The Effect Analysis of Manufacturing Execution Systems (MES) on the Strategy of Quality Cost Leadership

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ABSTRACT

Nowadays, the optimum use of available resources and the opportune identification and responsiveness to customer's needs is converted into an unavoidable issue in terms of economic limitations and complexity of markets. This issue has made organizations maintain their share in the market by eliminating structures and methods of traditional work. In this direction, manufacturers have had great attempt in simplifying, making activities effective and increasing productivity (Oral, 2003)[24].

This research is an applied, descriptive-correlative and survey one. The statistical population included 300 managers and experts of Pars Khodro Company. Simple random sampling method and Cochran formula are used to determine the statistical sample and sample size, respectively. The sample size (Cochran, P=0.5, Z=1.96 with the coefficient of error E=0.05) was determined 168 persons. Different methods of descriptive and inferential statics, Cronbach's alpha and SPSS and LISREL software are used to analyze data, determine the reliability of questionnaire and test hypotheses, respectively. On this basis, a positive and significant relation exists between manufacturing execution system and the strategy of quality cost leadership.

Thus, organizations increase their own tasks better and simpler by employing and implementing manufacturing execution system. Managers, using this system in implementing cost management, can reduce costs by analyzing information and failure simultaneous with analyzing market, production lines, experiments and the plan of the capacities of product assurance, while increasing quality.

KEYWORDS: Manufacturing Execution System, Strategy of Cost Leadership, Quality Management

INTRODUCTION

In the third millennium, traditional concepts of manufacturing are confronted with a fundamental challenge with the development of world competition among large and small industries and with the ever-increasing growth of information and communication technologies. Data and information are created in the industrial units by machinery, sensors and operators every moment in different places and managerial processes need the information at a higher level. Access to manufacturing information as soon as possible in an electronic and standard format is a reason for integrating the systems of data processing of the different manufacturing levels. (ERP) and Manufacturing Execution Systems (MES) as two important informational systems in the industrial units both need accurate and real-time data from the level of factory in order to contribute to make decision at managerial levels. This decision should be transferred to the control system of factory level so that manufacturing is started and continued after creating programs and orders suiting manufacturing (Rouhani & Rabiyemehr, 2005)[28].

Nowadays, organizations are under ever-increasing pressures by their customers to develop higher-performance products. In this direction, successful companies attempt to a steady and unique competitive situation in the market by employing resources, capacities and competencies in the frame of strategic management process. It is necessary to not that only devising and selecting a competitive strategy in accordance with market conditions do not affect organization's ultimate performance significantly by itself, but the relation and interaction between high-rank strategies and duty-level ones result in developing organization's performance in its operational environment (James & Hatten1995) [17] Each organization's goal in following the strategy of cost leadership or strategy of low cost is having better performance in relation to the competitors owing to doing each possible work for having lower cost in comparison with them (Husseini , 2008) [16]. Achieving a situation with a low general cost often requires a high relative share of market and other advantages such as achieving raw materials desirably. In addition, it may needs designing goods to facilitate the process of manufacturing, making and maintaining a wide line for manufacturing relevant and codirected goods, distributing costs and offering services to all purchasing groups to increase the volume of manufacturing. Factors affecting the strategy of lowest cost include the simplicity of product design, control of raw materials, low cost of manpower, innovation in manufacturing,

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automation, cost reduction of overload, economy resulted from manufacturing in scale, and economy resulted from experience curve (Ahmadi, 1998) [1].

MATERIAL AND METHODS

Manufacturing Execution Systems (MES)

It is a system placed between business information and the level of manufacturing workshop. Using this system has demonstrated benefits such as increasing productivity, reducing costs and arriving at market more rapidly. This system is a bridge between planning system and control system that manages information of the programs of manufacturing resources (manpower, equipment and material circulation) y using it opportunely (McClellan, 2000)[22].

MES is special industrial software for manufacturing environments. Reports, which are presented concerning it show that MES is utilized in different manufacturing industries including discontinuous, continuous and mass ones particularly air and space, car-making, semiconductor, petrochemical and medicinal industries and its application in industries such as metals, plastic and medical tool is increasing. MES in the competitive market suggested as a series of technology vital for improving efficiency, manufacturing and production capacity (Payame Pardazsh, 2008)[25] Generally, the performance of MES is placed in categories such as management of materials, management of resources, management of order, quality management, management of compatibilities, unification of human resources planning, unification distribution of control system and management of employees (Duel, 1994) [9]

Cost Leadership Strategy (CLS)

In this strategy, company attempts to manufacture and offer standard products that the cost of each unit is reduced for the customer (the person who is sensitive to price). Each organization's goal in following CLS or low cost strategy is having a better performance than its competitors' owing to doing any work for having lower cost in relation to them (Husseini, 2008) [16].

Companies that follow CLS should have high-quality products so that customers' cost for troubleshooting would be minimum. Companies with low total cost have good after-sale services for the operations of invoice deliverance, deliverance status, faults and returned products. The proper understanding of customers' needs in companies with low total cost is conducted through professional marketing research teams (Kaplan & Norton, 2005)[5].Duel (1994)[9] in one research titled "the benefits of MES in developing factory automation" points out that in the 1990s, manufactures sought to compete in the world market. The dependency of products on customers' needs makes the production of order-ready products, improvement of new processes and increase of offering services to customers in different markets for MES. MES suggest fundamental and technological benefits that equip the environment to continue the improvement of factories. When MES is accompanied with ERP and DCS, it can have double benefits. Many of the obtained benefits are derived from the employment of this system in decomposing the process of business. Manufacturers identified that MES is indispensable, but its qualitative and quantitative benefits is difficult without initial benchmarking. The benefits of MES are beyond a product. Introducing MES to the manufacturing environments requires three solutions based on the manufacturing information, manpower, and organizational structure. The success of implementing MES can be achieved by joining to providers who know new technological needs.

LITERATURE REVIEW

In one paper published by Emerald Article in the section of strategic direction (2004) [12] titled "meeting the manufacturing challenge", it was shown that factories that used MES, had greater improvement an progress in calculating the real time of the process of manufacturing, manufacturing instructions and manufacturing employees' progress. This research is conducted on 106 companies in 1998-2002.

Meier (2007) [20] in the research of MES for small industries expresses that nowadays, the process of manufacturing is out of mind beyond benefiting from information system. The term "MES" usually refers to selecting the applied software components, which are placed between the two layers of manufacturing operation and control operation and on the other hand, exchanges accurate information between upper and lower layers, accompanies the details of workshop process until the final frame of trade and provides an extremely strong level of operational access to optimize the level of operations in the workshop in different scales such as quality of product, use of product, accuracy of distribution date with various standards in different industries to make the use of system simple.

Du Laihong (2008) [10].In the research of the development of optimizing manufacturing resources using MES expressed that using this system, the selection and plan of the direction of manufacturing and information technology can be conducted easily.

Ziaohong Wang et al. (2009) [30] in one similar research conducted in cement industry, analyzed the different performances of MES to unify information system and the productivity of manufacturing process in cement industry. Analysis program, quality management, operational work design, material balance and inventory management, management of equipment flow, management of process cost and other daily kinds of management are operational models stated in cement industry.

Saver Olaf (2010) [29] in one research titled "tendencies in MES" pointed out six tendencies of research and development sector depended on MES and concluded that this system is as the catalyst of the process of transportation system and the structure of manufacturing.

Gaoliang Peng (2011)[14] in the article of preparing the background for MES for developing pace products, showed that implementing the system identifies the change of manufacturing process and as the result rapid response to changes.

Mi Zhongi et al. (2012)in the research of analyzing automation design system for the combinational products of manufacturing workshops showed that monitoring the real time of information and guaranteeing the feedback of manufacturing activities are conducted by the system and the information of manufacturing system fills the distance between the upper layer of ERP and workshop level and provides the company with backup information. All companies investigated in the researches had the problems of material flow control, design, inventory of material, equipment management, and real time of data collection for making decision, because handy integration included different calculative reports. The real time of accessing information and sharing it for redesigning and restructuring had low productivity due to fast inaccessible information. The appropriate implementation of MES improves the efficiency of the traditional manufacturing process of products and the real time of monitoring the process.

Makuyi and Shahrudi (2005) [32]in the research of vale chain modelling in the car industry of Iran to achieve CLS specified that the model of ideal planning is presented based on the concepts of purposeful costing, ideal goals for parts and complexes of car. Since achieving CLS requires the optimum consumption of different resources of manufacturing, the developed mathematical model determined the optimum consumption of the resources. The developed mathematical model is multiple Objective Decision Making (MODM). The results of such analyzes can be used to devise CLS. In many cases, the cost reduction of in an activity can be achieved through increasing cost of other activities.

Ghasemi and Ebrahimi (2007)[13] in the paper of the effect of employing appropriate competitive strategy on the efficiency of Iranian companies point out that the strategy of total cost leadership with the first priority has the highest effect in the financial efficiency of trade companies and after it, the strategy of best costing method, distinction and differentiation are on the other priorities affecting trade companies' efficiency. They suggest that Iranian trade companies at first step should put the strategy of total cost leadership by observing the principles of quality and world standards to access trusted channels as well as presence in the international trade arena.

Mirghorbani Ganji (2012)[21]in the paper of cost management and identification of reducible cost factors considers the gap between customer and organization and the long distance between financial system and technical one as one of the effective factors in increasing cost. He mentions that the following topics should be regarded in the process of cost reduction strategy:

The optimum use of all manufacturing and servicing capacities

Educating and developing the culture of growth and productivity and making forces purposeful towards improving indices

Managing energy costs

Managing the costs of capital outlay

Managing the loss reduction of organizational resources, raw materials and parts

Promoting the quality level and reengineering in organization

Considering informational systems and flowing information in organization

Identifying and eliminating added value-free activities, parallel and repetitive activities

Reducing the contribution of manpower of headquartered sectors to executive and manufacturing ones

Honarbakhsh et al. (2012)[15]in the paper of the relative effect of trade strategies on the relation between financial leverage and the performance of companies listed on the Tehran Stock Exchange point out that the goal of CLS is that company would be among low-cost manufactures in an industry. CLS is achieved through gaining experience, investing in the facilities of mass production, using economy and accurate supervising the total of operational costs through programs such as reducing size and quality management. Companies that use CLS in conditions where the managerial efficiency is increased with creditor's supervision will be benefitted by using financial leverage. Supervision by the creditor limits managers' opportunistic behaviors by reducing accessible resources for precautionary costs. Thus, the task of controlling debts is more important for companies, which seek to increase their efficiency. In addition, in CLS, companies are obliged to control the main costs and prevent from the increase of many marketing or innovation costs and conclude that if company's strategy is based on CLS, the variables of financial leverage and divided stock profit have a direct relation to company's performance.

Banker et al. (2006)[8]in the paper of generic strategies and sustainability of financial performance point out that adopting the goal of CLS increases market share based on the achievement of low-cost situation than other

competitors. To achieve this strategy, the company should do the activities of providing, manufacturing, selling and delivering products and services faster and cheaper than other competitors. To lead cost, different tactics such as the facilities of scale, improvement of process, minimization of costs, TQM (Total Quality Management), overload cost control and bench marketing should be used.

Adler et al. (1995)[3]carried out an analysis titled "Can MES the manufacturing cost of bulk medicines?" This analysis was conducted in the medicine factory of Eli-Lilly. The following hypotheses were investigated:

      A) MES is executable with complete performances

      B) Considerable reengineering will occur in the process of trade.

According to the obtained results 10-30 percentage of the manufacturing employees' and support group' activity time that does the works related to documents is reduced by MES and reengineering process. This issue is achieved by substituting current paper documents for electronic system when the personnel do not spend their time on duties that MES does easily. Certainly, a kind of balance should be sustained between personnel's need and the system's one in order to use it for a long time. Through this trend, 5% of the whole personnel are reduced. Paper-free system and managerial tools make working trend faster. The wasted time in the laboratory for quality control will be reduced more than 70%. The time of material flow, semi-process product and end product is reduced more than 30%. This issue is achieved through improving manufacturing program. In-process tracking, electronic labels and the management of documents reduce the confirmation time of material. This work reduces the standby time of material during manufacturing and costs of responding marketing and sale are reduced. The relation of MES between control system and manufacturing planning system can reduce the possible flow and the stoppage of end product. Finally, it is predicted that 15% of process time is reduced. Customers who want to solve their problems by ME should employ reengineering system.

Hypotheses

The Main Research Hypothesis

MES affects CLS significantly.

Sub-hypothesis

Quality management affects CLS significantly.

METHODOLOGY AND MATERIAL

The present research is an applied and descriptive-correlative one in terms of objective and nature and method. Simple random method was usedfor sampling. The statistical population included 300 of managers and experts of Pars Khodro Company (Megan and L90 lines) and the sample size was determined 18 persons based on Cochran formula and in accordance with Morgan Table. In this research, content validity is used to analyze the validity of questionnaire. To determine content validity, the questionnaire was given to five experts and professors of management and their views were asked concerning questions, and the evaluation of hypotheses. Finally, the validity of the questionnaire was confirmed.

The questionnaire was presented to 333 managers and experts of Pars Khodrov Company (Megan and L90 lines) as pre-test to measure its reliability. The coefficient of Cronbach's alpha for 33 questionnaires in the pretest stage for the relevant questions to each of variables was obtained 0.881, 0.887 and 0.928 for MES, CLS and all questions, respectively. According to the mentioned coefficients higher than 0.7, it can be claimed that the questionnaire has desirable reliability (at pretest stage) and finally the coefficient of Cronbach's alpha for 168 returned questionnaires for the questions relevant to each of variables was obtained 0.902, 0.902 and 0.935 for MES, CLS and all questions, respectively. These numbers indicate that the questionnaire has trustworthiness, in other words, it has necessary reliability.

Results

In this research, one main hypothesis and one sub-hypothesis were analyzed using the methods of descriptive and inferential statistics. In this section, the description and analysis of the inferential results of the relations between research variables are dealt with correlation, regression and path analysis. The results of testing hypotheses are also presented. In the main hypothesis, it was claimed that MES affects CLS significantly.

Table 1: Correlation coefficients between the variables of MES and CLS

Variable	CLS						Relation	Type of relation
MES	Pearson correlation coefficient			Spearman correlation coefficient			Yes	Direct
	Coefficient of correlation	Sig	Number	Coefficient of correlation	Sig	Number		
	0.631	0.000	168	0.604	0.000	168		

Results of Pearson correlation test and Spearman show that MES affects CLS significantly (significance level lower than 0.01) and this relation is direct and at average level.

Table 2: Results of regression test: the effect of MES on CLS

Independent variable	Depended variable	R	R^2	Adjusted R^2
MES	CLS	0.631	0.398	0.394

As it was observed in Tables 1 and 2, the value of correlation coefficient is 0.631 and the value of sig is 0.000 that is lower than 0.05 indicating the direct effect between MES and CLS. The value of adjusted coefficient of determination is 0.394 suggesting 39.4 of the changes of CLS are affected by MES.
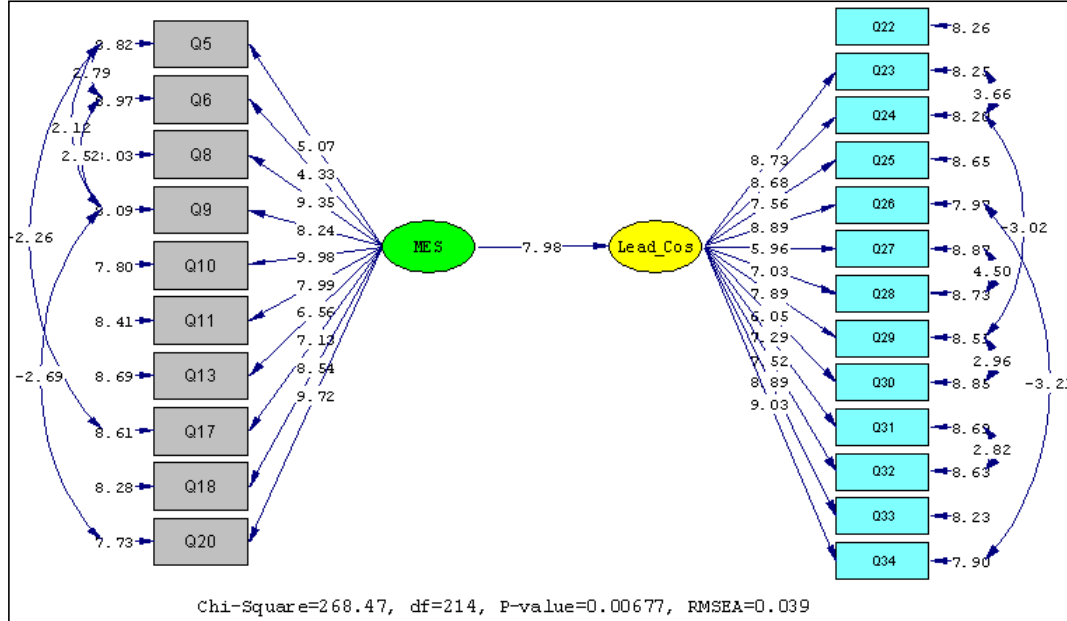

Diagram 1: Significant numbers of the coefficients of the structural model for the main hypothesis

As it was observed, the significant coefficient between MES and CLS is equal to 7.98 based on the model of structural equations. Therefore, the structural model shows that the existence of MES affects CLS significantly. Thus, the main hypothesis is confirmed similar to the analysis of correlation coefficients. Sub-hypothesis: Quality management affects CLS significantly.

Table3: Correlation coefficients between the variables of quality management and CLS

Variable	CLS						Relation	Type of relation
Quality management	Pearson correlation coefficient			Spearman correlation coefficient			Yes	Direct
	Coefficient of correlation	Sig	Number	Coefficient of correlation	Sig	Number		
	0.563	0.000	168	0.562	0.000	168		

Results of Pearson correlation test and Spearman show that quality management affects CLS significantly (significance level lower than 0.01) and this relation is direct.

Table 4: Results of regression test between quality management and CLS

Independent variable	Depended variable	R	R^2	Adjusted R^2
Quality management	CLS	0.563	0.318	0.313

As it was observed in Tables 5 and 6, the value of correlation coefficient is 0.563 and the value of sig is 0.000 that is lower than 0.05 indicating the direct effect of quality management on CLS. The value of adjusted coefficient of determination is 0.313 suggesting 31.3 of the changes of CLS are affected by quality management.
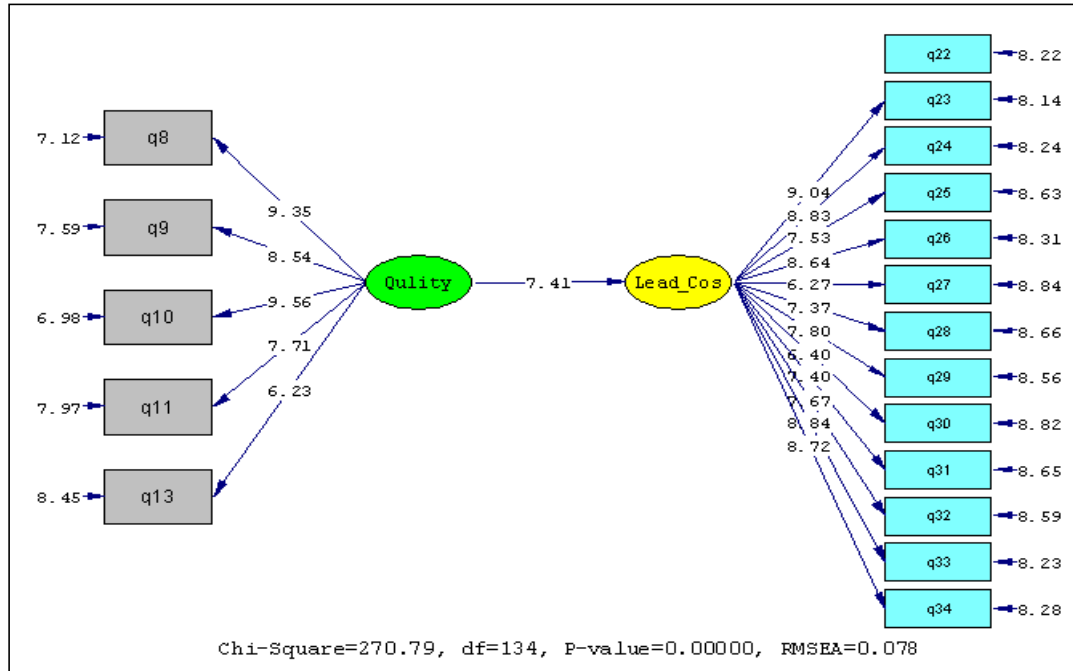
Diagram 2: Significant numbers of the coefficients of the structural model for the sub-hypothesis

As it is observed, the significant coefficient between quality management and CLS is equal to 7.41. Therefore, the structural model shows that the existence of quality managements affects CLS significantly. Thus, the sub-hypothesis is confirmed similar to the analysis of correlation coefficients.

DISCUSSION

Since MES affects CLS significantly, it is absolutely necessary that organizations pay special attention to the dimensions of MES. Thus, based on the results, it is suggested that:
According to the direct effect of and significant of quality management on CLS
- Familiarizing employees with the importance of information and technology
- Gaining knowledge and information to develop and improve costs using information technology
- Creating proper beliefs and mental models
- Creating the committee of CLS with the management of the highest organizational authority
- Converting the issue of the necessity of reducing cots into employees' general conception

Conclusion
- The objective of the present research was to determine the level of CLS in Pars Khodrov Company that the dimension of quality and manufacturing cost was used to measure the variable of CLS.
- Regarding CLs, the results indicate that the status of CLs is at an average level in Pars Khodrov Company, because the obtained mean for the variable of CLS is 3.23. According to the results, quality and manufacturing cost is at an average status. Furthermore, based on independent t-test and variance analysis, gender and educational degree have not a significant effect on CLS.
- The other objective of the research was to determine the relation between MES and CLS that the suggested hypotheses were tested to achieve the objective and all hypotheses were confirmed.

Limitations
1- The area of MES is considered virgin one, therefore, finding scientific references in this regard is hard. The work is harder when the research title is analyzing the effect of MES on CLs. Thus, accessible scientific references are among the limitations of this research.
2- The inherent limitation of questionnaire, since questionnaire conveys individuals' perception of reality, this probability should not be ignored that the perception would not be in accordance with the reality completely. Therefore, the inherent limitations of questionnaire are among the limitations of the research.

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Appendix:

Correlations

		Quality	Cost_Leader
Quality	Pearson Correlation	1	.563[**]
	Sig. (2-tailed)		.000
	N	168	168
Cost_Leader	Pearson Correlation	.563[**]	1
	Sig. (2-tailed)	.000	
	N	168	168

[**]. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			Quality	Cost_Leader
Spearman's rho	Quality	Correlation Coefficient	1.000	.562[**]
		Sig. (2-tailed)	.	.000
		N	168	168
	Cost_Leader	Correlation Coefficient	.562[**]	1.000
		Sig. (2-tailed)	.000	.
		N	168	168

[**]. Correlation is significant at the 0.01 level (2-tailed).

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.563[a]	.318	.313	.52561

a. Predictors: (Constant), Quality

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.335	1	21.335	77.225	.000[a]
	Residual	45.861	166	.276		
	Total	67.195	167			

a. Predictors: (Constant), Quality
b. Dependent Variable: Cost_Leader

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.471	.205		7.173	.000
	Quality	.529	.060	.563	8.788	.000

a. Dependent Variable: Cost_Leader