

## Review and Discussion of Theories related to Dynamic Model of World Class Manufacturing Strategy

Seyed Mohammad Seyedhosseini<sup>1</sup>, Alireza Soloukdar<sup>2\*</sup>

<sup>1,2\*</sup>Department of Industrial Management, Science and Research Branch, Islamic Azad University, Tehran, Iran  
[a\\_soloukdar@hotmail.com](mailto:a_soloukdar@hotmail.com)

**Abstract:** World Class Manufacturing (WCM) has attracted so much manufacturing industries and operation strategists' attention. The expansion of this issue gets back to using "Best Techniques" of the companies with "Best Performance". In this study, we have addressed the lack of identifying WCM factors by using several different criteria and test of the relations between techniques and WCM performance. Studying different perspectives for acquiring a dynamic model which is capable of covering all aspects and primary/secondary factors including the internal and external ones, strategies, objectives and policies is highly important. Therefore, determining the relations between mentioned factors can bring about a systemic enterprise which helps identify the World Class Manufacturing level of performance status and devising an appropriate mental/conceptual model in a way that it involves the effective leading causes and factors is the initial stage of implementation and institutionalization of a dynamic model. In this paper by reviewing sources, viewpoints, definitions, attitudes, and WCM causes and factors, the research carried out in this regard, the conceptual model and WCM dynamic elements and the relations between them have been discussed. Finally, the dynamic model conceptual model of WCM strategy is presented.

[Mohammad Seyedhosseini, Alireza Soloukdar, **Review and Discussion of Theories related to Dynamic Model of World Class Manufacturing Strategy**, Journal of American Science 2011;7(7):890-896]. (ISSN: 1545-1003).  
<http://www.americanscience.org>.

**Keywords:** Dynamic Model, World Class Manufacturing, Strategy, Conceptual Paradigm.

### 1. Introduction

Today, to achieve world class manufacturing (WCM), any producer shall have superior performance in terms of competition major criteria (quality, price, prompt delivery, reliable delivery, flexibility and innovation). Such an organization should increase its own performance with respect to the aforementioned yardsticks for the purpose of enhancing its compatibility.

Some scholars maintain that a plant considered being of WCM provided that its maximum production capacity. Other suggests that high quantity in production together with high quality signify a manufacturing division of WCM. Having two dynamic and pro-active strategies (one for currently area and the other one for the future) has been regarded the dominant characteristic of a world class organization in some other specialists' viewpoint. Yet there some commentators who look at this subject matter from a competition-oriented perspective, that of client's or consumers, in order to establish a WCM and specify the features of such an organization. Some authors have been studying the internal functioning factors and have outlined the definition for WCM. Nonetheless, another group of professionals have taken into account the external factors with respect to the point, as well. By virtue of such diverse outlooks, we reach the conclusion that WCM is actually a status which any given organization seeks to protect (Nouri & Asgari, 2004).

"World class manufacturing" was first used by Hayes and Wheelwright (1985) for the purpose of describing an organization that has managed to achieve competition superiority through exploitation of their production capabilities serving as strategic weapons. Schonberger (1986) interestingly compared "world class manufacturing" with the Olympics games motto: faster, higher and stronger. Its equivalent is continuous and rapid improvement where we are concerned with WCM. WCM as a general expression has been defined to cover several specific production processes and organization strategies whose main objective has been determined to be flexibility. Womack and others (1990) presented a method for measuring and defining WCM. Furthermore, they proposed lean production which operates economically in all respects, in other words half the workforce at the plant, half the production space, half the investment in tools, and half the working hours allocated to develop a new product by the relevant engineers.

### Literature Review

Grobler (2005) were discussed four capabilities: cost, quality, delivery, and flexibility and he illustrated the relationship between these four factors and causes on the basis of flow and stock model, supportive a preventive priorities in a direct or an indirect manner. Descriptive model of system dynamic examines the strengths (capabilities) general rule, hence through development of the model, experimentation and simulation we can test the

dynamic conditions, and moreover the short term situation and various policies can be tested by it, as well. The model potential improvement involves quantifying some specific parameters. The flaw and weak point of mentioned study are that the model in the presently status does not reflect the integrity of qualifications and outlet and this model is definitely an ideal for operations management, but it has not demonstrated the important relations between this model and capabilities and other secondary departments of organization and the way they affect each other.

Wang (2001) has studied the experimental relationship between WCM techniques and performance, and he sought a measuring model for WCM techniques and performance. Moreover, through making use of efficiency analysis and one-directional, multidirectional and variance analysis statistics method (ANOVA). He examined hypotheses and analyzed efficiency. Due to the fact that Wang's study lacks nonlinear and multi causal relations and dealing with statistical correlation causal relations, it can not account for balanced and nonlinear feedback structures of WCM model and its occlusions are provisional and ephemeral.

Bueno (2005) presented a practical model of macro economy which demonstrated the economy changes and fluctuations responding to stability policy by using system dynamic method, and he also demonstrated the time delays in the industry provision and supply division. He concluded that system dynamic together with control theory denote a modern language. Mentioned investigation is very useful in terms of a study conducted in the area of economy, but no studies have been carried out regarding establishing links with other fields of economy sub divisions and their particulars, thus by expanding this model and relating it to different levels it can turn into a comprehensive and realistic model of an economic system.

Rydzak & et al (2004) teaches the way system dynamic method can be configured with balanced scorecard and its application. Moreover, he has provided an example of cause effect and stock & flow charts concerning six sets of machines, production/inventory, material/workforce productivity and market at IBM Corporation. This investigation disadvantage is that it simply delves into the categories of studies, concepts and has not reached the execution and simulation stages in a way that the model's validation and verification would be secured and by taking use of analysis tool the reliability and validity of the model at all levels could be checked upon.

Muda and Hendry (2002) constructed a new model of WCM for production upon order division. The objective of this study was to bridge the gap between companies in terms of reaching global level or

determining their strong points and making some revisions in the 16 principles already stipulated by Schonberger. Its investigation method has been in the form of case study and comparing the companies' causes and principles. This study involves a conceptual model of establishment stages and suggests the relevant principles for companies which apply customization system, yet it illustrates the companies' problems and difficulties with regard to attainment of WCM or explains the changes of concerned rivals, customers, time and etc. And it is devoid of deep knowledge about the dynamic model out of organizational changes and can not be considered a yardstick for analyzing and examining the policies based upon mathematical relations.

Shabahang and Ebrahimi (2005) presented a model for designing the balanced scorecard performance evaluation comprehensive model. They eventually checked upon the four separate aspects of balanced evaluation (financial, customer, internal processes, growth and learning) in the form of hypothesis and quantitative data and results obtained denote that there is a significantly relationship between most components of growth/learning facet and internal processes, on one hand and between the internal process facet and that of the customer's and between the customer facet and that of the financial facets, on the other hand). This work, from the perspective of testing the relations between dimensions and levels, is a good study and enhances the authenticity and validity of balanced evaluation model but it has not examined the various causal and multiple feedback relations existing in each of the realms by the help of WCM elements and causes and just indicates a one directional relationship (logic of cause & effect), whereas most strategies perceptive factors influence each other in feedback circle pattern. Furthermore, simple balanced evaluation without taking into account system dynamic might lead to incorrect and misleading conclusions with regard to strategic intuition effect since the delays and dynamic major factors in each certain environment has not been accounted for. And due to its sustainable nature, the mapping system is not capable of answering questions such as "what will happen if".

Kodali and Sangwan (2004) have dealt with measuring factors and values of WCM performance in India's industries and by the help of PVA algorithm the assessed indicators/criteria/quantitative and qualitative of the gap and distance between the presently level and the ideal. Kodali's study weak point is like that of the previous one's. In other words, this investigation is a kind of identification behaviors such as experiences and historical trends and it is incapable of responding and reacting to the thoroughly new circumstances and policies. In this study the issue of presently knowledge is considered the knowledge of a temporal and

ephemeral nature and rapid changes in factors/criteria may dissect the previous existing sustainable and trust-worthy correlation between the variables. Therefore, having a vantage point and system causal method is definitely very much important for getting to know the actual system.

Todd and Palmer (2001) focused on designing and developing a "dynamic" measuring system and explore some of the current factors in this regard. This model, In particular, through a case study in a governmental department in newzland executed three stages of pre-designing, designing and post-designing and presented the stock & flow for four outlooks: finance, customer, internal process and growth/learning. In this mentioned study, WCM factors and criteria at any given organization can be added to the model and in accordance with the WCM yardsticks and elements and organizational problems at any of those four spheres we can further contribute to the model comprehensiveness, and its becoming realistic in terms of demonstrating the system structure and behavior and through getting it balance embark on analyzing the governmental strategies.

Kim et al (2006) approached the construction of a model that could be compatible with dynamic balanced scorecard dedicated to the governmental organizations and by introducing the system dynamic method concentrated on cause & effect relations and interactions between key indicators and accounting for feedback time delays by means of the new policy and its changes. This investigation is the basis for identification of the constituents complexity conceptually and the cause & effect structure. By virtue of further research the detailed and nuanced particulars of factors and indicators can be incorporated and demonstrated in the sphere of flow – aggregation mathematical charts, structure and behavior. And it should be noted that this study has only recourses to examination of dynamic balanced scorecard structure in the conceptual province.

Steen and Erland Nielson(2006) has analyzed dynamic of balanced scorecard theoretical principles by the help of simulation method and this model comprises five perspectives and several financial and non financial criteria. All the indicators have been defined and are based upon cause & effect relations. The time delays in this study are considered as one of the important characteristics of BSC. And this model has been employed for simulating several different policies and scenarios through passage of time. The obtained results show that at least there are three variables: Skill, primary customer, and workflow which influence the profit in different manners. Advantage of this study is that the concerned model requires further development and expansion so as to provide adequate coverage for balanced evaluation and

all of its levels. And the effects of other variables of importance in a real organization should be also examined at other levels so that the model can get into the organization's problem and its difficulty as much as possible.

### **WCM Strategy Key Elements**

The manufacturing management's perspective, the strategic capability significantly contributes to the companies' success in terms of competition. In other words, supporting the institution strategy and helping its improvement and accomplishment in the target market is the strength and power of an enterprise. Development, cultivation and assignment of the strategic capabilities are all the crucial functions of manufacturing strategy. Frequently, this function conflicts with daily affairs handling and difficult activities of the operation management. One of the most renowned authors in this field has discussed four strategic capabilities with regard to operation and productions: Manufacturing ability with lower costs(1), with high quality(2), with assured delivery(3), with flexibility in combining the products and the number of products manufactured(4)(Grobler, 2005).

Behzadian (2000) has specified the key elements and factors of Manufacturing Strategy and WCM performance criteria which are briefly outlined in Table 1.

One of conceptual pattern that exhibits the relation between technique and performance is demonstrated in figure 1. The efficiency indicator has measured the relationship between technique and performance and it is considered to be a medium (Wang, 2001, p. 42).

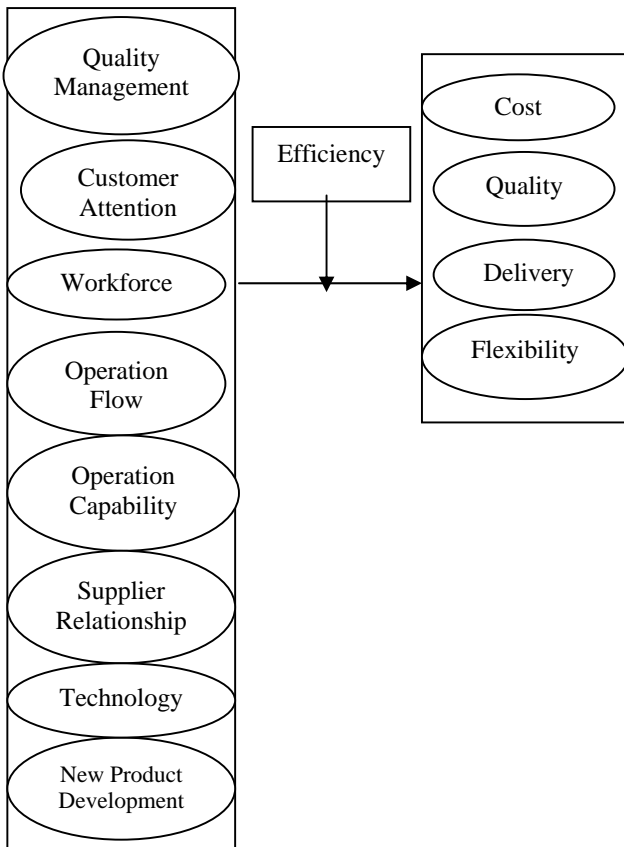
So as example for modeling of dynamic World Class Manufacturing, The factors and variables affecting the demand and market share in Iranian Auto Industry are concisely illustrated in Table 2, in primary and secondary parts of a dynamic and BSC and by including the factors of WCM.

### **Model Conceptualization**

After recognizing system Boundaries and identifying endogenous and exogenous factors in the four levels of customer, learning and growth, internal processes and finance, a unified and comprehensive model was designed (figure 2) displaying the major and minor factors (model and sub models). Regarding the technological, social, political and economic changes as well as the time changes, the deletion of ineffective factors and addition of effective and important factors are possible in this model. And by setting it in software, the model updating can be possible.

Descriptive model of dynamic systems have the ability to support the capability of general rules; thus, it

can be possible to examine the development of model, the simulation of dynamic conditions, short-term status, and various policies.



Source: Wang, 2001.

Figure 1. The Relation between Technique and performance

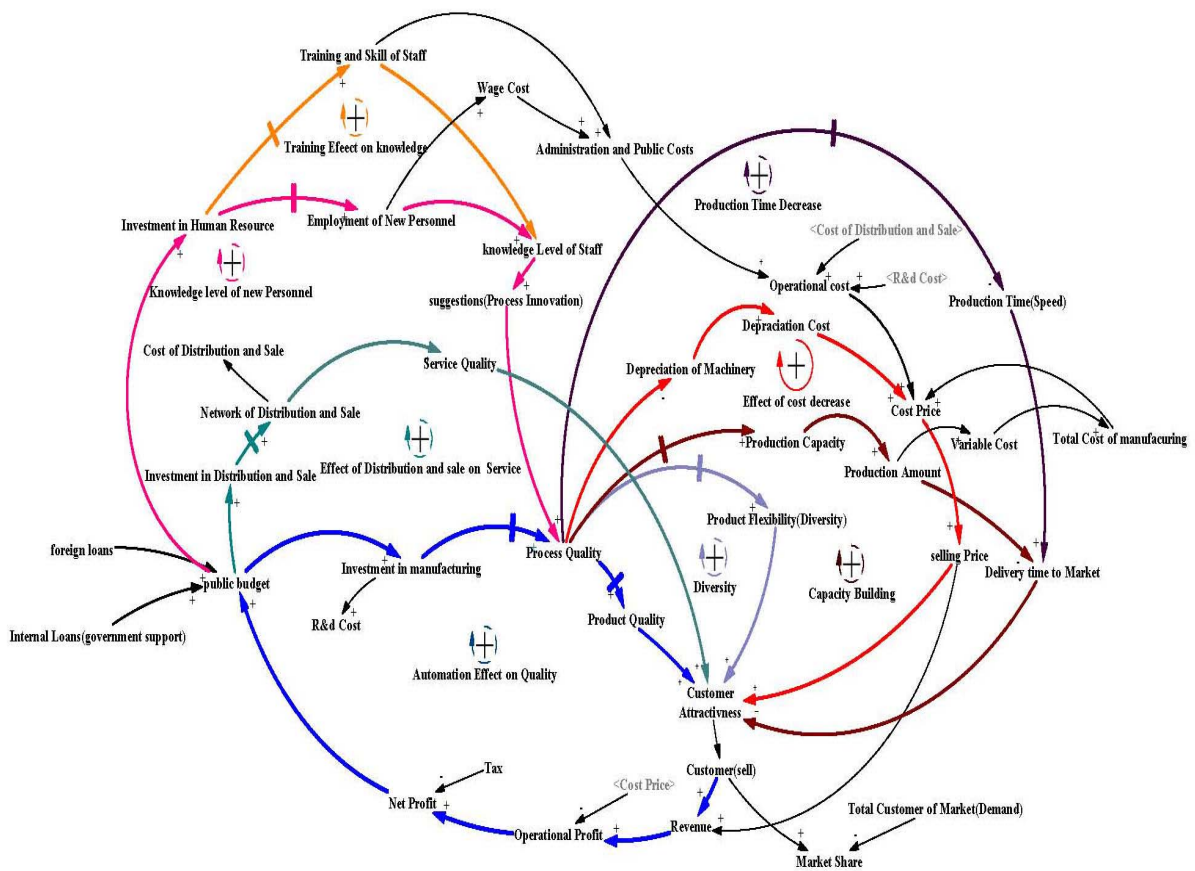
Table 1. Key Elements and Performance Criteria of WCM Strategy

No	Elements	Performance Criteria
1	Manufacturing Cycle Time	-processing time or processes -Transfer time - Line time -Setup Time
2	Flexibility	- Number of different Processes - -Ratio of output to Capacity - Number of New Products - Training grade supplied into market per year - Date of New Product into market -Number of levels in material - Quick response to Flexibility in product design goods delivery - Flexibility in responding to products volume
3	Quality	- Quality of incoming materials - Data quality - Production Quality - Quality cost - Preventive Maintenance plans effectiveness
4	Delivery	-Performance of seller delivery -Production Scheduling - lost sales -level of customer services
5	Workforce Management	-Responsibility Assignment -Training -Workforce Moral -Teamwork
6	Cost	-Ratio of Defects -Turn over -Value-added analysis -Human resource productivity -Cost productivity -Overhead efficiency

**Table 2.** System Boundary and level Relations within Effective Variables.

<b>Levels</b>	<b>Endogenous Variables</b>	<b>Exogenous Variables</b>	<b>Excluded Variables</b>
Customer and Market	<ul style="list-style-type: none"> <li>- Market Share</li> <li>- Customer Satisfaction</li> <li>- Sale Price</li> <li>- Volume of Sales</li> </ul>	<ul style="list-style-type: none"> <li>- Supply</li> <li>- Demand</li> <li>- Domestic Competitors and Import</li> </ul>	<ul style="list-style-type: none"> <li>- Vehicle Price Index</li> <li>- Consumer goods price</li> <li>- Export</li> <li>- The public's Perception</li> <li>- Competitors' Price</li> <li>- competitors' quality</li> <li>- Gasoline Consumption</li> <li>- Gasoline Ration</li> <li>- popularity (brand familiarity)</li> <li>- Volume of advertizing and marketing</li> <li>- Gasoline Import</li> <li>- Average time of retendering vehicles</li> <li>- Environmental rules and principles</li> <li>- Security principles</li> <li>- Air Pollution</li> <li>- Non-oil Goods exports</li> <li>- political threats</li> </ul>
Internal processes (Manufacturing)	<ul style="list-style-type: none"> <li>- Vehicle Replacement rate</li> <li>- Products Lifetime</li> <li>- Inventory</li> <li>- Production Capacity</li> <li>- Delivery Time</li> <li>- Process Quality (Technology and Automation level)</li> <li>- Machinery depreciation</li> <li>- Volume of New Products(Products Diversity and Flexibility)</li> <li>- Products Quality</li> <li>- Production Rate</li> <li>- Operations Time Period (production cycle)</li> </ul>	<ul style="list-style-type: none"> <li>- Cost of a made unit</li> <li>- Products lifetime</li> <li>- Depreciation Rate</li> <li>- Cost of a unit of training</li> <li>- Number of R&amp;D programs</li> <li>- Overhead Cost</li> <li>- Process Quality elevation rate</li> <li>- Rate of Change in Manufacturing Investment</li> </ul>	<ul style="list-style-type: none"> <li>- Project Completion date</li> <li>- Flexibility in the processes (office automation)</li> <li>- work volume in Manufacturing Process</li> <li>- Wastage volume</li> <li>- Gross Domestic product(GDP)</li> <li>- replacement goods conditions (public transportation)</li> </ul>
Learning and Growth	<ul style="list-style-type: none"> <li>- Employees' knowledge level</li> <li>- Number of innovations and recommendations</li> <li>- Labor productivity</li> <li>- Employment</li> </ul>	<ul style="list-style-type: none"> <li>- Level of knowledge and skill</li> <li>- Rate of knowledge loss</li> </ul>	<ul style="list-style-type: none"> <li>- Morality</li> <li>- Labor participation rate</li> <li>- Labor flexibility</li> <li>- Capabilities</li> <li>- Rate of ceded responsibility</li> <li>- Unemployment rate</li> </ul>
Finance	<ul style="list-style-type: none"> <li>- Operating Profit</li> <li>- Net Profit</li> <li>- Revenue</li> <li>- Cost price</li> <li>- Manufacturing costs (wages and materials)</li> <li>- Overhead costs</li> <li>- Operating costs: <ul style="list-style-type: none"> <li>a-general and administrative</li> <li>b- Sales and Distribution</li> <li>c- R&amp;D</li> </ul> </li> <li>- Capital budget</li> <li>- Investment in manufacturing technology</li> <li>- Investment in Human Resource</li> <li>- Investment in sales and distribution networks</li> </ul>	<ul style="list-style-type: none"> <li>- Customs Tariff and Tax</li> <li>- Government Support (domestic loans)</li> <li>- Investment in R&amp;D</li> <li>- Foreign Funds.</li> </ul>	<ul style="list-style-type: none"> <li>- Investment in marketing and advertizing</li> <li>- Stockholders value</li> <li>- Growth of per capita income</li> <li>- People's median income</li> <li>- Vehicle ownership costs (insurance, tax, maintenance, and gasoline)</li> <li>- Inflation rate</li> <li>- Growth of liquidity</li> <li>- Economic Development</li> <li>- Investment in Information Technology</li> </ul>





**Figure 2.** Integrated Model of Dynamic Balanced Scorecard within Causal loop For WCM Strategy

**Conclusion**

With regard of the above mentioned perspectives, it is highly crucial to achieve a dynamic model which can cover all the aspects and major/secondary factors including the internal and external ones, strategies, objectives and policies. Therefore, determination of the above factors can bring about a systematic movement helping specify the performance condition of world class manufacturing. And the execution backdrop and institutionalization of a dynamic model is to design a proper mental and conceptual model in a way that incorporates the effective key factors and causes.

Of course, this is not a static situation but it is a dynamic one meaning that by customers, consumers and rivals changes this very status is constantly transforming. Thus, It can be said that the ideal functional conditions for an organization or world class manufacturing is a target by itself which Is not a static goal but a dynamic one. In other words, this objective constantly gets transformed in line with changes in the conditions of customers and rivals. Mobility and high

level performance of world class organizations compel them to persistently pursue" superior goals" within their real time.

Respecting the fact that there are no particular definitions offered in the various definitions already provided by relevant authors and they have all introduced somehow the new ideas and thoughts about production and the best performance, here through reviewing the available definitions and literature we are present a comprehensive definition for world class manufacturing:

"World Class Manufacturing is an instantaneous, integrated and systemic approach of the WCM factors and elements at Learning and Growth, Internal Processes, Customer, and Finance levels in a way that it becomes capable of responding dynamically to environmental complicated changes and organizational difficulties so that by implementation of this dynamic model and accounting for adjoining time and delay. It can systematically react immediately in the face of

quick changes and attain the best strategies, objectives and competitive advantage at a global scale."

#### Acknowledgements:

Authors thank the Department of strategic studies of Irankhodro Company for their helpful and comments to carry out this work.

#### Corresponding Author:

Alireza Soloukdar

Department of Industrial Management, Science and Research Branch, Islamic Azad University, Tehran, Iran.

E-mail: [a\\_soloukdar@hotmail.com](mailto:a_soloukdar@hotmail.com)

#### References

1. Behzadian M. 2000. Presenting a Model of Balanced Measuring for WCM. M.S Thesis, University of Trabiati Moddares.
2. Bueno N.P. 2005. Stabilization Policy Debate, Control Theory and System Dynamics Methodology. In the Proceedings of the 2005 System Dynamics Conference.
3. Grobler A. 2005. An Exploratory System Dynamics Model of Strategic Manufacturing Capabilities. In the Proceedings of the 2005 System Dynamics Conference.
4. Hayes R. and Wheelwright S. 1985. Restoring our Competitive Edge: Competing through Manufacturing. John Wiley & Sons, New York.
5. Kim et al. 2006. on Building a Dynamic BSC Model for Strategic Performance Measurement in Public Sector. In the Proceedings of the 2006 System Dynamic Conference.
6. Kodali R. and Sangwan K.S. 2004. Performance Value Analysis for the Justification of World Class Manufacturing Systems. Journal of Advanced Manufacturing Systems. 1 (3):85 - 102.
7. Muda S. and Hendry L. 2002. Proposing a World Class Manufacturing Concept for The Make to order Sector. International journal Production & Research. 40 (2):353 - 373.
8. Nielsen S., and Nielsen E. 2006. System Dynamic Modeling for a Balanced Scorecard: With a Special Emphasis on Skills, Customer Base, and WIP, the EAA Annual Congress.
9. Nouri S. and Asgari A. 2004. Insights, Definitions and Specifications of world class manufacturing and presenting a Conceptual model. International Journal of Engineering sciences. 15(15):127-141.
10. Rydzak F. and et al. 2004. Teaching the Dynamic Balanced Scorecard. In the Proceedings of the 2004 System Dynamics Conference.
11. Schonberger R. 1986. World Class Manufacturing: The lessons of simplicity Applied. Free Press, New York.
12. Shabahang R. and Ebrahimi Sarveolia M. H. 2005. Designing and Implementation BSC as Integrated System in Performance Evaluation. Journal of Management and Economic, 16 (67):1-11.
13. Todd D. and Palmer E. 2001. Development and design of Dynamic Balanced Scorecard in local Government, In the Proceedings of the 2001 Operations Management Association & the International Annual Conference.
14. Wisener D. J., Fawcett E. S. 1991. Linking firm Strategy to Operation through Performance Measurement. Production and Inventory Management Journal, Third quarter.
15. Womack J. and Jones D. and Roos D. 1990. The Machine that Changed the World. Rawson Associates, New York.
16. Xinyan W. 2001. A Definition of World Manufacturing and an Empirical Analysis of practice -Performance Relationship in Manufacturing, Ph.D. Thesis, Michigan State University.

**Submission date:** 6/14/2011