Factor Model Proposition of World Class Manufacturing in Brazilian Companies

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Abstract

The present paper aims to develop a modelo of World Class Manufacturing, to achieve this goal was elaborated a questionnaire with 35 assertives divided in 7 areas suggested by literature review. This questionnaire was send to manufacture specialists, product developers and techinician through Linkedin the participants was select by researchers in discussion groups taking in consideration their experience using the professional profile. About 1000 invite was send to professional from metal-mechanic sector which returned 180 valid questionnaries. The data was analised through factor analises and was obtained 7 constructs which explained 67% of data variance. The KMO was 0,84 which is considered good for analyzes purpose. The seventh factor was eliminated because it Cronbach Alpha was below 0,6 and the remained factor was nominated as: Lean Manufacturing, Human Resources Management to achieve flexibility, Marketing Integration, Costs Reduction and Flexibility.

Keywords: World Class Manufacturing, Production, Competitive Edge, Lean Manufacturing, Resource Management

1. INTRODUCTION

The new global competition press the enterprises to reduce cost, improve quality, develop products to achieve high performance, offer a large product portifolio for customers and better services delivering this in dynamically way (DIGALWAR; SANGWAN, 2007).

Because of this enterprises that's desiry position itself globally are intend to become world class manufacturing aiming to delivery the same quality world wide and in this way gain consumers.

However the term world class manufacturing (WCM), but needs one enhance defition because lacks consensus about what is and which enterprises should be considerited World Class Manufacturing. Thus the problem of this research was: Which criteria the manufacturing and product development professionals think about what things defines World Class Manufacturing Enterprises?

The main work objetive was develop a World Class Manufacturing Model using professional opinion about what they consider WCM Enterprises aiming to create foundation model to serve as base to maybe create a certification.

To achieve this objetive was developed a literature review in chapter 2 aiming to understand the state of art about this theme, the methodological procedures was explained in chapter 3, the data and research report was presented in chapter 4 and concluding remarks was presented in chapter 5.

2. LITERATURE REVIEW

The consumer globalization drive the enterprises to a global competition which causes changes in consumer behaviors and affects the way which products and services are manufactured. That's situation is influenced by ICTs (Information and Comunication Tecnhologies) which makes the transactions and global cooperation easier than ever improving the conscious about manufacturing condition and process regulation world wide. Nevertheless the global action leverage a competitive advantage is consensus among big players.

Therefore for enterprises take competitive advantage over their concurrents the enterprises starting to use a production system aiming to became World Class, thus the WCM methodology is based in building a global competitive advantage raising the profits in International Competitive Advantage (HOSSEINE *et al.*, 2012; MURINO *et al.*, 2012).

The literature about this topic revels that's there isn't a universal agreed definition about WCM (KODALI *et al.*, 2004; MASKELL, 1992; DIGALWAR; SANGWAN, 2007). The term was used by Hayes and Wheelright (1984) to describe organizations that uses their capability to produzi through a global production system building a global competitive strategy.

Shonberger defined the benefits sought by WCM compared as the Olympic Games because the athetes works are guided by the motto "Citius, altius, fortius", which can be translated as "faster, bigger and stronger". Therefore the WCM adopts continuous improvement approach which consists in changes in a lot of organizations are such as: quality management, work relationships improvements, support and training, improves in relations with suppliers and customers, inventory programming and management, equipaments maintance, process automation with information technology among other things (SCHONBERGER, 2008; LIND, 2001; DIGALWAR; SANGWAN, 2007).

Some benefits that's WCM can provides for one organization that's uses WCM are: profit improvement, new manufacturing programs, alignment with customer needs, suppliers reducement, reduction in production costs, inovation, improvemnt using metrics to mesure performance etc (HOSSEINE *et al.*, 2012; FORTUNATO, 2007; MURINO, 2012; JUSKO, 2013).

Therefore the WCM approach becomes a critic factor for the enterprises competitivity because promotes the hability for change faster through the flexibility aiming to achieve the Market and customer needs. This requirement is nowadays necessary due the way globalization affects all kinds of enterprises (FORTUNATO, 2009; GAJDZIK, 2013).

Thus an industry that's keeps the mass product caracteristics and traditional practices can't follow the changes and global demands. The WCM approach presents a set of practices and metholodologies aiming to achieve customers needs while keep the quality patterns and control production costs.

Normally WCM enterprises have the following characteristics: emphazises the strategic thinking instead short term profits; have systematic domain about global competition such as: quality, costs and flexibility; managerial attitude toward customer needs; better performance in profits compared to their competitors; quick reaction for changes at external environment; eliminates the unecessary process; have a good information system; have a culture of innovation and quality; have self-suficients employes performing efficient maintenance and system corrections (HOSSEINE *et al.* 2012; SCHONBERGER, 2008).

The WCM is strongly related to Lean Manufacturing concept because have focus on waste reduction too. However the WCM adds a new paradigm which are have focus on customer needs faster as possible to fit the quick changes that's happens in market with regard in preferences and produced volumes (GORIWONDO; MHLANGA; MUTSAMBWA, 2013).

Wu, Melnik and Swin (2012) advocte the use of operational practices to enterprises achieve the WCM concept such practices include specific procedures, new organizational arrangements, protocols, tools, techniques and other way to do organizational things. For example to improve quality for example you can use learning process and knowledge creation concepts.

The same authors analyzes the aspects relateds to WCM using studies about the more commom organizational practices used by organizations and this one are:

- Quality Management Practices;
- Just in Time Practices;
- Customer Orientation Practices;
- Supplier Relationship Management;
- Integrated Product Development Practices;
- Employees Development Practices;
- Leadership Practices.

Thus these set of practices contributes to create a new work form building a competitive diferential for entrerprises that's apply these practices in organizational life. Furthermore a new dimension is added to enterprises which desire to become WCM enterprises and this dimension is environmental practices and accord Pinheiro et al, (2012) theses practices promotes a rupture in the way the organizations think, and act before society.

Thus enterprises that's wants to build long term competitive advantages are seeking to develop WCM practices while at same time are tryng to atualize them to the new values demanded by the society such as environmental management. However this reality is relatively new for academic research and in the management field but is becoming one important ruling for discussion.

Many researchs about WCM was done as for example Goriwond, Mhlandga and Mutsambwa (2013) develop with some enterprises from Zimbabwe, Murino (2012) developed in one automotive supplier in 150 countries, Mey (2011) developed in Aceloer Mitall among others and the main aiming was undertand the process and benefits obtained by the product changes can take to enterprises. Stands out the study about the WCM 12 critical factors and 73 performance variables developed by Ghadikolei et al. (2011), this study was based in one similar study which compared one Iranian automotive enterprise and a Indian automotive enterprise.

By the way when the WCM are treated is applicable to highlight the metodologies applieds in production system area in last two decades, with this in mind Furlan, Vinelli and Pont (2011) studied the complementarity between the two main production system metodologies which are Just-in-Time(JIT) and Total Quality Management (TQM). The main contribution of this study is the idea that lean product in the ideal setting to WCM because the complementarity integrates a lot of sociotechincal practices aiming to eliminate the wastes through a supplie chain long link in the enterprise (FURLAN; VINELLI; PONT, 2011; FUENTES; DÍAZ, 2012).

The Kedia, Gaffney and Clampit (2013) studies can help the organizations to create a knowledge management structure aiming to evaluate the application maturity of practices

comented before enabling the managers analyze which practices fit better to enterprises and to create this mecanism they can use mesurement tools such BSC, KPI, CMM such suggested Konsta and Plomaritou (2012) because this approachs become popular during the last twenty years. This practices are related to WCM model and aim to create a conceptual model about this practice.

However Muda, Rahman and Hassan (2013) alerts to the fact that many studies about WCM studied the make-to-stock enterprises and in this way its necessary develops researchs using enterprises that use make-to-order approach because this kind of metholody uses Just in time and Lean Manufacturing Concept which are integrated parts of WCM methodology.

This aspect can be found in Lin, Ma and Zhou study that analyze the Chinese Enterprise that produce buses performance whose sucess isn't determined by high productivity and low price but by the quick response to customers through the integration and modularity logic and process otimization. These practices are coming from MTO concept, Lean Manufacturing and Just-in-Time practices that turned these enteprises manufacturing WCM system.

These definitions corroborates with that pointed by Harrison (1998) in his research where was found the practices related to WCM: Quality Management, Lean Production, Logistics, Organization and Culture, Manufacture Systems and Concurrent Engineering and the factor that's enterprises which achive 80% score in practices and 80% in performance are considerad as WCM enterprises.

3. **METHODS**

The paper methodological procedures aiming to get the specialists opinion about WCM (World Class Manufacturning) methodology definitions. The study justification is because this methodology need to explored more more consolitdate aiming to become a managerial practice because this reason a descritive research method was choosed. This kind of research can be used to answer questions about variable relations including cause and effect model (MALHOTRA, 2006; SELLTIZ *et al.,* 1987). The participant's interrogation was done through questionnaires with questions about motivation and characteristics.

The paper was developed through a transversal survey because in this type of research the questionnarie is applied once time for a population sample (BABBIE, 1999). Kerling (2007) explains that in survey small and big populations are studied through sample to discover the incidence variable relative incidence, variable distribution and variable interrelations.

To make the interrogation the respondents were used a questionnaire with closed questions based on seven points Likert scale.The Likert scale is one scale type which demands the respondents to indicate the agreement or disagree degree in a serie of afirmatives and normally this one has five answer category through totally dissagree until totally agree (MALHOTRA, 2006).

The research instrument was send to people from metal-mechanic sector mainly to product development specialists, production managers, production supervisors and production specialists composing the population sample in this way. It's importante to highligth that the sample composition is one target elemenso population representation and are make tool of question for this population to identify which that population elements (MALHORTRA, 2006).

The data was analyzed through factor analises because the aim was identify which constructs emerges from collected data. Thus the presented results can validate or refutes the conceptual model, keeping or change this one. The factor analises is composed by set of statistics

techiques aiming to explain the correlation among variables to describe them (PESTANA; GAGEIRO, 2005).

Hair et al (2005) defines factor analises as a techinique which aims to analise multidimensional complex relations and belongs to a class of multivariate statistical classes which objectivates to discover subjacent structure in a matrix data. The use of factor analises in this study was explain the factors that explain WCM methology and how they can be used to provide a framework to researchers and production enterprises which wants to use and study WCM concepts.

The questionnarie was send through Linkedin Professional Social Network for about 1000 profissionals from metal-mechanic área and was returned 180 valid for research questionnaries. The participant was selected by research judgement which was responsable for enter in discussion groups and analise the participant profile and then send the invite the selected one to participate at this time the reserch objective was explained in email body and the link for access research form was send.

4. RESULTS AND DISCUSSION

The research results are colected, tabbed and submited to factor analise using varimax rotation, principal component extraction method, suppresing values less than 0,4 to create statistical model. The initial model presented 7 constructs.

The 7 construct explained variance was 67% which indicates that 33% of variation is explained by other factos. The next step was analise the factors internal reliability presented the KMO value 0,84 indicating that the reliabity was good for factor analise (SELLTIZ *et. al.*, 1987).

For verify the internal reliability for each factor was used Cronbach Alpha test which considers 0,6 the low limit for acceptance (HAIR *et al*, 2005). The presented values are showed in table 1:

Table 1 – Cronbach's Alpha Reliable Test

Factor	Cronbach's Alpha	Itens Number
1	0,816	5
2	0,914	8
3	0,896	5
4	0,836	5
5	0,857	5
6	0,721	3

Source: Prepared by Authors, 2014.

The factor 7 was eliminated because presented cronbach alpha less then 0,60 as suggested by Hair et al (2005). The remained factor was nominated as the name indicated in table 2.

Table 2 – Conceptual Matrix of World Class Manufacturing

Rotated Component Matrix							
		Component					
		1	2	3	4	5	6
Lean Manufacutring	13. They needs to seek continuous improvement.	,689					
	1. They reduce the maximum in-process.	,660					
	2.Have a layout that facilitate the shop floor and reduce in process material stock.	,624					
	12. They have efective maintanance plans.	,623					
	4. They invests in reduce machine setup time at the expense other things.	,616					

To be continued

Human Resource Management	17. They have flexibility to suit customer needs.		,780				
	18. They seek to reduce the number of losts sales by delivery time reason.		,619				
	16. They always are worried about sales orders agenda.		,596				
	22. They always sempre se preocupam em manter os funcionários motivados.		,593				
	19. They have mecanims to manage customer service levels.		,579				
	21. Always invests in training to capacitate employees.		,565				
	20. Always ecourage their managers to delegate responsabilites to other people.		,548				
	23. Always invests in capacitate their leaders.		,548				
Environmental Practices	33. Always develops products environmentally correct even if this harm the competitivity.			,838			
	34. They don't give up from environmental practices even if its impact in the company's revenue.			,817			
	32. Always use reverse logistics at end of product lifecycle even this raise the costs.			,697			
	35. They have consistent environmental programs.			,638			
	8. They seek to achieve flexibility in product Project involving supplier during product development process.			,540			
Marketing Integration	28. Always integrates Marketing area with whole enterprise process.				,753		
	30. They Always seek for customers collaboration.				,733		
	31. They Always involves Marketing area in decisions about productive process.				,719		
	29. They Always promotes the integration with suppliers during the whole fases of products projects.				,665		
	3. Requires that Supplier Works in Just in Time Mode.				,494		
Costs Reduction	27. Are only worried to reduce production costs.					,877	
	26. Only analises the value chain and don't pay attention to other aspects.					,864	
	25. only invests in keep low low stock volumes.					,835	
	24. Always invests in cost reduction without worrying about other aspects.					,775	
	15. don't have competitive delivery time because they understand other factors influences customer choice.					,510	
Flexibility	6. They invests to raises the material output over other actions.						,827
	7. They invests to raise the product delivery to Market.						,749
	5. They invests in create a lot of diferente process.						,710

Source: Prepared by Authors, 2014.

The factor 1 was nominated "**Lean Manufacturing**" because contains variable 1,2,4,12 and 13 which are called to this aspect. The important thing about this according Goriwond, Mhlanga and Mutsambwa (2013) it's an approach which focus in attend customer needs while the enterprise keeps the quality patters and control production costs.

The agile manufacturing is strongly related to Lean Manufacturing concept that the focus in waste reduction. However worth mentioning that agile manufacturing adds a new paradigma which is the focus on a customer needs aimed to attend them faster as possible. This posture allows the enterprises to adapt them faster to changes in the Market in respect to preferences and product volumes (GORIWONDO; MHLANGA; MUTSAMBWA, 2013).

For this reason Furlan, Vinelli and Pont (2011) studied the complementarity between the Lean Manufacturing and Total quality Management aiming to auxiliary enterprises that wants to become Word Class Manufacturing Enterprises.

To study the complementarity the lean product is the ideal scenario because this techinique uses a tool of sócio techiques practice to eliminate was through the chain value within the company (FURLAN; VINELLI; PONT, 2011; FUENTES; DÍAZ, 2012)

To improve the accompaniment Konsta and Plomaritou suggested the use of consagrated approachs such: Balanced Score Card, KPI (Key Perfomance Indicator) and CMM (Capability Maturity Model) which become popular in the last twenty years but its up to managers the more suitable indicators to reflect the reality. All these practices are related to WCM concept and aim to compose a conceptual model about WCM practice.

The factor 2 was nominated as "**Human Resource Management**" because contais the variable 16,17, 18, 20, 21 and 23 which contains aspects related to human resources and aspects related to customer servisse to improve enterprise flexibility aiming to attend the customer needs.

The aspect corroborate with the things described by Muda, Rahman and Hassan (2013) where they points the attitude change in WCM that enterprises need to have mainly related to make to order production to improvement customer service.

Goriwond, Hlanga and Musambwa (2013) suggests that to achieve enterprise flexibility is necessary forecast the market changes facts that corroborates with the factor explained before and to have succes with the forecast is necessary to bring customers closer and keep the employees motivated. Aiming this Kedia, Gaffney and Clampit (2013) points the organizations need to create knowledge management structures to create a relationship network to keep the information change among customers, employees and stakeholders.

The Kedia, Gaffney and Clampit (2013) studies can help organizations to create knowledge management structure aiming to evaluate the practices comented before enabling managers to evaluate in which grade each methodology better fit to organization needs.

Hosseine et al (2012a) suggests that the human resource management, the faster reaction to competitors, meet the customer needs and organization flexibility are the main characteristics of one WCM enterprise. Therefore this is an important factor analyzed by Lin, Ma and Zhou (2012) which aimed to analise the Bus Chinese Industry performance whose sucess isn't determined by high productivity and low price but by the faster response to customer needs.

The factor 3 was named "**Environmental Practices**" because contains variable 8, 32, 33, 34 and 35 which are linked to organization environmental practices aiming to achieve the current demands for the use of products enviromentally correct, both in terms of disposal and in the use of recycled product to improves the reuse of raw material.

Pinheiro et al (2012) regards the environmental aspect as a one dimension to enterprises achieve the WCM grade mainly because the environmental conciuousness influences the customers behavior. Furthermore this behavior reflects the problems faced by the society due to the unbridled use of raw material and the polution generated by the society as a whole.

To achive this dimension the enterprises need to invests in reverse logistics, product Project aiming to disassembly, use of recycled products in product projects and partner with customers and suppliers.

The factor 4 was nominated as "**Marketing Integration**" the importance of this factor lies on the fact that the marketing research and know about customer needs and because of this complements factor 2 which prepares the enterprise human resource to achieve flexibility to achieve organization flexibility by responding to customer needs.

Although the WCM studies concetrate mainly in production question the marketing practices are important because this area develops researchs about customer needs so in this way builds a enterpise vision focused in offer to customer products more adequated to customer needs focusing mainly the production based on customer demands and not in a make to stock (pushed production).

The factor 5 was nominated as "**Costs Reduction**" because contains variables 15,24, 25, 26 and 27. This factor representes the main enterprises aim when applies WCM approach. For achieve this enterprises look for apply production methodologies such Lean Manufacturing, Quality Management Systems and Six Sigma MUDA; RAHMAN; HASAN, 2013; FURLAN; VINELLI; PONT, 2011) because these methologies change messy enterprises in clean and organized places reducing costs in this way.

The factor 6 was nomited "**Flexibility**" it's one the main organization objective when they want to achieve WCM. This factor is factor 1 dependent because both want to reduce enterprise manufacturing cycle. Thus the practices cited before assume central hole and enable organizations to attend customer needs through product development achieving customer needs.

5. CONCLUDING REMARKS

The main objetive from this paper was achieved when was developed a World Class Manufacturing using the respondents opinion and the data was analised using factor analises to elaborate quantitative model.

To elaborate the model was evidenced that's the respondentes understend that the aspects called to lean manufacturing, resource management to achieve flexibility, environmental practices, marketing integration and flexibility are the most importante aspects to enterprises that want to become World Class Manufacturing Enterprises.

Invests in Lean Manufacturing methology means that enterprises needs to invest in such methologies such: Just-in-time, six sigma aiming to simplify product manufacturing to reduce costs one of the factors present in this paper and can promote the quality incremente however this aspect only can be achieved if the enterprise invests in human resource development because in this way people will be prepared to face the organizational challenges fact that possible organizations to flexible productive process answering to customer needs faster than the concorrency enterprises.

The integration with marketing will possible the customer and enterprise interface because this departamento is very close to custumer aiming to understand their behavior creating a kind symbiosis among enterprise departaments to fit and generate products that can meet the customer needs generating a competitive advantae in this way. The integration with marketing demands the investimento in human resource and lean manufacturing aiming to generate the enterprise flexibility to fit the enterprise to the environment and face the future challenges.

Future research can develop studies using other countries or regions aiming to validate the concept moreover the study gap is the fact that the research uses only Brazilian reality so the questionnaire can be applied to other realities to create a panel about World Class Manufacturing. New studies can stabilish relations among the factors discovered in this study create a new research analising the aspects and grade of correlation among them.

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