appropriate measures. Many authors believe that performance should be measured based on the three main measures including property management performance, quality performance, and market and financial performance (Freeland, 1991, Chapman and Carter, 1990).These measures were indicated in the table 1.

Table 1: The performance measures.

Measures	Description	Resource
Property management performance	Total property operation, material buying operation	(Freeland, 1991, Chapman and Carter, 1990)
Quality management	Product/service quality, productivity, defects and reworking costs as a percent of sale	(Chapman and Carter, 1990, Freeland, 1991, Prajogo and Sohal, 2006)
Market and financial performance	Return on investment, sale growth, market share	(Chapman and Carter, 1990, Freeland, 1991, Prajogo and Sohal, 2006)

Research methodology:

In order to analyze the relationships among the quality performance management and their effects on the performance measures, interpretive structural modeling was used in this study. The interpretive structural modeling is a technique that examines the systems complexity and also forms the system so that is perceivable simply (Abbaszadeh *et al*., 2010). The process of interpretive structural modeling transforms the mental and unclear models to the clear and observable ones that are useful for the organizations goals. This is an interactive learning process that set of different variables are constructed in the systematic and comprehensive model frame (Salimifard *et al*., 2010). The developed model shows the structure of a problem or issue or a system through a developed precise model. This method is an appropriate instrument for regularizing the complex relationships among variables. Some of these methods benefits include convenience of its perceiving for different users, its integration in combining the experts' viewpoints, and its application in studying the complex systems with different components. In order to apply the interpretive structural modeling in this study, the following steps should be passed,

1. Identifying the factors that are related to the research subject. This can be done by examining the study literature or group-based techniques of problem solving.
2. Creating the conceptual relationships among the examined variables. This indicates that whether variable influences each other.
3. Creating the structural self-interactive matrix of the variables. This indicates the paired- relationships among the systems variables.
4. Developing a structural self-interactive matrix to the reachability matrix and examining the transit ability in the matrix. Transit ability is a fundamental prerequisite in the conceptual relationships for interpretive structural modeling. This refers that if "A" influences "B" and "B" influences the "C", then "A" influences "C".
5. Segmenting the reachability matrix to the different levels
6. Constructing the diagraph. It is possible to map a graph of the direct relationships (diagraph) based on the resulted accessibility matrix and then the accessibilities will be eliminated.
7. Transforming the extracted diagraph to the interpretive structural model through replacing the variables sang by the bulletins.
8. Reexamining the model for controlling the conceptual incompatibilities and securing the results accuracy.

J. Appl. Sci. Res., 9(4): 2639-2645, 2013

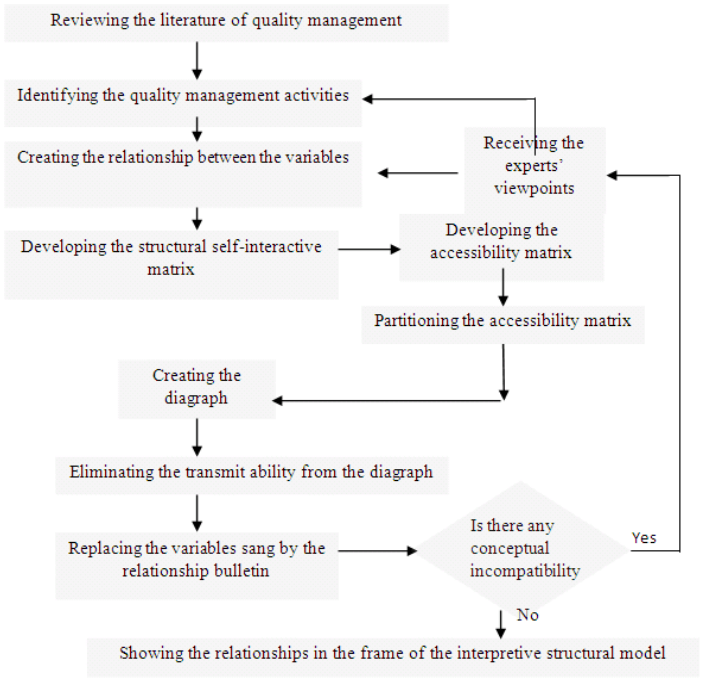

Fig. 1: The diagram of the research steps.

The above steps will result in interpretive structural model. These steps were described in the following section.

Developing the structural self-interactive matrix:

The interpretive structural modeling suggests using the experts' viewpoints based on the different techniques such as brain storming, nominal group, and others. In this study, 17 experts were participated in examining the relationships among quality management activities and their effects on the performance measures that 11 of them were from Iranian cement industries and the remaining 6 ones were academic professors. From the participated managers, two of them were senior managers and others were middle and operational managers. In order to develop the structural self-interactive matrix, it is necessary to identify and then examine the dependencies among the variables. In order to this, the following symbols were used.

V: refers to the one-way relationship (i lead to j)
A: refers to the one-way relationship (j lead to i)
X: refers to the two-way effect
O: refers to the lack of relationship between two variables
The structural self-interactive matrix of this study was indicated in the following table.

Table 2: The structural self-interactive matrix.

Variables	11	10	9	8	7	6	5	4	3	2	1
1: management leadership	V	V	V	V	V	V	V	V	O	V	
2: education	O	O	O	O	O	O	O	V	V		
3: employees participation	V	V	O	O	O	O	O	O			
4: quality reports and data	O	V	O	O	O	O	O				
5: the supplier quality management	V	V	O	A	O	O					
6: product/service designing	O	V	V	A	O						
7: customer-orientation	V	V	O	O							
8: process management	V	V	V								
9: the property management performance	V	X									
10: quality management	A										
11: market and financial performance											

J. Appl. Sci. Res., 9(4): 2639-2645, 2013

Developing the reachability matrix:

In order to acquire the primary reachability matrix, the above symbols should be transformed to 0,1. Therefore, the primary reachability matrix is resulted. In order to this, the following rules are used.

- If the (i, j) entry in the SSIM is V, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.
- If the (i, j) entry in the SSIM is A, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1.
- If the (i, j) entry in the SSIM is X, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry also becomes 1.
- If the (i, j) entry in the SSIM is O, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry also becomes 0.

After acquiring the primary reachability matrix, the final reachability matrix is resulted through interfering the transmit ability in the resulted relationships. This matrix is indicated in the table 3. In this matrix, dependency level and the influence power were offered for every variable. The influence power is resulted from row sum of 1 and the dependency level is resulted from column sum of 1.

The levels Partitions:

In order to determine the variables level in the final model, three sets of output, input, and common sets are created for each of them.

- The output includes the variable and the other variables that are influenced by the variable.
- Similarly, the input includes the variables and other variables that are influenced by the variable.
- The common set includes the joints of these sets.

If the output and common sets are same for a variable, this variable will be located in the highest level of the hierarchic model. After determining every variable level, the variables will be eliminated and the classification repeated for every variable for determining their level. The first repeat was indicated in the table 4.

Table 3: The final reachability matrix.

Variables	1	2	3	4	5	6	7	8	9	10	11	Influence power
1: management leadership	1	1	1	1	1	1	1	1	1	1	1	11
2: education	0	1	1	1	0	0	0	0	1	1	1	6
3: employees participation	0	0	1	0	0	0	0	0	1	1	1	4
4: quality reports and data	0	0	0	1	0	0	0	0	1	1	1	4
5: the supplier quality management	0	0	0	0	1	0	0	0	1	1	1	4
6: product/service designing	0	0	0	0	0	1	0	0	1	1	1	4
7: customer-orientation	0	0	0	0	0	1	1	0	1	1	1	5
8: process management	0	0	0	0	1	0	0	1	1	1	1	5
9: the property management performance	0	0	0	0	0	0	0	0	1	1	1	3
10: quality management	0	0	0	0	0	0	0	0	1	1	1	3
11: Market and financial performance	0	0	0	0	0	0	0	0	0	0	1	1
Dependency level	1	2	3	3	3	3	2	2	10	10	11	

Table 4: The first iteration.

Variables	Output set	Input set	Common set	Level
1: management leadership	1 ،2 ،3 ،4 ،5 ،6 ،7 ،8 ،9 ، 10 ،11	1	1	
2: education	2،3 ، 4 ،9 ،10 ،11	1 ،2	2	
3: employees participation	3 ،9 ،10 ،11	1 ،2 ،3	3	
4: quality reports and data	4 ،9 ،10 ،11	1 ،2 ،4	4	
5: the supplier quality management	5 ،9 ،10 ،11	1 ،5 ،8	5	
6: product/service designing	6 ،9 ،10 ،11	1 ،6 ،7	6	
7: customer-orientation	6 ،7 ،9 ،10 ،11	1 ،7	7	
8: process management	5 ،8 ،9 ،10 ،11	1 ،8	8	
9: the property management performance	9 ،10 ،11	1 ،2 ،3 ،4، 5 ،6 ،7 ،8 ،9 ،10	9 ،10	
10: quality management	9 ،10 ،11	1 ،2 ،3 ،4، 5 ،6 ،7 ،8 ،9 ،10	9 ،10	
11: Market and financial performance	11	1 ،2 ،3 ،4، 5 ،6 ،7 ،8 ،9 ،10 ، 11	11	1

As indicated, after determining every variable's level, the variable will be eliminated and this elimination will continue so that the variable's level is determined. In this study, five iterations were done that the first one was indicated in the table 4 and the second and fifth iteration were indicated in the table 5. As indicated in the

table 4, the 11th variable (the market and financial performance) is located in the first level in the first iteration. This means that this variable is influenced by other variables.

Table 5: The second - fifth iteration.

Iteration	Variables	Output set	Input set	Common set	Level
2	9: property management performance	9,10	1,2,3,4,5,6,7,8,9,10	9,10	2
2	10: quality performance	9,10	1,2,3,4,5,6,7,8,9,10	9,10	2
3	3: employees' participation	3	1,2,3	3	3
3	4: quality reports and data	4	1,2,4	4	3
3	5: supplier quality management	5	1,5,8	5	3
3	6: product/service designing	6	1,6,7	6	3
4	2: education	2	1,2	2	4
4	7: customer-orientation	7	1,7	7	4
4	8: process management	8	1,8	8	4
5	1: management leadership	1	1	1	5

Developing the interpretive structural model:

Regarding every variable's levels and also the final reachability matrix, the primary interpretive structural model is mapped through considering the transmit abilities. The final interpretive structural model is constructed through eliminating the transmit abilities. The resulted final model was offered in the fig 2. The model consists of five levels. The variables that are located in the high levels of this hierarchy have low effects.

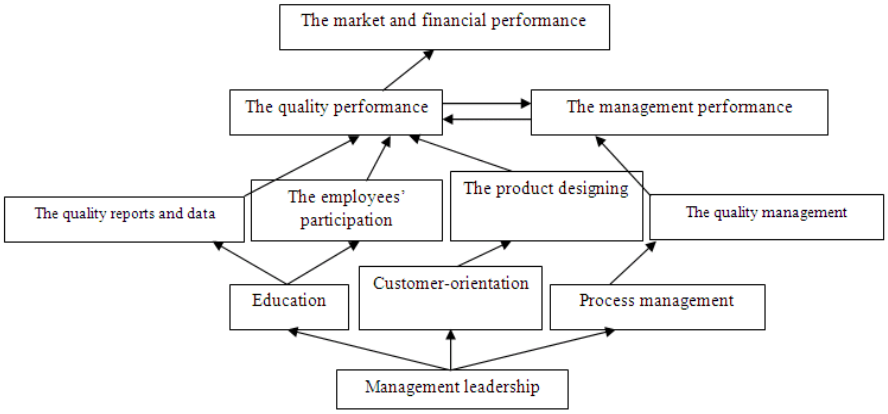

Fig. 2: The research interpretive structural.

Analyzing the influence power-dependency level:

In this section, the research variables were divided into four groups based on their influence power and their dependency level. The first group includes autonomous variables (the first region) that have weak influence power and dependency level. These variables are distinct from other variables and have some relationships with them. The second group includes the variables that are located in the second region. These variables have weak influence power, but have high dependency levels. The third group includes the hybrid variables (the third region). These variables have high influence power, but have low dependency level. Variables that have high influence power are defined as key variables. It is clear that these variables are located in one of the autonomous or hybrid groups. The influence power and dependency level of every research variables are indicated in the table 3. Therefore, the influence power and dependency level diagram is developed that is indicated in the fig 3.

Conclusion:

This study seeks to analyze the relationships between quality management activities and their effects on the performance measures in Iranian cement industries. In order to examine the effects of quality management activities on performance measures and the organizations' performance, the interpretive structural modeling approach was used. For this purpose, a model of the effective factors and the relationships between them was resulted. This model includes five levels. The factors that are located in the higher levels have low influence levels and the factors that are located in the bottom of the hierarchy have more influence levels. Some variables are located in the bottom of the hierarchy such as management leadership and education. Indeed, these factors are considered as the fundamental factors, because have effects on all of the other factors. The results of the influence power and dependency level analysis indicate that these factors can be grouped in different four

groups. The first group that includes autonomous factors such as the employees' participation, the quality reports and data, the suppliers quality management, the product/service designing, customer-orientation, and the process management. The property management performance and the quality performance are located in the second region. As indicated, these factors have high dependency level and low influence power. The variables that are located in the third region have high dependency and influence power and are considered as the hybrid factors. Any factor did not locate in this region. Some variables such as management leadership and education also are located in the fourth region. Also the results of analysis indicate that the factors that are located in the third and fourth regions have high influence power and so should be attended by the company's managers.

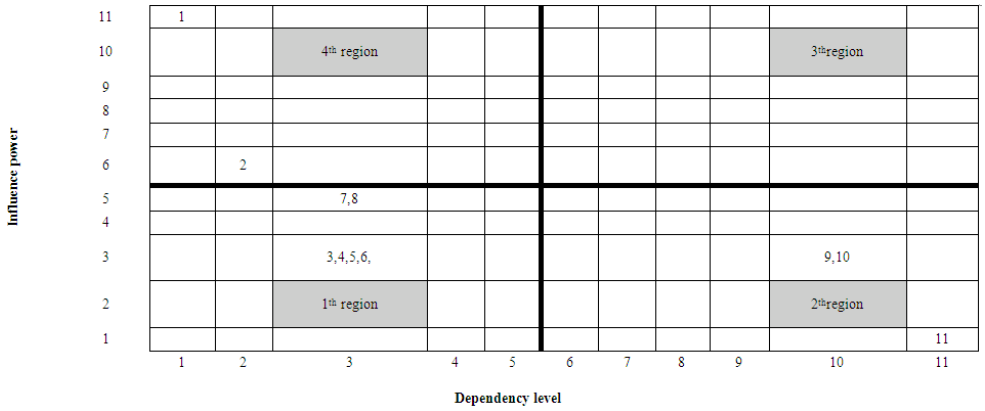

Fig. 3: Influence power and dependency diagram.

References

Abbaszadeh, M.A., M. Ebrahimi, H. Fotouhi, 2010. "Developing a causal model of critical success factors for knowledge management implementation, *2010 International Conference on Education and Management Technology (ICEMT)*.

Ahire, S.L., P. Dreyfus, 2000. "The impact of design management and process management on quality: an empirical investigation", *Journal of Operations Management*, 18(5): 549-575.

Black, S.A., L.J. Porter, 1996. "Identification of the critical factors of TQM", *Decision Sciences*, 27: 1-21.

Chapman, S., P.L. Carter, 1990. "Supplier/customer inventory relationship under just-in-time". *Decision Science*, 21: 35-51.

Criteria for Performance Excellence, 2002. "Baldrige National Quality Program. Department of Commerce", National Institute of Standard and Technology, Technology Administration Gaithersburg, MD, USA.

Dean, J.W., D.E. Bowen, 1994. "Management theory and total quality: Improving research and practice through theory development", *The Academy of Management Journal*, 19(3): 392-418.

Flynn, B.B., R.G. Schroeder, S. Sakakibara, 1994. "A framework for quality management research and an associated instrument". *Journal of Operations Management*, 11(4): 339-366.

Freeland, J.R., 1991. "A survey of just-in-time purchasing practices in the United States". *Production and Inventory Management Journal*, 32: 43-50.

Kanji, G.K., 1990. "Total quality management: The second industrial revolution". *Total Quality Management,* 1(1): 3-13.

Marr, B., G. Schiuma, 2003. "Business Performance Measurement: Past, Present and Future", *Management Decision*, 32: 41-48.

Nair, A., 2006. "Meta-analysis of the relationship between quality management practices and firm performance-implications for quality management theory development", *Journal of Operations Management*, 24: 948-975.

Prajogo, D.L., A.S. Sohal, 2006. "The relationship between organization strategy, TQM, and organization performance - the mediating role of TQM", *European Journal of Operation research*, 168: 35-50.

Salimifard, K., M.A. Abbaszadeh, A. Ghorbanpur, 2010. "Interpretive Structural Modeling of Critical Success Factors in Banking Process Re-engineering", *12th International Business Research Conference, Dubai.*

Sila, I., 2007. Examination the effects of contextual on TQM and performance through the lens of organizational theories: An empirical study, *Journal of Operations Management,* 25: 83-109.

Sila, I., M. Ebrahimpour, 2005. "Critical linkages among TQM factors and business results". *International Journal of Operation and Production Management*, 24: 1123-1155.

Yeung, A.C.L., T.C. Edwin, K. Lai, 2006. "An operational and institutional perspective on total quality management", *Production and Operational Management,* 15(1): 156-170.