Knowledge Management and World Class Manufacturing: an initial approach based on a literature review

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This paper presents the partial results of an ongoing research on the proposal of a methodology for the integration between Knowledge Management (KM) and World Class Manufacturing (WCM). The initial investigation of theoretical and conceptual nature aimed at developing a comprehensive and current vision on KM, WCM, and how (or "whether") these constructs relate to one another. The primary sources for the literature review were Web of Science, Scopus, Emerald, Ebsco, SciELO and Spell, and the time frame was 2000 to 2016. The analysis of the selected papers showed that, although the initial WCM model evolved into a "new WCM" in the 2000s, the literature is still focused on the broad conceptual aspects and basic methods and tools, such as Total Quality Process, Total Productive Maintenance and Just-in-Time, conceived in the Toyota Production System,

which shows the need for more studies focused on the current scenario of companies associated with the "new WCM" and its Methods and Tools. Only one article explicitly addressing the interaction between KM theories with WCM was found in the databases surveyed, thus reinforcing the lack of theoretical approximation of these constructs.

Keywords: *Integrated approach; Lean manufacturing; WCM Light; KM*

Gestão do Conhecimento e *World Class Manufacturing*: uma aproximação inicial a partir da revisão de literatura

Este artigo apresenta resultado parcial de pesquisa em andamento sobre a proposta de uma metodologia para a integração entre a Gestão do Conhecimento (GC) e o World Class Manufacturing (WCM). A investigação inicial de natureza teórico-conceitual visa desenvolver uma visão abrangente e atual sobre a GC, o WCM, e como (ou "se") esses construtos se relacionam. As fontes primárias usadas na revisão de literatura foram as bases Web Of Science, Scopus, Emerald, Ebsco, SciELO e Spell, consultadas para o período de 2000 a 2016. A análise dos trabalhos selecionados mostrou que, apesar de o modelo inicial do WCM ter evoluído para um "novo WCM" na década de 2000, ainda existe na literatura um foco muito direcionado aos aspectos conceituais amplos e em métodos e ferramentas de base, como Total Quality Process, Total Productive Maintenance e Just-in-Time, originados do Sistema Toyota de Produção, o que deixa transparecer a necessidade de estudos mais voltados ao ambiente atual das empresas ligadas ao "novo WCM" e aos seus Métodos e Ferramentas. Apenas um artigo abordando de forma explícita a interação das teorias da GC com o WCM foi encontrado nas bases pesquisadas, reforçando a carência da aproximação teórica destes construtos.

Palavras-chave: *Abordagem integrada; Manufatura enxuta; WCM Light; KM*

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1 Introduction

Faced with a scenario of intense competition and uncertainties in the market, the industry is constantly seeking to reduce its manufacturing costs and mitigate its losses, and regarding the external environment, to remain competitive, mainly through innovation, sustainable, within this micro and macro relationships, and able to support internal and external pressures.

With this objective, several concepts and techniques related to quality, productivity, engineering and waste reduction have been developed, mostly arising from the study of successful cases. One such concept is the World Class Manufacturing (WCM) (HAYES; WHEELWRIGHT, 1984).

The term WCM was first used by Hayes and Wheelwright (1984), who introduced a set of principles, best practices and techniques – derived from their research conducted in Japanese and German companies – that would lead any company to superior performance. According to the authors, WCM creates the "sense of direction" for a world-class manufacturer: to become a top-performing company, especially in operations management. The WCM originates from techniques and production tools that aim to reduce waste, increase quality and production, and improve logistics flow, among other benefits. Many of these techniques originated in the Toyota Production System (TPS) (HAYES; WHEELWRIGHT, 1984; SCHONBERGER, 1986; DIGALWAR; SANGWAN, 2011; MUTHUKUMAR *et al.*, 2014; CHIARINI; VAGNONI, 2015).

In the 2000s, WCM was reinvented from the incorporation of Total Quality Control (TQC) concepts into TPS methods and tools in a "step-by-step" approach adapted to the Western culture (CHIARINI; VAGNONI, 2015). Considering that organizational culture is a determining factor for the operation of a production system such as TPS, the model created from the integration of TQC presents a structure initially adapted to European companies that allows the implantation of the necessary organizational culture where it eventually does not yet exist (OVERVIEW WCM, 2014).

In order to develop this new model of excellence, some companies around the world have met in the WCM Association, among them the Ariston Group, Elica, Embraco, Fiat Industrial, Fiat Spa & Chrysler, Royal Mail, System Polónia, Unilever and Volvo Powertrain (CHIARINI; VAGNONI, 2015). From this point on, the WCM acronym has been used as a reference to this new model developed in the 2000s by the WCM Association.

Among the companies cited, according to Pałucha (2012), the Fiat group has been working around the world in the development and implementation of the WCM program in its suppliers. The author also states that after Fiat merged with Chrysler, the program was extended to both companies.

Until December 2015, at least 95 companies related to Fiat Chrysler Automotive (FCA) in Latin America had already joined the WCM, many of them as part of the WCM Light program, which has leaner characteristics and disregards the Management Pillars of WCM that is applied in FCA ("WCM Fornecedores…, 2015).

One of the several goals established by the WCM Light for the auto parts supplier is the constant generation of ideas for operational improvement. Every nine months, each operator should develop six "quick kaizens", which are low-complexity improvements. ("WCM for Supplier Scorecard", 2015, "WCM Fornecedores: Supplier Quality", 2015).

In the view of the authors of this paper, the concepts of "Enabling Context" and "Knowledge conversion processes" from Knowledge Management (KM), described below, are directly related to the quick kaizens implementation and monitoring processes – since the absorption of the operational knowledge generated would be facilitated by an adequate Enabling Context – this being the initial motivation for conducting the present research. It should be highlighted that one of the authors of this paper is currently one of the responsible employees for the implantation and monitoring of quick kaizens in two projects of an auto parts multinational in Minas Gerais, Brazil.

Part of the relevance of the present research is justified by the scarce literature that deal with World Class Manufacturing and Knowledge Management issues jointly, since only one article was found in two of the scientific databases surveyed for the period from 2000 to 2016, as will be demonstrated below. Another contribution is the presentation to the Industry, especially the organizations that joined World Class Manufacturing, of the importance of Knowledge Management as a mechanism for achieving the goals established by the model, especially the gathering of operational ideas that are converted into improvements such as the reduction of internal costs.

For the main author, this research brings a great contribution and interaction with his job and professional career, because in 2015 the company in which he works as a Quality and Engineering Supervisor started the implantation of the WCM Light with the support of the assembler and the author was chosen to work as a "WCM Support", a position that supports all WCM pillars within the organization and in the interaction between the projects and the client, seeking and sharing information and knowledge.

The next sections present the methodology adopted for the bibliographic research, the quantitative results followed by a review of concepts of KM, WCM and reflections on possibilities of integration of these constructs identified in the literature.

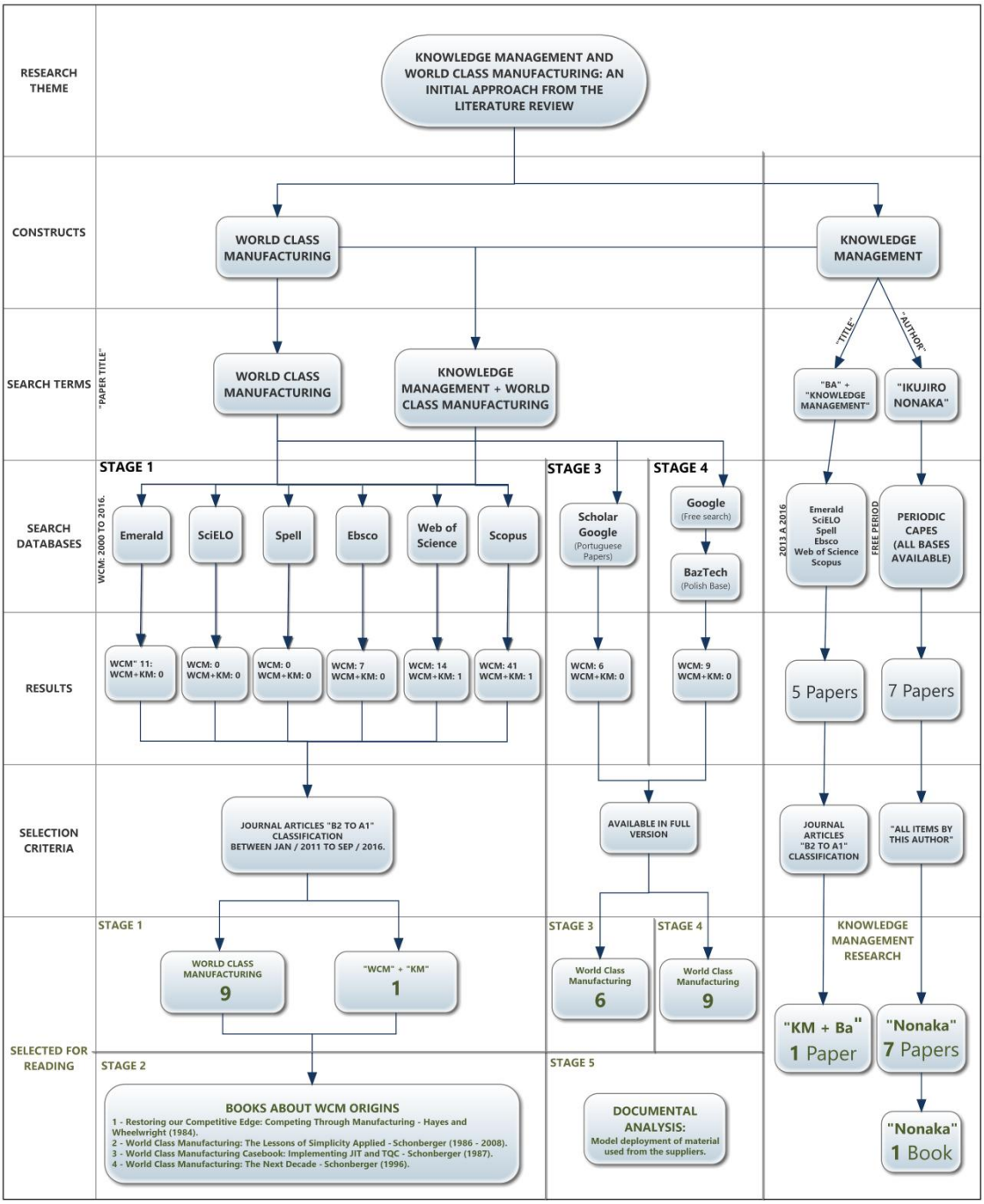
2 Methodology

To achieve the purpose of the ongoing research – the proposal of a methodology for integrating Knowledge Management and World Class Manufacturing in the automotive business – a bibliographic research was

initially carried out for theoretical and conceptual investigation. The aim was to develop a comprehensive and current view of the constructs of Knowledge Management and World Class Manufacturing and gain an understanding of how (or whether) these constructs relate to one another.

Figure 1 below summarizes the methodological procedure adopted:

Figure 1 – Methodological Procedure of the Research



Source: The authors.

For a bibliometric analysis of the WCM, a first stage consisted of two searches. The first one used the term "World Class Manufacturing" in the title as a criterion. Then, the second search was performed with the query

"World Class Manufacturing" AND "Knowledge Management" in the title, keywords and abstract. The sources of this first stage were the databases Web of Science, Emerald, SciELO, Spell, Ebsco and Scopus. Years were limited from 2000 to 2016.

The articles found in this first stage – 54 different articles in their full text version – were used to establish the theoretical basis used regarding the WCM, considering the presence of the constructs searched only in the title of the publications. From the 54 articles found, the study selected for reading only those which received classification B2 to A1 in the areas of Administration, Accounting and Tourism, by the Brazilian Qualis evaluation system for scientific journals, regulated by the Sucupira Platform (PLATAFORMA…, 2017). Thus nine articles were reviewed.

Based on the reading of the nine selected articles, the second stage focused on the works most cited or with greater adherence to the objectives of the ongoing research, with a greater focus on the explanation of the WCM origins. This stage identified four books that address the historical context of WCM and that are widely cited in the nine articles found in the first stage.

A third stage was carried out using Google Scholar because no Brazilian articles were found in the databases surveyed (even Spell and SciELO), and the authors thought it was important to include national texts that could help to understand the local reality. The query was "World Class Manufacturing" OR WCM OR "Manufatura de Classe Mundial" in the title from the year 2000 on. Five of the six articles retrieved (disregarding duplicates and a master's thesis) address the configuration of the pillars of World Class Manufacturing according to the WCM Association and the model applied by FCA to a large part of its suppliers (CHIARINI; VAGNONI, 2015; WCM for Supplier…, 2015, WCM Fornecedores…, 2015). It is important to highlight that four of these Brazilian studies correspond to case studies, thus demonstrating the interest to explore in a practical way how this construct has been present in the local industry.

The fourth stage was held freely on Google Scholar, and the Polish database BazTech stood out, since articles of great adherence to the theme and objectives of this research were found there (DUDEK, 2013; GAJDZIK, 2010; 2012; 2013a; GÓRSKA-SZKARADEK, 2008; ŁAWNICZAK; IWANOWICZ; MAZUREK, 2014; MIDOR, 2012; PAŁUCHA, 2012; STANEK; CZECH; BARCIK, 2011).

The fifth and last stage consisted of a desk research of manuals and trainings used by the auto parts companies that have adopted the World Class Manufacturing model in the state of Minas Gerais, as it was considered relevant to include the method applied for the analysis of theoretical constructs.

The present research was mainly focused on classic authors for the construction of the theoretical basis regarding Knowledge Management, especially Nonaka, Takeuchi and Von Krogh. Publications from 2013 to 2016 were surveyed, based on the same databases used in the first stage of research, as long as they jointly addressed in their titles the terms Knowledge Management and "ba", which according to Nonaka and

Toyama (2002) is a term that expresses a specific context in terms of time, space and relationships, in which knowledge can be created, shared and used.

In a complementary way, the content of the articles available in the same databases consulted in the first stage of research that presented in the abstract or keywords the terms "Knowledge Management" and "World Class Manufacturing" was also evaluated for the period from 2000 to 2016, totaling eight different articles, one being the same identified by the search of terms in the title.

The bibliometric results are presented below.

3 Bibliometric results

After the articles were collected in the first stage, it was found the result presented in Table 1:

Table 1 - Summary of the number of academic papers found by each search term (2000 to 2016)

DATABASES / TERMS	Knowledge Management (Title)	World Class Manufacturing (Title)	World Class Manufacturing (Title, keyword or abstract)	Knowledge Management + World Class Manufacturing (Title)	Knowledge Management + World Class Manufacturing (Title, keyword or abstract)
Emerald	1375	11	110	0	5
SciELO	376	0	5	0	0
Spell	170	0	0	0	0
Ebsco	1880	7	24	0	0
Web of Science	3783	14	261	1	2
Scopus	6913	41	508	1	3
TOTAL	**14497**	**73**	**908**	**2**	**10**

Source: The authors.

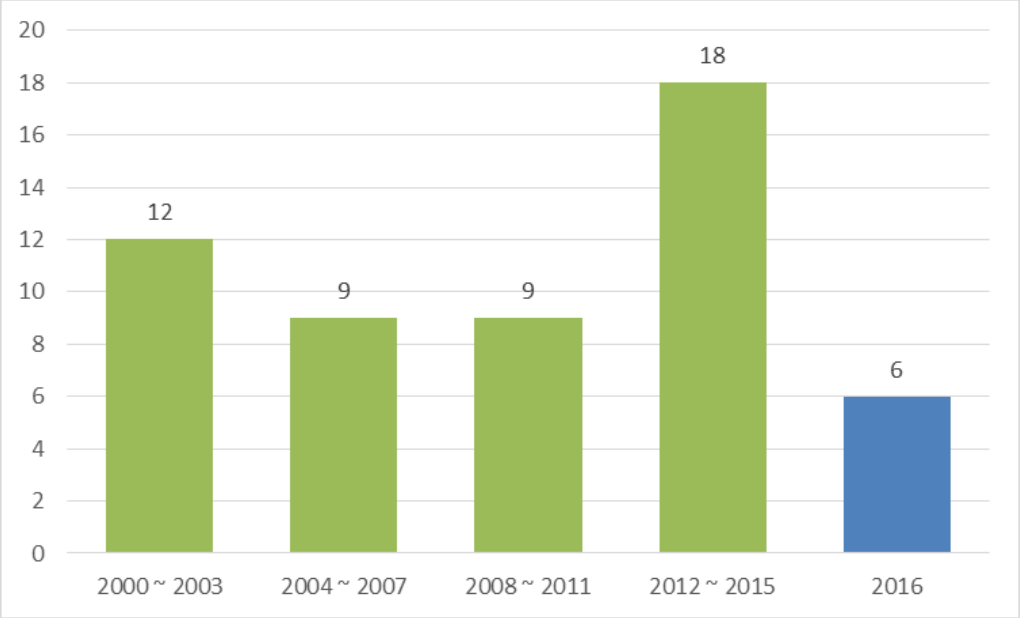
Table 1 shows that, considering possible repetitions of articles in the databases, in addition to the high number of papers that addresses Knowledge Management in their titles (14,497), it was found a total of 908 articles dealing with WCM, being the term in the title (73 articles), keywords or abstract.

There is a total of 10 articles that relate WCM to Knowledge Management in Keywords or Abstract, but only two results found these terms in the title – it is important to consider that it is the same work found in two different databases, and this also repeats twice in the search for the terms in the Keywords or Abstract fields.

An analysis of the evolution of the use of the term "World Class Manufacturing" in the title of the articles, disregarding repetitions of works among the databases researched, and considering the distribution of frequency in four categories between 2000 and 2015, shows that

publications about WCM seemed to be losing prominence and stabilizing until 2011, however, renew strength after 2012, as Chart 1 shows below:

Chart 1: History of publications with the term WCM in their titles



Source: The authors.

This renewal may be explained by the increased use of World Class Manufacturing as a model structured by the WCM Association (CHIARINI; VAGNONI, 2015). From 2009 to December 2014, only companies affiliated to the FCA Group had 184 plants involved with WCM and 391 suppliers, 95 in Latin America, thus representing 45% of the direct suppliers of the continent ("WCM for Supplier Scorecard", 2015, "WCM Fornecedores: Supplier Quality", 2015).

Eliminating duplicates and considering only articles with the term "World Class Manufacturing" in their titles, Table 2 presents the relationship between academic researches and the model that has been widely used in the Industry:

Table 2: Relationship between academic researches and the WCM Association model

Database	Number of Papers	Number of Papers about technical pillars of WCM	% Papers about technical pillars of WCM
First Stage - (Emerald, Spell, SciELO, Ebsco, Scopus, Web of Science)	54	4	7,4%
Second Stage - (Books about WCM origins)	4	0	0,0%
Third Dtage - (Google Scholar - Pages in Portuguese)	6	5	83,3%
Fourth Stage - (BazTech = Polish database)	9	9	100,0%

Source: Authors.

The analysis of the selected works shows that within the WCM approach there is still too much focus on broad conceptual aspects and basic methods and tools, such as Total Quality Process (TQP), Total Productive Maintenance (TPM) and Just-in-Time (JIT), originated from the Toyota Production System, often not making clear the distinctions between WCM and Lean Manufacturing, since both have the TPS as the main reference (HAYES; WHEELWRIGHT, 1984; SCHONBERGER, 1986; DIGALWAR; SANGWAN, 2011; MUTHUKUMAR *et al.*, 2014; CHIARINI; VAGNONI, 2015).

This scenario reveals the need for more studies focused on the current environment of the companies associated with the WCM and how it is widely applied today in the industry – especially in the automotive sector – since the creation of the WCM Association, highlighting its Methods and Tools. This prominence can already be observed more frequently in countries – among them Brazil – that directly experience this model in their industrial parks, as shown by academic studies found in Brazilian and Polish bibliographic databases (BORGES; DE ABREU; VAZ, 2014; BORGES; DE OLIVEIRA, 2016; BORGES; OLIVEIRA; OLIVEIRA, 2013; DE OLIVEIRA *et al.*, 2016; DUDEK, 2013; GAJDZIK, 2010; 2012, 2013a; GÓRSKA-SZKARADEK, 2008; ŁAWNICZAK; IWANOWICZ; MAZUREK, 2014; MIDOR, 2012; PAŁUCHA, 2012; PARREIRAS *et al.*, 2014; STANEK; CZECH; BARCIK, 2011).

Poland is one of the countries where this interaction between academy and industry is very clear. All articles from the BazTech Polish database were in line with the WCM model presented by the WCM Association. This result mainly demonstrates the interaction of the academy with the practices of WCM in the local industry, especially the Fiat Group, installed in the country since 1992 (STANEK; CZECH; BARCIK, 2011).

Regarding the search for the term "Knowledge Management", the results indicate that it is a construct that is widely recognized in the academy, and in full development, as the number of articles in the databases consulted shows that the publications with the term "Knowledge Management" in their titles after 2000 is ten times greater than the sum of all previous years, as Table 3 below shows :

Table 3: Publications with the term “Knowledge Management” in their titles

SOURCE	BEFORE 2000	2000 TO 2016
Emerald	93	1375
SciELO	0	376
Spell	1	170
Ebsco	73	1880
Web of Science	456	3783
Scopus	708	6913

TOTAL	**1331**	**14497**

Source: The authors.

Only one article explicitly discussing the interaction between KM theories and WCM was found in the databases searched, thus reinforcing the importance of the theoretical approximation of these constructs. The following section presents a review of the literature on Knowledge Management, World Class Manufacturing and their relationship.

4 Theoretical constructs

This section is devoted to the development of theoretical constructs that support the ongoing research. The concepts related to Knowledge Management are listed, as well as their developments according to the research objectives. The World Class Manufacturing model is presented, based on the literature and the reference material made available by the vehicle assembler to its suppliers for the implementation of the model. Considering as main points the origin and contemporary approach of the model, the interaction between Knowledge Management and WCM is then analyzed, addressing these two constructs from the context of companies using WCM.

The construction of the theoretical basis of this research was first made through an introductory approach to Knowledge Management to place this construct into context, based on classic authors such as Nonaka, Takeuchi and Von Krogh. Contemporary journals were also studied for a deeper understanding of Knowledge Management theories that align with the specific objectives of the present research, especially the processes of transformation of knowledge and the enabling contexts.

5 Knowledge management

Today, a company can only survive the intense global competition if it uses creativity and efficiency in its operation, creating and exploiting knowledge effectively (NONAKA; TOYAMA, 2002). Success in knowledge management depends on behavioral change (CHOO; NETO, 2010) that allows people within the organization to use what they know to learn and innovate, since the source of real innovation stems from the creation and exploitation of knowledge (NONAKA *et al.*, 2014).

Nonaka and Von Krogh (2009) define the creation of organizational knowledge as the process of making the knowledge created by individuals available and amplified, as well as "crystallizing" and connecting it to the company's knowledge system. According to the authors, the concept of tacit knowledge is a cornerstone in the theory of the creation of organizational knowledge, and encompasses knowledge that is disjointed and tied to the senses, motor skills, sensorial perception, intuition or implicit rules; and the explicit knowledge can be expressed in formal language, systematized and shared in the form of data, scientific

formulas, specifications, manuals and other similar formats (NONAKA; TOYAMA; KONNO, 2000; NONAKA; VON KROGH, 2009).

Nonaka *et al.* (2014) complement saying that all knowledge is rooted in tacit knowledge, and even the most explicit knowledge contains some tacit parts or aspects. Knowledge is information inserted in a context, and once context is added, tacitness is also added.

The Theory of Knowledge Creation defines that the process of creation and use of knowledge constitutes a continuous line in which individual limitations and those imposed by information passed on through the acquisition of a new context are overcome, leading to a new vision and diversity as a consequence of various levels of involvement of individuals, teams and organizations (NONAKA *et al.*, 2014; NONAKA; VON KROGH; VOELPEL, 2006).

Choo and Neto (2010) conclude that knowledge management in organizations is fundamentally about creating an environment conducive to the creation, sharing and use of knowledge – processes defined by Nonaka and Takeuchi (1995) from the four conversion modes (SECI Model). Nonaka, Von Krogh and Voelpel (2006) emphasize the importance of the interaction of this knowledge to the dynamics of the company, stating that in general, by interacting and sharing tacit and explicit knowledge with others, people within the organization improve their ability to understand a situation or problem, and thus apply their knowledge to act and solve the problem – which may lead to innovation.

Several authors (NONAKA; TAKEUCHI, 1995; NONAKA; TOYAMA; KONNO, 2000; NONAKA; TOYAMA, 2002; NONAKA; VON KROGH; VOELPEL, 2006) explain that through the SECI spiral of creation and continuous use of knowledge, the tacit and explicit knowledge expand in terms of quality and quantity, from the individual to the group and then to the organization and even to the inter-organizational level. The study by Kwanya, Stilwell and Underwood (2015) revealed that the concept of a "knowledge market" is relatively new, emerging in the late 1990s, and has gained momentum as a platform for knowledge sharing.

To be created and shared, however, knowledge needs a facilitating context (NONAKA; TOYAMA; KONNO, 2000; ERDEN; KROGH; NONAKA, 2008; KWANYA; STILWELL; UNDERWOOD, 2015). Kwanya, Stilwell and Underwood (2015) report that the SECI model has been modified and adapted by several scholars to suit these contexts. The authors emphasize that an important addition to the revised model is the concept of "ba" as a platform of interactions that lead to the creation and sharing of knowledge. "Ba" was originally proposed by the Japanese philosopher Kitaro Nishida and corresponds to a shared context in which knowledge is created, shared and used (KWANYA; STILWELL; UNDERWOOD, 2015).

Based on the assumption that knowledge can only be created, interpreted and applied in a specific context, according to Nonaka, Toyama and Konno (2000) "ba" provides the social, physical, psychological, historical and cultural space in which knowledge is created, interpreted and learned. It is worth noting that the terms "ba" and

"enabling context" are often used as synonyms (CHOO; NETO, 2010; ERDEN; KROGH; NONAKA, 2008).

Ba is a shared space for emerging relationships where knowledge is acquired through individual experiences or reflections on the experience of others. It may arise in individuals, work groups, project teams, informal circles, temporary meetings, virtual spaces such as e-mail groups, and in direct contact with the client (NONAKA; TOYAMA, 2002; NONAKA; VON KROGH; VOELPEL, 2006). For Nonaka and Toyama (2002), although it is easier to consider ba as a physical space such as a boardroom, it should be understood as interactions that occur in a specific time and space. For Nonaka, Toyama and Konno (2000), "interaction" is the key concept in understanding ba.

Nonaka, Toyama and Konno (2000) emphasize that the participants of a ba cannot be mere spectators; instead, they must demonstrate their commitment to the ba through their actions and interactions. For the authors, "ba" is alive, active and dynamic; it is constantly created, used and maintained to suit the needs of the participants.

In addition to the concept of "ba", Nonaka and Toyama (2002) also highlight some KM practices presented as "thesis and antithesis" to generate a process of continuous self-overcoming in the creation of knowledge. These practices constitute the ability to synthesize of a company, encompassing its vision of knowledge, bas, creative routines, reward systems and decentralized management.

6 World Class manufacturing

According to Muthukumar *et al.* (2014), for more than 40 years the Industry around the world has adopted tools and techniques of continuous improvement to perfect its operations, becoming more competitive. The continuous and simultaneous improvement of production processes and management methods are also pointed out by Gajdzik (2013b) as key factors for the success of a company in the market, because the competitive advantage is a consequence of low cost and high efficiency.

Chiarini and Vagnoni (2015) report that techniques such as the Toyota Production System (TPS), Just-in-time (JIT), Total Quality Control (TQC) and Lean Manufacturing have been implemented by many companies, leading them to reinvent their strategic management, accounting management system, performance measurement system and operations management.

Digalwar and Sangwan (2011) emphasize that in the last two decades the world witnessed the emergence of effective forces aimed at reforming economic and organizational communities. In accordance with the authors, this scenario anticipated fundamental changes in business strategy, and these driving forces have led individuals and organizations to appreciate the importance of World Class Manufacturing (WCM). In addition, removing trade barriers and intensifying international competition have put organizations under extreme pressure to review their traditional manufacturing practices and consider adopting emerging

practices such as WCM, seeking differentiation and advantage over competitors (HALEEM *et al.*, 2012).

According to Schonberger (1986), the term WCM captures the breadth and essence of the fundamental changes occurring in the industrial business. The main assumption of WCM is the optimization of processes by eliminating all losses and wastes. A company that significantly minimizes the costs of its activities is considered a benchmark in a given sector and is considered a "World Class" company (GAJDZIK, 2013b).

Gajdik (2013b) affirms that WCM is a kind of problem-solving philosophy in the manufacturing company. Also, according to the author, the concept was initially implemented because of automotive interests, but currently the functions of the WCM system are present in many sectors of the industry.

According to Chiarini and Vagnoni (2015), in the years in which Hayes and Wheelwright's studies took place there was a great debate on the supremacy of the Japanese industry over the Western Industry. In the late 1970s and 1980s, American and European companies learned a new industrial lesson based on JIT and TQC from Japanese companies such as Toyota.

As stated by Chiarini and Vagnoni (2015), Hayes and Wheelwright's study (1984) introduced WCM principles around the world, showing that Western industry needed profound strategic change. However, inspired by that research, Schonberger (1986) reinterpreted the WCM creating a new template. His book "World Class Manufacturing: The Lessons of Simplicity Applied" was widely cited and launched a debate on WCM in the late 1980s and 1990s (CHIARINI; VAGNONI, 2015).

Schonberger (1986) reviewed the principles of WCM, bridging the gap between strategic management and the processes and tools required from a company to achieve its strategies.

Chiarini and Vagnoni (2015) point out that WCM, however, was left aside since the late 1990s to make way for Lean Manufacturing. According to the authors, the WCM was not completely abandoned, since although Lean Manufacturing cast a shadow over all the theoretical models originated from the Toyota Production System (TPS) in the 2000s, some companies around the world renewed and reinvented WCM.

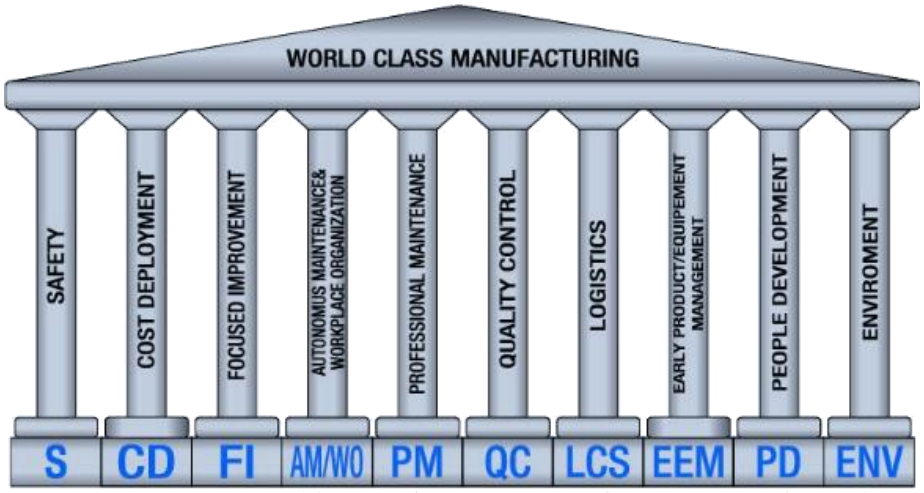
These companies met in the "WCM Association" and began sharing a WCM model of excellence influenced by TPS and TQC. Companies like Ariston Group, Elica, Embraco, Fiat Industrial, Fiat Spa & Chrysler, Royal Mail, System Polónia, Unilever and Volvo Powertrain are part of this association (CHIARINI; VAGNONI, 2015).

According to Dudek (2014), a growing number of metallurgical industry companies are implementing the WCM concept. The author asserts that the basic principle underlying WCM is to optimize production processes through continuous improvement and elimination of any waste. The elimination of losses is preceded by its identification and cost evaluation. This assessment is associated with the area of the occurrence of loss. In the supply process, losses also occur, and their detailed

estimation allows a better calculation of the actual cost of production (DUDEK, 2014).

Gajdik (2013b) states that, in practice, each company has to work its own way to reach the WCM level. However, many organizations have adopted the configuration of 10 main pillars that, after their implementation, should provide the reference position in its sector of activity, as shown in Figure 2 (GAJDZIK, 2013b; PAŁUCHA, 2012; SAXENA; SAHAY, 2000; STANEK; CZECH; BARCIK, 2011).

Figure 2 – World Class Manufacturing pillars



Source: Adapted from GAJDIK (2013b).

These pillars, Safety (S), Cost Deployment (CD), Focused Improvement (FI), Autonomous Maintenance and Workplace Organization (AM/WO), Professional Maintenance (PM), Quality Control (QC), Logistics and Costumer Service (LCS), Early Equipment and Product Management (EEM), People Development (PD) and Environment (ENV) are aligned with the model proposed by the WCM Association (CHIARINI; VAGNONI, 2015).

The WCM configuration based on ten technical pillars has been widely applied in today's industry, especially in the automotive business, and gives great prominence to knowledge, as well as to the enhancement and gathering of ideas for operational improvements, setting bold targets for this type of process (GAJDZIK, 2013b; PAŁUCHA, 2012; STANEK; CZECH; BARCIK, 2011; WCM Fornecedores…, 2015).

Midor (2012) says that ambitious goals set by WCM require the company to make a profound change, not only for the operation of the plant, but also for the way of working and the way of managing production processes.

According to Pałucha (2012), special attention should be given to the WCM initialization process for factors such as the development of a favorable environment, understanding the benefits of the model by everyone, the need to increase staff creativity, improvement and growth of team motivation. According to the author, the management of the

organization according to the principles of WCM is based on reliable and high-quality methods, and tools with broad participation of all employees and managers of the company. Also, to execute the world class manufacturing processes, it is necessary to use teamwork and prepare employees to work in such teams. The continuous involvement of all workers is necessary, regardless of their position in the organizational structure.

Several of these aspects refer to intellectual capital, an important point for Knowledge Management. The explicit relationships identified in the literature between these two constructs – KM and WCM – are presented in the next topic.

7 Knowledge management and world class manufacturing

The complete reading and analysis of the nine articles that presented the terms Knowledge Management and World Class Manufacturing in their titles, abstract or keywords, showed that the relationship between these two subjects is low or almost null in the eight articles that don't have the terms in the title. These eight papers were always focused on one of the two constructs, only citing the other at some point. The only article in which both terms appear in the title of the article discusses this relationship. This session addresses the main points raised in this one article, entitled "Role of Knowledge Management in World Class Manufacturing: An Empirical Investigation", published in 2011 and written by Abhijeet Digalwar and Kuldip Singh Sangwan. The article was found on two databases: Web of Science and Scopus.

It is important to note that in a previous paper, Digalwar and Sangwan (2007) presented performance measures and variables for Indian companies following WCM practices, and treated Knowledge Management as one of the possible performance measures for World Class Manufacturing, allied to Top Management Commitment, Employee Training, Innovation and Technology, Employee Empowerment, Environment, Health and Safety, Supplier Management and Production Planning and Control. According to the authors, knowledge allows to make predictions, random associations or descriptive decisions on what to do, and the knowledge created in a company must be reused to improve the performance of business processes (DIGALWAR; SANGWAN, 2007). The highlight of the variable Knowledge Management in their research directed to another study developed by these authors, with a greater emphasis on the role of this measure in the WCM, discussed below.

Digalwar and Sangwan (2011) reported identifying for the first time the role and benefits of Knowledge Management (KM) within the WCM context by means of a systematic review of the literature. The data collected through a survey of 87 manufacturing organizations were used to refine and validate these benefits.

The results of the analysis performed by the authors regarding the index of importance of the answers show that all the benefits identified

are in the "very important" or "important" category. The validation of this finding was made through the SPSS statistical tool, thus providing evidence that the benefits identified are reliable and valid for the manufacturing industry, as well as being unidirectional and independent.

From a literature review, Digalwar and Sangwan (2011) found that many researchers have justified the role and benefits of Knowledge Management in the process of manufacturing excellence through theoretical findings. According to the authors, the numerous success cases in the implementation of KM indicate the existence of tangible and intangible benefits thereof, such as reduction in manufacturing cost, increase in revenue, new open markets, speed of innovation, improvement and acceleration of learning, increased coordination and team collaboration, improved ability to manage organizational changes, retention of tacit knowledge and increased employee retention rate.

In accordance with the authors, WCM and KM present some similarities, as follows:

a) they are oriented towards people;

b) both are oriented towards results;

c) they play a fundamental role in leadership;

d) both promote effective communication;

e) they encourage teamwork;

f) both seek to exceed customer expectations.

Digalwar and Sangwan (2011) affirm that Knowledge Management is primarily focused on building cultural support for sharing and generating knowledge. In addition, people play a vital role in the dissemination, acquisition and use of knowledge. Therefore, according to the authors, understanding the KM would improve the implementation of basic quality tools that will enhance the competitiveness of companies.

From this perspective, the WCM implementation may be complemented by KM. The authors point out that KM is an organized and systematic way to improve an organization's ability to use the knowledge that will be directed to improve decision-making and deliver results in improving existing business strategies. Therefore, when used and leveraged correctly, knowledge may allow organizations greater competitiveness, innovation and sustainability.

As mentioned, Von Krogh and Voelpel (2006) emphasize the importance of this knowledge to the dynamics of the company, stating that by interacting and sharing tacit and explicit knowledge with others, people within the organization improve their ability to understand a situation or problem, and thus apply their knowledge to act and solve the problem.

Likewise, Midor (2012) says that in WCM, employees must reach a level of awareness in which they are able to identify the types of problem and know exactly the proper ways to solve them. They can also call other people involved for help. According to the author, continuous improvement of workers' qualifications, skills and knowledge is what is needed to solve problems through WCM methods and tools.

8 Final considerations

This article presented the results of an initial theoretical and conceptual research that aimed at developing a comprehensive and current view on Knowledge Management (KM), World Class Manufacturing (WCM), and how (or "whether") these constructs relate to one another.

The results refer to the bibliographic research on WCM and Knowledge Management in the following databases: Web of Science, Emerald, SciELO, Spell, Ebsco and Scopus. After the presentation of bibliometric results, it was evidenced the lack of articles that relate these two constructs, thus reinforcing the relevance of this work to the academy, since only one article was found with the terms World Class Manufacturing and Knowledge Management in the title, and eight articles were found with both terms in the Abstract and/or Keywords for the period from 2000 to 2016, excluding repetitions in different databases.

Based on the literature analyzed, the two themes were presented separately, and then in an integrated way.

One of the main common points observed between KM and WCM involves the emphasis organizations give to intellectual capital. Many authors have indirectly addressed common terms in Knowledge Management from the WCM context.

Still, with the need for broad and applied knowledge regarding the WCM, as addressed in the theoretical basis session of the current article, the importance of the theoretical approximation of these constructs is reinforced for the definition of a methodology, based on KM, which may enhance the results expected and achieved with the implementation of the WCM that is being used by the market.

This hypothetical extension of the WCM from the elaboration of methods and tools based on KM becomes even more particular regarding the management of facilitating contexts in the process of capturing valid suggestions for improvement and reduction of costs, since this is an explicit and quantified target established for companies that stick to the model developed by the WCM Association (MIDOR, 2012; “WCM for Supplier Scorecard”, 2015).

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