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PROPOSITION FACTOR MODEL OF WORLD CLASS MANUFACTURING IN BRAZILIAN ENTERPRISES

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ABSTRACT

The present paper aims to develop a model of World Class Manufacturing. To achieve this goal we designed a questionnaire with 35 items divided into 7 areas as suggested by a literature review. This questionnaire was sent to manufacture specialists, product developers, and technicians through LinkedIn. The participants were selected by researchers in discussion groups taking into consideration their experience using the professional profile. About 1000 invites were sent to professionals from the metal-mechanic sector. One hundred eighty valid questionnaires were returned. The data was analyzed through factor analyses and 7 constructs were obtained, which explained 67% of the variance in the data. The KMO was 0.84, which is considered good for analyzes purposes.

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The seventh factor was eliminated because its Cronbach's Alpha was below 0.6. The remaining factors were nominated as: Lean Manufacturing, Human Resources, Environmental Practices, Management to achieve flexibility, Marketing Integration, Costs Reduction, and Flexibility.

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

1. INTRODUCTION

The emergence of global competition has pressed enterprises to reduce costs, improve quality, develop products to achieve high performance, offer a larger product portfolio for customers, and provide better and more dynamic services (DIGALWAR; SANGWAN, 2007). Because of this, manufacturers who desire to position themselves globally and who intend to become world-class manufacturers must aim to deliver the same quality worldwide in order to gain consumers.

The term world class manufacturing (WCM), however, needs to be more clearly defined because current research on the topic demonstrates a lack of consensus about what it is and which enterprises should be considered World Class Manufacturers. Thus, the problem of this research was: Which criteria do manufacturing and product development professionals think are required to define a company as a World Class Manufacturing Enterprise?

The main objective of this research was to develop a World Class Manufacturing Model using professional opinions about required criteria to be considered a WCM Enterprise. With this, we aim to create a foundation model to serve as a base to create a possible certification model.

To achieve this objective we developed a literature review to understand the current state of the field. This review will be discussed next in chapter 2. We then provide methodological procedures, explained in chapter 3, provide our data and research in chapter 4, and offer concluding remarks in chapter 5.

2. LITERATURE REVIEW

Consumer globalization drives enterprises due to global competition, which causes changes in consumer behaviors and affects the way which products and services are manufactured. That situation is influenced by ICTs (Information and

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Communication Technologies), which makes global transactions and cooperation easier than ever by improving the conscious about manufacturing conditions and process regulations worldwide. Nevertheless, large companies believe that global action is a competitive advantage.

Therefore, for enterprises to have a competitive advantage over their competitors, they are starting to use a production system to become World Class. Thus, the World Class Manufacturing (WCM) methodology is based in building a global competitive advantage raising the profits and International Competitive Advantage (HOSSEINE *et al.*, 2012; MURINO *et al.*, 2012).

The literature about this topic revels that there is not a universal definition of WCM (MASKELL, 1992; DIGALWAR; SANGWAN, 2007). The term was used by Hayes and Wheelwright (1984) to describe organizations that use production capacity on a global production system as a competitive strategy. Shonberger (2008) defined the benefits sought by WCM as similar to the Olympic Games because the athletes' works are guided by the motto "Citius, altius, forties," which can be translated as "faster, bigger, and stronger." Therefore, the WCM adopts a continuous improvement approach which consists of changes in a lot of organizations, such as: quality management, work relationship improvements, support and training, improvement in relations with suppliers and customers, inventory programming and management, equipment maintenance, and process automation with information technology, among other things (SCHONBERGER, 2008; LIND, 2001; DIGALWAR; SANGWAN, 2007).

Some benefits that WCM can provide for organizations that use it are: profit improvement, new manufacturing programs, alignment with customer's needs, suppliers reduction costs, production reduction costs, innovation, improvement using metrics to measure performance, etc. (ANH, YEN & MATSUI, 2015; HOSSEINE *et al.*, 2012; FORTUNATO, 2007; MURINO, 2012; JUSKO, 2013).

Therefore the WCM approach becomes a critical factor for an enterprise's competitive advantage because it promotes flexibility and ability to change more quickly to address Market and customer needs. This flexibility is now essential due the way globalization has affected all kinds of enterprises (FORTUNATO, 2009; GAJDZIK, 2013; JIMÉNEZ and AMAYA, 2014).

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Thus, an industry that keeps the mass product rigid and maintains traditional practices will not be able to keep up with changes and global demands (FINGER, FLYN and PAIVA, 2014). The WCM approach presents a set of practices and methodologies to meet customer's needs while keeping high quality and controlling production costs.

Normally, WCM enterprises have the following characteristics: emphasis on strategic thinking instead short term profits; systematic domination of global competition such as: quality, costs, and flexibility; managerial attitude toward customer needs; better performance in profits compared to their competitors; quick reaction to changes in the external environment; elimination of unnecessary processes; good information system; culture of innovation and quality; and self-sufficient employees performing efficient maintenance and system corrections (ANH, YEN and MATSUI, 2014, HOSSEINE *et al.* 2012; SCHONBERGER, 2008).

The WCM is strongly related to the Lean Manufacturing concept because there is also a focus on waste reduction. However, the WCM adds a new paradigm which focuses on meeting customer needs as fast as possible and meeting the quick changes that happen in markets with regard to preferences and produced volumes (ANH, YEN and MATSUI, 2014; GORIWONDO, MHLANGA and MUTSAMBWA, 2013).

Wu, Melnik, and Swin (2012) advocate that enterprises use operational practices to achieve the WCM concept. Such practices include specific procedures, new organizational arrangements, protocols, tools, techniques, and other ways of organizing things. For example, to improve quality you can use learning process and knowledge creation concepts. Wu, Melnik, and Swin (2012) also analyze aspects related to WCM using studies about the more common organizational practices used by organizations. These include:

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

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- Employee Development Practices;
- Leadership Practices.

Thus, these sets of practices contribute to create a new structure of competitive differentials for enterprises that apply these practices in organizational life. Furthermore, another new dimension is added for enterprises that desire to become WCM enterprises. This dimension is environmental practices and, according to Pinheiro et al. (2012), environmental practices may present a conflict between the way organizations think and how they act.

Thus, enterprises that want to build long-term competitive advantages are seeking to develop WCM practices, while at same time remaining flexible enough to stay updated with both new social values and new environmental management strategies. However, this reality is relatively new for academic research and for those in the management field, but is becoming an important area for discussion.

Many studies in WCM have been recently published. For example, Goriwondo, Mhlandga, and Mutsambwa (2013) completed research with enterprises from Zimbabwe. Murino (2012) examined one automotive supplier in 150 countries. Mey (2011) looked at Acelor Mital, among others, to understand the process and benefits obtained by the enterprise by changing the product. One study developed by Ghadikolei et al. (2011) stands out. This study examined 12 critical factors and 73 performance variables for the WCM. This study was based on a similar study, which compared an Iranian automotive enterprise and an Indian automotive enterprise.

To understand the way WCM is treated, it is applicable to highlight the methodologies applied in the production system area in the last two decades. With this in mind, Furlan, Vinelli, and Pont (2011) studied the complementarity between the two main production system methodologies, which are Just-in-Time (JIT), and Total Quality Management (TQM). Their main contribution is the idea that lean product is the ideal setting for WCM because the complementarity integrates a lot of socio-technical practices aiming to eliminate the wastes inherent in a long supplier chain in the enterprise (FURLAN; VINELLI; PONT, 2011; FUENTES; DÍAZ, 2012).

Studies by Kedia, Gaffney, and Clampit (2013) can also help organizations to create a knowledge management structure with the aim of evaluating mature practices, allowing the managers to analyze the practices that better fit their

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environment. To create this mechanism, they can use measurement tools such as BSC, KPI, and CMM as suggested by Konsta and Plomaritou (2012). These practices are related to the WCM model and aim to create a conceptual model about this practice.

However, Muda, Rahman, and Hassan (2013) alert us to the fact that many studies about WCM studied the make-to-stock enterprises. It is necessary to develop research about enterprises that use the make-to-order (MTO) approach because this kind of methodology uses the Just in time and Lean Manufacturing Concepts, which are integrated parts of WCM methodology. This aspect can be found in Lin, Ma, and Zhou's (2012) study that analyzes the Chinese Enterprise that analyzes bus performance, whose success is not determined by high productivity and low price, but by the quick response to customers through the integration of modular logic and process optimization. These practices are coming from the MTO concept, Lean Manufacturing, and Just-in-Time practices turned these enterprises into WCM systems.

These definitions corroborate with those pointed out by Harrison (1998) in his research where he found the practices related to WCM: Quality Management, Lean Production, Logistics, Organization and Culture, Manufacture Systems, and Concurrent Engineering. He found that that enterprises that achieve an 80% score in practices and an 80% in performance are considered to be WCM enterprises.

3. METHODS

The methodological procedures for this paper aim to get the specialists' opinions about WCM (World Class Manufacturing) methodology definitions. This is important because this methodology needs to be explored and consolidated to define how to become a managerial practice. For this aim, a descriptive research method was chosen. This kind of research can be used to answer questions about relationships between variables, including a cause and effect model (MALHOTRA, 2006; SELLTIZ *et al.,* 1987). The participant interviews were done through questionnaires with questions about motivation and characteristics.

The paper was developed through a transversal survey because, in this type of research, the questionnaire is applied one time to a population sample (BABBIE, 1999). Kerling (2007) explains that in survey research, small and big populations are

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studied using samples to discover the incidence of relative variables, variable distribution, and variable interrelations.

For the interview, the respondents were given a questionnaire with closed questions based on a seven-point Likert scale. The Likert scale is one scale type that demands the respondents indicate how strongly they agree or disagree degree with a series of responses. Normally one has five answer categories, from totally disagree to totally agree (MALHOTRA, 2006).

The research instrument was sent to respondents from the metal-mechanic sector. The populations' sample was predominantly composed of product development specialists, production managers, production supervisors, and production specialists. It is important to highlight that the sample's composition is only one representation of the population, and questions were made for this population to identify other populations' elements (MALHOTRA, 2006).

The data was analyzed through factor analyses because the aim was to identify which constructs would emerge from collected data. Thus the presented results can validate or refute the conceptual model, and can inform whether to keep or change each one. The factor analyses are composed of a set of statistical techniques used to explain and describe the correlation among variables (PESTANA, GAGEIRO, 2005).

Hair et al. (2005), define factor analysis as a technique to analyze multidimensional complex relations that belongs to a class of multivariate statistical procedures, which attempt to discover subjacent structures in matrix data. The use of factor analysis in this study was to explain the factors that explain the WCM methodology and how they can be used to provide a framework for researchers and production enterprises who want to use and study WCM concepts.

The questionnaire was sent through the LinkedIn Professional Social Network to about 1000 professionals from the metal-mechanic industry area and 180 valid research questionnaires were returned. The participants were selected by a research group who analyzed and selected participants based on their LinkedIn profiles. Each selected participant was sent an invitation and was asked to respond to the questionnaire. The research objective was explained in an email and the link to the questionnaire was sent.

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4. RESULTS AND DISCUSSION

The research results were collected, tabbed, and submitted to factor analyses using varimax rotation, a principal component extraction method, suppressing values less than 0.4 to create a statistical model. The initial model presented 7 constructs.

The 7 constructs explained 67% of the variance, which indicates that 33% of the variation is explained by other factors. The next step was to analyze the internal reliability of the factors and the KMO value was 0.84, indicating that the reliability was sufficient for factor analyses (SELLTIZ et. al., 1987).

To verify the internal reliability for each factor, we used Cronbach's Alpha test, which considers 0.6 to be the lowest limit for acceptance (HAIR et al., 2005). The presented values are showed in Table 1:

Table 1: Cronbach's Alpha Reliability Test

Factor	Cronbach's Alpha	Items 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

Factor 7 was eliminated because the presented Cronbach's alpha value was less than 0.60, as required by Hair et al (2005). The remaining factors were named and described in Table 2.

Table 2: Conceptual Matrix of World Class Manufacturing

Rotated Component Matrix							
		Component					
		1	2	3	4	5	6
Lean Manufacturing	13. They need to seek continuous improvement.	.689					
	1. They reduce waste while processing products.	.660					
	2. They have a layout that facilitates the shop floor and reduces in process material stock.	.624					
	12. They have effective maintenance plans.	.623					
	4. They invest in reduced machine setup time at the expense other things.	.616					
Human Resource Management	17. They have flexibility to suit customer needs.		.780				
	18. They seek to reduce the number of lost sales for delivery time reasons.		.619				
	16. They always are worried about sales orders' agenda.		.596				
	22. They always are worried about keeping their workers motivated.		.593				
	19. They have mechanisms to manage customer service levels.		.579				
	21. Always invest in training to capacitate employees.		.565				
	20. Always encourage their managers to delegate responsibilities to		.548				

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	other people.						
	23. Always invests in training their leaders.		.548				
Environmental Practices	33. Always develop environmentally-friendly products even if that harms their competitiveness			.838			
	34. They don't give up environmental practices even if it impacts the company's revenue.			.817			
	32. Always use reverse logistics at end of a product's lifecycle even if this raises the costs.			.697			
	35. They have consistent environmental programs.			.638			
	8. They seek to make the product Project more flexible, involving suppliers in the development process.			.540			
Marketing Integration	28. Always integrate the Marketing area with whole enterprise process.				.753		
	30. They always seek customers' collaboration.				.733		
	31. They always involve the Marketing area in decisions about productive processes.				.719		
	29. They always promote integration with suppliers during the whole phase of products' projects.				.665		
	3. Requires that supplier works in just in time mode.				.494		
Costs Reduction	27. Are only worried about reducing production costs.					.877	
	26. Only analyze the value chain and don't pay attention to other aspects.					.864	
	25. Only invests in keeping low stock volumes.					.835	
	24. They always invest in cost reduction without worrying about other aspects.					.775	
	15. They don't have competitive delivery times because they understand that other factors influence customer choice.					.510	
Flexibility	6. They invest in raising material output over other actions.						.827
	7. They invest in raising the product delivery to Market.						.749
	5. They invest in creating a lot of different processes.						.710

Factor 1 was named "**Lean Manufacturing**" because it contains variables 1, 2, 4, 12, and 13, which are all a part of lean manufacturing. The important thing about this, according to Goriwond, Mhlanga, and Mutsambwa (2013), is that it is an approach which focuses on attending to customer needs, while the enterprise maintains quality patters and controls for production costs.

Agile manufacturing is strongly related to the Lean Manufacturing concept because of the focus on waste reduction. However, it is worth mentioning that agile manufacturing adds a new paradigm, which is a focus on attending to customer needs as fast as possible. This posture allows the enterprises to adapt faster to changes in the Market with respect to preferences and product volumes (GORIWONDO; MHLANGA; MUTSAMBWA, 2013).

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

The lean product environment is the ideal place to study complementarity, because of the use of practices of social techniques in the chain value of the company (FURLAN; VINELLI; PONT, 2011; FUENTES; DIAZ, 2012).

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To improve the accompaniment, Konsta and Plomaritou (2012) suggested the use of established approaches such as: Balanced Score Card, KPI (Key Performance Indicator) and CMM (Capability Maturity Model) which have become popular in the last twenty years, but it is up to managers to decide on the most suitable indicators to reflect reality. All these practices are related to the WCM concept and aim to compose a conceptual model about WCM practice.

Factor 2 was named "**Human Resource Management**" because it contains variables 16, 17, 18, 20, 21, and 23, which all relate to human resources and aspects related to customer service, specifically to improve enterprise flexibility to better attend to customer needs.

This aspect corroborates with Muda, Rahman, and Hassan (2013). The authors pointed out the necessity of an attitude change in WCM because the company needs to upgrade MTO production in order to increase customer service.

Goriwond, Hlanga, and Musambwa (2013) suggest that to achieve enterprise flexibility, it is necessary to forecast market changes that corroborate with all of these factors. To have success with the forecast, it is necessary to bring customers closer and to keep employees motivated. Kedia, Gaffney, and Clampit (2013) point to the organizations' need to create knowledge management structures to create a relationship network to keep the information change among customers, employees, and stakeholders.

Kedia, Gaffney, and Clampit's (2013) studies can help organizations create a knowledge management structure to evaluate these practices, enabling managers to evaluate in which grade each methodology better fits to organization needs.

Hosseine et al. (2012a), suggest that in human resource management the main characteristics of a WCM enterprise are faster reactions to competitors, meeting the customer needs, and organization flexibility. Therefore, this is an important factor analyzed by Lin, Ma and Zhou (2012), who analyzed the Chinese Bus Industry performance, whose success is not determined by high productivity and low price, but by faster response to customer needs.

Factor 3 was named "**Environmental Practices**" because it contains variables 8, 32, 33, 34, and 35, which are linked to organization environmental practices. These variables aim to meet current demands for the use of environmentally friendly

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products, both in terms of disposal and in the use of recycled products to improve the reuse of raw materials.

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

To achieve this dimension, the enterprises need to invest in reverse logistics, product projects, use of recycled products in product projects, and partner with customers and suppliers.

Factor 4 was nominated "**Marketing Integration.**" The importance of this factor lies in the need for marketing research and knowledge about customer needs. It complements factor 2, which prepares the human resource enterprise to achieve flexibility to achieve organization flexibility by responding to customer needs.

Although the WCM studies concentrate mainly on production, questions about marketing practices are important because this area develops research about customer needs. In this way, an enterprise builds vision focused on offering customers products more suitable to customer needs, focusing the production on customer demands instead of on stocking up on products (pushed production).

Factor 5 was nominated "**Costs Reduction**" because it contains variables 15, 24, 25, 26, and 27 which all relate to lowering costs. This factor represents the main enterprises aim when it applies a WCM approach. To achieve this, enterprises look to apply production methodologies such as Lean Manufacturing, Quality Management Systems, and Six Sigma MUDA; RAHMAN; HASAN, 2013; FURLAN; VINELLI; PONT, 2011) because these methodologies change messy enterprises into clean and organized places, reducing costs in this way.

Factor 6 was nominated "**Flexibility.**" It is one of the main organizational objectives needed to achieve WCM. This factor is dependent on factor 1 because both want to reduce the enterprise manufacturing cycle. Thus, the practices cited before assume a central role and enable organizations to attend to customer needs through product development to meet customer needs.

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5. CONCLUDING REMARKS

The main objective of this paper was achieved when we developed a World Class Manufacturing model using the respondents' opinions and the data was analyzed using factor analyses to elaborate a quantitative model.

To elaborate the model, we showed that the respondents understand that the aspects called lean manufacturing, resource management to achieve flexibility, environmental practices, marketing integration, and flexibility are the most important aspects for enterprises that want to become World Class Manufacturing Enterprises.

Investments in Lean Manufacturing means that enterprises need to invest in such methodologies as Just-in-time and six sigma. These techniques simplify product manufacturing, reduce costs, and promote improvement in quality. However, the quality aspect can only be improved with investment in human resources since the employees need to be trained to face organizational challenges in order to make the product process more flexible and to answer customer demands faster than competitors.

The integration with marketing will enrich the customer and enterprise interface because this department is very close to customers. Thus, they will understand their behavior, creating a kind of symbiosis among enterprise departments to fit and generate products that meet customer needs, generating a competitive advantage in this way. The integration with marketing demands the investment in human resource and lean manufacturing to generate enterprise flexibility to fit the enterprise to the environment and face future challenges.

Future research can develop studies using other countries or regions to validate the concept. A limitation of the study is the fact that the research uses only Brazilian respondants so the questionnaire can not be applied to other countires to create a panel about World Class Manufacturing. New studies can establish relations among the factors discovered in this study to create a new research analyzing the aspects and grade of correlation among them.

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