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IDENTIFY AND RANKING OBSTACLES OF WORLD CLASS MANUFACTURING IMPLEMENTING BY THE FUZZY ANALYTIC HIERARCHY PROCESS

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ABSTRACT
Today with increase competition among manufacturing companies of the world, it is necessary that Iranian companies have an outstanding presence in the global markets and produce their productions at the global level, but they are exposed to a lot of obstacles for World Class Manufacturing implementing. Therefore, this study has tried to identify and ranking the different obstacles for implementing of world class manufacturing system in Iranian manufacturing companies using fuzzy Analytical Hierarchy Process (FAHP). In this study, first the obstacles to implementation of WCM system were recognized by library studies and some questionnaires and interviewing experts, then Hierarchical decision tree was designed. The second questionnaire, which consists of fuzzy decision matrix, was then distributed among 12 experts in Appliance industry. Then in order to ranking the criteria, gathered information were analyzed through fuzzy Analytical Hierarchy Process. The results show that management, manpower, technology and organizational culture are respectively the most important factors and are the main obstacles in the implementation of manufacturing systems at the global level in Iranian companies.

Keywords: *World Class manufacturing, FAHP, management, manpower, technology, organizational culture.*

1. INTRODUCTION

Manufacturing activities in the current situation and during the recent decades have been faced with globalization. Transfer of manufacturing activities in a competition from a national level to a global level competition and increasing capability of the present competitors, has made manufacturing companies and even governments to revise their national and manufacturing policies. Companies must have such a manufacturing system, with help of which they can quickly design new products, rapidly improve available products, rapidly react to the market changes, have shorter manufacturing cycles and eventually have more flexibility.

Today modern manufacturing system should be able to produce products of higher quality, lower costs, less waiting time, and finally more flexible. Globalization of manufacturing market has caused manufacturing companies to re-evaluate their attitudes towards international competition and has caused governments to change their national policies. World Class Manufacturing system (WCM) is a proper combination of key elements of productivity such as Just in Time production (JIT), Total Quality Management (TQM), along with staff cooperation. In fact, such a combination system consists of advanced manufacturing techniques that have considered staff cooperation as the basis of its activities and paying attention to quality and customer as the core of its activities. Although there are a lot of viewpoints from experts regarding global manufacturing, and a lot of parameters have appointed for them, and there are a lot of different opinions about these parameters, there is an overall end about all these viewpoints and that is competitiveness in global business. Today, the situation is so that each company has to evaluate itself in such a situation and appoint its status. Globalization of economic, industrial and service activities is the most important change in the current century business environment. Increasing competition and advent of various rivals in different countries, made manufacturing companies to focus on their manufacturing process with a global vision. Today, the global economy territory has moved from

national markets to transnational markets. Consumers also play a more important role than before in today market and in order to give quick response to consumers' tastes changes, the company should acquire such capacity to be able to rapidly design new products and improve available ones, so there should be established a flexible system which focuses on small manufacturing accumulations. Such a system should be able to produce high-quality; low prices and less waiting times products and quickly design new products. For this purpose, it is recommended to establish a system as a global scale manufacturing. Such a system contains key productivity elements and modern management concepts such as: Total Quality Management (TQM) and staff cooperation and Just in Time manufacturing (JIT). Therefore, in such an increasing competition, organizations have no choice but to get into the trenches of WCM, so all manufacturers should be familiar with these terms and pas them. Successful global competition requires to be fitted to WCM.

Most seniors in undeveloped countries still look to the market as "national" rather than "global" market and consider products as "good enough" rather than "world-class" products. Undoubtedly, such attitudes will lead to failure and leaving the scene of manufacturing in this global perspective. Presence in global competition manufacturing requires compliance with rules and global criteria and scales; therefore, to achieve this goal, managers should forget "national-scale manufacturing" and think of world class manufacturing. These are possible by accepting the manufacturing system in the global level and identify obstacles and problems of implementing this system in Iran manufacturing companies.

2. LITERATURE REVIEW

2. 1.World class manufacturing

In spite of various definitions on world class manufacturing system, all have the same message that is world class manufacturing is known as the world best manufacturers (Falah et.al, 1998). Schonberger was the first one who used the term manufacture in world class in 1982 and proposed his argue as lessons of simplification. He defines world class manufacturing system as:

World class manufacturing system is a wide agreement on continuous improvement of quality, cost, waiting time and service to the customer. Flexibility as a primitive goal is considered a part of this system (Schonberger, 1996). Kodali and Sang Wan reviewed the definitions on world class manufacturing system as bellow: the term manufacture in world class defines organizations that achieve superiority in global competition using their manufacturing capabilities, as a strategic weapon (Kodali and Sang wan, 2004). Sumy Shana defines world class manufacturing system in his article as bellow:

World class manufacturing system is a wave that begins by multi-functional teams and contains concepts of manufacturing design, continuous improvement of the process, total quality management and generalization of quality functions (Shana, 1994).

Jacobsen believes that world class manufacturing is a wide term for various organizational functions such as manufacturing techniques, processes and systems, each of which can cause increase in the company flexibility. He argues that WCM considers technology, process and staff to create flexibility (Haynes, 1999). Voss considers world class manufacturing as the best functions (Voss, 1995). Some organizations can be considered as world class manufacturers, which in addition to having exceptional or beyond expectation performance criteria, can maintain this trend. Charles Ajalla in his article in addition to mentioning the results of establishing world class manufacturing techniques explains them in more details: Increase in the customer service, Increase in annual inventory turnover, Increase in production flexibility, Increase in employee morale, Decrease in inventory investment, Decrease in the space required to produce (Ajalla, 1998).

Wisner and Stanley Fawcett have also listed some features for the world class manufacturing companies:-Paying attention to two powerful forces of global competition (quality and efficiency) - Actively searching for a competition - based systematic and integrated attitude - Emphasis on training and human resource development - Serious pursuit of continuous improvement in product and process at the same time-Paying simultaneous attention to all basic aspects of competition (quality, cost, flexibility, innovation, reliability) -More emphasis on long-term considerations comparing to short-term profitabilities (Wisner and Fawcett, 1991).

2. 1.1 Key elements of world-class manufacturers

Hayes, Wheelwright and Clark have listed the key elements for world class manufacturers as bellow: - Being the best competitor: being better than other countries in that industry at least in one aspect of production - Rapid growth and high profitability comparing to the rivals: such superiority is evaluated through market and liquidity conditions - Recruit and maintenance of the best workforce: maintenance of expert and effective staff and managers, so that other organizations try to attract them - Ability to rapidly and firmly react to the market changes - Adjusting the engineering attitude of the process and the product so that optimize the performance

(Hayes et.al, 1988). Hayes and Wheelwright also express aspects of the world class manufacturing system as bellow: - Capabilities and skills of workforce - Management competency - Workforce cooperation - Competitiveness in terms of quality - Re-engineering the production - Methods of continuous improvement (Salaheldin, 2007).

When an organization achieves the world class manufacturing step that can create its production capabilities and capacities in order to achieve a sustained and unique competitive advantage such as competitive advantage in cost, quality, goods delivery, flexibility and innovation . The world class manufacturers continue their production in such a way that always are protected by outside environment and are always looking to optimize their equipment and manpower. In these organizations modeling the rival and analyzing them is of great importance. Of the key features of world class manufacturers is the ability of adapting to the changes customer and market needs. The managers in the world class organizations always precede changes and move ahead of them. World class manufacturing is a philosophy applied to achieve the world class manufacturing situation. The nature of WCM is continuous and timely improvement of the organization's various resources in order to achieve the best.

2.2. Analytic hierarchy process (AHP)

The AHP methodology, which was developed by Saaty (1980), is a powerful tool in solving complex decision problems.AHP integrates experts' opinions and evaluation scores, and devises the complex decision-making system into a simple elementary hierarchy system. The evaluation method in terms of ratio scale is then employed to perform relative importance pair-wise comparison among every criterion. This method decomposes complicated problems from higher hierarchies to lower ones. In the AHP approach, the decision problem is structured hierarchically at different levels with each level consisting of a finite number of decision elements. The upper level of the hierarchy represents the overall goal, while the lower level consists of all possible alternatives. One or more intermediate levels embody the decision criteria and sub-criteria (Partovi, 1994).Through AHP, the importance of several attributes is obtained from a process of paired comparison, in which the relevance of the attributes or categories of drivers of intangible assets are matched two-on-two in a hierarchic structure.

2.2.1 Establishing fuzzy number

To deal with vagueness of human thought, Zadeh (1965) first introduced the fuzzy set theory, which was oriented to the rationality of uncertainty due to imprecision or vagueness. A major contribution of fuzzy set theory is its capability of representing vague data. The theory also allows mathematical operators and programming to apply to the fuzzy domain. A fuzzy set is a class of objects with a continuum of grades of membership.

The mathematics concept borrowed from Hsieh, Lu, and Tzeng (2004) and Liou et al. (2007).
A fuzzy number Ã on R to be a TFN if its membership function is $\mu_{\tilde{A}}(x)$: R→ [0, 1] is equal to following Eq. (1):

$$\mu_{\tilde{A}}(x) = \begin{cases} \dfrac{(x-a)}{(b-a)} & a \le x \le b \\ \dfrac{(c-x)}{(c-b)} & b \le x \le c \\ 0 & otherwise \end{cases} \qquad (1)$$

From Eq. (1), l and u mean the lower and upper bounds of the fuzzy number Ã, and m is the modal value for Ã (as Fig. 1). The TFN can be denoted by Ã= (a, b, c).

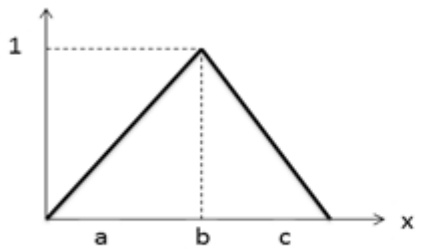

Fig. 1. The membership functions of the triangular fuzzy number.

2.2.2. Determining the linguistic variables
Generally, the decision-making problem is made under uncertainties, vagueness, fuzziness, risk, time pressure and some information is incomplete or missing. For example, it is difficult for decision makers to give an exact value to express their opinion on a company's capability. They prefer to describe their feeling in the fuzzy term. The triangular fuzzy number is the simplest fuzzy number and is used most frequently for expressing linguistic terms in research (Chen, 2000; Deng, 2006).

An appropriate linguistic variable set can help decision makers to give right judgments on decisions.

Here, we use this kind of expression to evaluation dimension by seven basic linguistic terms, as ''Very important,'' ''important,'' ''Relatively important,'' ''Medium,'' ''Relatively low importance,'' ''low importance,'' and ''Unimportant,'' with respect to a fuzzy seven level scale. Here, each membership function (scale of fuzzy number) is defined by three parameters of the symmetric triangular fuzzy number, the left point, middle point, and right point of the range over which the function is defined.

Table 1. Membership functions of linguistic scale (example).

Linguistic	**Scale of fuzzy number**
Very important	(0.9, 1,1)
important	(0.7, 0.9,1)
Relatively important	(0.5, 0.7,0.9)
Medium	(0.3, 0.5,0.7)
Relatively low importance	(0.1, 0.3,0.5)
low importance	(0,0.1,0.3)
Unimportant	(0, 0,0.1)

2.2.3. Change of Fuzzy numbers to crisp numbers
Fuzzy theory has been widely used for assisting in decision making where fuzziness exists in defining variables (Feng and Xu, 1999; Tah and Carr, 2000; Seo et al., 2004).

The result of fuzzy polls for each criterion is a fuzzy number. Therefore, it's necessary to change the resulted fuzzy numbers to crisp numbers. The method used for Change of Fuzzy numbers to crisp numbers in this article is known as mark the distance method shown in the following equation: (Sheng et.al .2002).

$$M = \frac{2b + c + a}{4}$$

2.3 Research questions
1-What are the obstacles of implementing of World Class Manufacturing system in Iranians Companies?
2- How is Priority of obstacles of implementing of World Class Manufacturing system in Iranians Companies?

3. RESEARCH METHODOLOGY
Given the goal of this research that is identify and ranking obstacles in implementation of world class manufacturing system, this is done in two stages. In first stage, the researcher tries to recognize the obstacles of implementing WCM, which is done through library studies, design and distribution of questionnaire and also interview with different manufacturing companies' experts, during which factors affecting WCM system implementation is classified into 4 major criteria and 21 minor criteria, according which the decision tree hierarchy (Fig 2) is designed. In second stage, the researcher makes fuzzy decisions matrix in order to ranking the recognized criteria, whose entries are all fuzzy data. In order to gather these data, another questionnaire is designed and distributed among 12 experts in appliance industry. In this questionnaire experts are asked to express their opinions due to variable linguistic terms and their triangle fuzzy numbers.

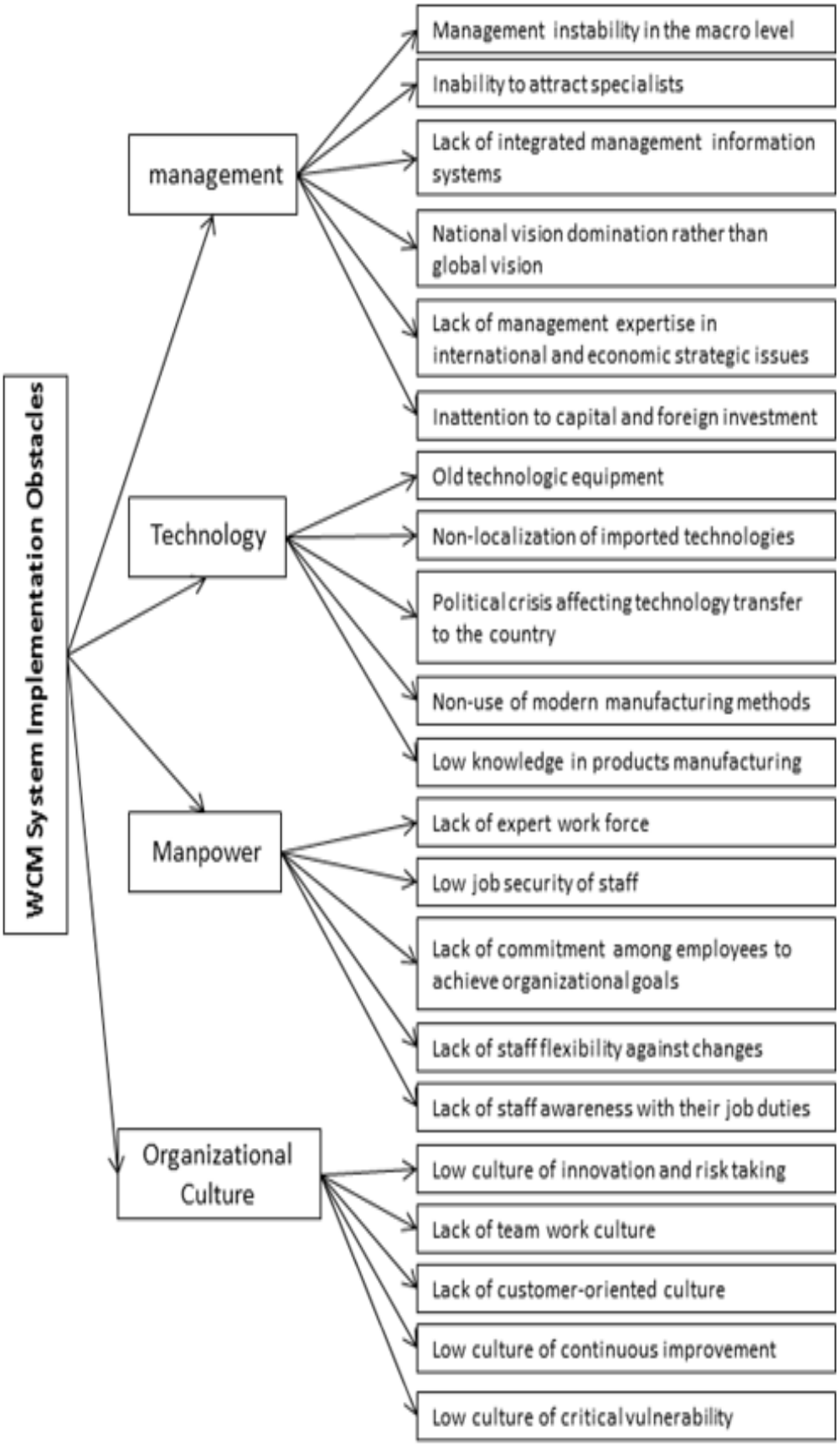

Fig2. WCM system implementation criteria and indices

4. DATA ANALYSIS TECHNIQUES

FAHP Process was applied for data analysis. Based on the achieved criteria in the current research, the decision tree hierarchy was drawn in 3 levels and shown in figure 2. Also after completion of the questionnaire No. 2, its data was first de-fuzzy and people's opinions were then integrated using Expert Choice Software. This software includes wide range of facilities for obtaining people's paired comparisons matrix and then integration of different people's matrices and making a single matrix. EC Software was also used to achieve relative weight and final criteria and final ranking of WCM system.

4.1 Data analysis

Here, the data achieved from Analytical Hierarchy Process (FAHP) are depicted in the form of the following tables, in order to answer the second question the research:

Table 2: relative and total weight of four main criteria

criteria	relative weight	total weight	rank
Management	0.365	0.365	1
technology	0.194	0.194	3
Manpower	0.258	0.258	2
Organizational culture	0.183	0.183	4

According to the results, experts believe that the most important factor affecting world class manufacturing system implementation is management, whose total weight is 0.365. Manpower is the second obstacle on WCM system implementation. And it is shown in table 2, technology with total weight of 0.194 and organizational culture with total weight of 0.183 are known as the third and the forth obstacles from experts' point of view.

Table 3: relative and total weights of management sub-criteria

sub-criteria	relative weight	total weight	rank
Management instability in the macro level	0.198	0.0723	4
Inability to attract specialists	0.157	0.0573	7
Lack of integrated management information systems	0.132	0.0482	11
National vision domination rather than global vision	0.227	0.0828	1
Lack of management expertise in international and economic strategic issues	0.192	0.0701	5
Inattention to capital and foreign investment	0.094	0.0343	13

According to the results, the most important minor criterion in management subsidiary is National vision domination rather than global vision. Management instability in the macro level is also an important obstacle on WCM system implementation in Iran Appliance industry. According to the experts, among management subdivisions, Inattention to capital and foreign investment is of less importance comparing to other subdivisions.

Table 4: Relative and total weight of technology sub-criteria

sub-criteria	relative weight	total weight	rank
Old technologic equipment	0.354	0.0687	6
Non-localization of imported technologies	0.158	0.0306	16
Political crisis affecting technology transfer to the country	0.103	0.02	20
Non-use of modern manufacturing methods	0.288	0.0559	8
Low knowledge in products manufacturing	0.097	0.0188	21

In sub-criteria of technology, Old technologic equipment and Non-use of modern manufacturing methods are known as the most important obstacles affecting WCM system implementation. According to the experts, Political crisis affecting technology transfer to the country and Low knowledge in products manufacturing are of less importance.

Table 5: Relative and total weight of manpower sub-criteria

sub-criteria	relative weight	total weight	rank
Lack of expert work force	0.127	0.0328	15
Low job security of staff	0.132	0.0341	14
Lack of commitment among employees to achieve organizational goals	0.315	0.0813	2
Lack of staff flexibility against changes	0.211	0.0544	10
Lack of staff awareness with their job duties	0.215	0.0554	9

According to the experts, Lack of commitment among employees to achieve organizational goals is of most important obstacles implementing WCM system. This factor among 21 obstacles has the second rank with weight of 0.0813. Besides, the experts don't actually believe in Lack of expert work force in companies and this factor has the less rank among manpower sub-criteria. In other word, experts believe that there is specialized work force in the country but organizations should increase organizational commitments using material and spiritual motivational tools.

Table 6: Relative and total weight of organizational culture sub-criteria

sub-criteria	relative weight	total weight	rank
Low culture of innovation and risk taking	0.403	0.0737	3
Lack of team work culture	0.116	0.0212	19
Lack of customer-oriented culture	0.214	0.0392	12
Low culture of continuous improvement	0.143	0.0262	17
Low culture of critical vulnerability	0.124	0.0227	18

The results show that Low culture of innovation and risk taking is of the most important obstacles in WCM system implementation in appliance industry. Besides, according to experts, Lack of customer-oriented culture is also an important obstacle.

For better understanding of ranking the obstacles on WCM system implementation, four main criteria and known 21 criteria along with their relative and total weights are depicted in table 6.

Table 7: ranking the obstacles on WCM system implementation

main criteria	Weight of the main criteria	sub-criteria	Weigh criteria in sub group	total weight	rank
management	0.365	Management instability in the macro level	0.198	0.0723	4
		Inability to attract specialists	0.157	0.0573	7
		Lack of integrated management information systems	0.132	0.0482	11
		National vision domination rather than global vision	0.227	0.0828	1
		Lack of management expertise in international and economic strategic issues	0.192	0.0701	5
		Inattention to capital and foreign investment	0.094	0.0343	13
technology	0.194	Old technologic equipment	0.354	0.0687	6
		Non-localization of imported technologies	0.158	0.0306	16
		Political crisis affecting technology transfer to the country	0.103	0.02	20
		Non-use of modern manufacturing methods	0.288	0.0559	8
		Low knowledge in products manufacturing	0.097	0.0188	21
manpower	0.258	Lack of expert work force	0.127	0.0328	15
		Low job security of staff	0.132	0.0341	14
		Lack of commitment among employees to achieve organizational goals	0.315	0.0813	2
		Lack of staff flexibility against changes	0.211	0.0544	10
		Lack of staff awareness with their job duties	0.215	0.0554	9
Organizational culture	0.183	Low culture of innovation and risk taking	0.403	0.0737	3
		Lack of team work culture	0.116	0.0212	19
		Lack of customer-oriented culture	0.214	0.0392	12
		Low culture of continuous improvement	0.143	0.0262	17
		Low culture of critical vulnerability	0.124	0.0227	18

5. CONCLUSION

The research results show that among main recognized criteria for implementation of WCM system, management, manpower, technology and organizational culture are respectively ranked as the most important obstacles on WCM system implementation in Iran appliance manufacturing companies. According to experts also, among 21 recognized sub-criteria, obstacles such as National vision domination rather than global vision, Lack of commitment among employees to achieve organizational goals, Low culture of innovation and risk taking, Management instability in the macro level, Lack of management expertise in international and economic

strategic issues and Old technologic equipment are respectively known as important obstacles of WCM system implementation and are of higher priority and importance in Iranian companies.

Therefore, as long as companies' managers have national vision and believe that they have relatively good positions in the country and so don't have any program for global market (global vision), they won't implement WCM system in the country. Therefore it is recommended that if managers have global vision and want to have a successful presence in global markets, they can apply systems such as Total Quality Management, Just in Time production, lean production, comprehensive repair and maintenance, poka yoke, six sigma and etc. to pave the way for implementation of WCM system. The required background for WCM system implementation is high organizational commitment among staff. Lack of staff commitment in Iranian companies prevents implementing this system. Therefore, it is recommended that companies try to create high organizational commitment among their staff to pave the way for WCM system implementation.

Innovation among staff is one of the important features in WCM companies. Today, the organization with no innovation, don't have any place among WCM companies. Therefore, due to the fact that Iranian companies have lack of innovation, it is recommended that the companies step toward innovation culture enhancement and pave the way for WCM implementation using various techniques such as paying attention to knowledge management and material and spiritual stimulations.

Of other important problems in Iranian companies is management instability in macro level, which is not consistent with world class manufacturing philosophy at all and its main reason is maybe because most manufacturing companies in Iran are governmental and managers are appointed by government. Therefore, it is recommended that companies active in appliance industry move toward privatization and pave the way for world class manufacturing system implementation by choosing qualified and competence managers.

REFERENCES

Ajalla, Charles, (1998), wasteful practices: Handicaps to JIT process, Industrial Engineering.

Chen, C.T. (2000), Extensions of the TOPSIS for group decision-making under fuzzy environment, Fuzzy Sets and Systems, Vol. 114 No. 1, pp. 1-9.

Deng, Y. (2006), "Plant location selection based on fuzzy TOPSIS", International Journal of Advanced Manufacturing Technology, Vol. 28 Nos 7-8, pp. 839-44.

Falah, K.L, Zairi, M. and Ahmed, A.M (1998), The role of supply- chain management in world class manufacturing, International Journal of Physical Distribution and Logistics Management,Vol.33 No.5,pp396-407.

Feng, S. and Xu, L.D. (1999), Decision support for fuzzy comprehensive evaluation of urban development, Fuzzy Sets and Systems, Vol. 105 No. 1, pp. 1-12.

Hayes, R.H. Wheelwright S.C, and Clark, K, (1988) Dynamic manufacturing: Creating the Learning organization, The Free Press NY.

Haynes, A. (1999), Effect of World class manufacturing on shop floor workers, Journal of European industrial Training, pp300-309.

Hsieh, T.-Y., Lu, S.-T., & Tzeng, G.-H . (2004). Fuzzy MCDM approach for planning and 751 design tenders selection in public office buildings. International Journal of Project Management , 22(7), pp.573–584.

Kodali, R. and K.S. Sang wan, (2004), Performance value analysis foe the justification of world class manufacturing system, Journal of Advanced Manufacturing Systems, Vol. 3 No.1, pp. 85-102.

Liou, J.-J.-H., Yen, L., & Tzeng, G.-H. (2007). Building an effective safety management system for airlines. Journal of Air Transport Management, 14(1), pp. 20–26.

Partovi, F.Y. (1994), "Determining what to benchmark: an analytic hierarchy process approach", International Journal of Operations & Production Management., Vol. 14 No. 6, pp. 25-39.

Saaty, T.L. (1980), the Analytical Hierarchy Process, McGraw-Hill, New York, NY.

Salaheldin, S.I (2007), The Implementation of world class manufacturing techniques in Egyptian manufacturing firms, Journal of industrial management and data systems, Vol. 107No. 4, pp.551-566

Schonberger, R.J. (1996) World class manufacturing the next decade .

Seo, S., Aramaki, T., Hwang, Y.W. and Hanaki, K. (2004), Fuzzy decision-making tool for environmental sustainable buildings, Journal of Construction Engineering and Management, Vol. 130 No. 3, pp. 415-23.

Shana, g. Sumy, (1994), new rules for world class companies, IEEE spectrum, July.

Sheng- H shiung Tscuur, Te- Yi change, change- Huayen. (2002). the evaluation of airline service quality by fuzzy MCDM, Tourism management, vol. 23, pp: 107-115

Tah, J.H.M. and Carr, V. (2000), A proposal for construction project risk assessment using fuzzy logic, Construction Management and Economics, Vol. 18 No. 4, pp. 491-500.

Voss, C. A (1995), Alternative paradigms for manufacturing strategy, Journal of Operation and Production Management, Vol. 15 No 4, pp. 5-16.

Wisner, D, Joel, Fawcett, E, Stanley, (1991), Linking firm strategy to operation decision through performance measurement, production and inventory management journal, third quarter.

Zadeh, L. A. (1965). Fuzzy sets. Information and Control , 8(3), pp.338–353.