Lean Six Sigma: The contribution to the resilience and organizational competitiveness.

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Abstract
This paper discusses the importance of concepts like Lean Manufacturing, Six Sigma and Lean Six Sigma and the contribution to the resilience and organizational competitiveness. The chapter also discusses the strategic role of information and information technology. The research method is the case study conducted in Brazilian industrial companies.

Keywords: Lean Six Sigma, Resilience, Organizational Competitiveness, Information Technology

Introduction
We are in the XXI century and living in a knowledge society, where business is changing rapidly and where success and survival depend on the organization's ability to adjust to dynamic business environment. In this context, some questions arise: How can we develop the best strategy for business? How information systems can contribute to the strategy? What is the contribution of information technology to the existing information systems in business?

The purpose of this paper is to seek to understand the importance of concepts like Lean Manufacturing, Six Sigma and Lean Six Sigma and the contribution to the resilience and organizational competitiveness. After the main themes of literature related to the subject as: Lean Manufacturing, Six Sigma, Lean Six Sigma and Resilience, we defined the following research questions, which will be key to the development of this research:

- What is the importance of the concepts of Lean Manufacturing and Six Sigma for industrial companies?
- How to identify the contribution of information and information technology for the management of production systems?

The research will be conducted in Brazilian industrial companies, aims to survey and analyze the maturity of these companies in the application of concepts such as lean manufacturing and six sigma and identify how these companies identify information needs, actions and solutions that contribute to the monitoring of the strategic goals set for the production.
Literature Review

Lean Manufacturing

Lean manufacturing is a concept already widespread and used by many industrial companies as well as services. The term that emerged through the engineer and MIT researcher John Krafcik, refers to the Toyota Production System (TPS) that became known worldwide through the book The Machine that Changed the World written Womack et al. in 1990 (Alves, Carvalho and Souza, 2012).

The main concept of Lean Manufacturing is the reduction and elimination of wastes aiming speed printing company. Lean Manufacturing in the center is the reduction of seven types of waste: Overproduction, Waiting, Transportation, Excessive processing, Inventory, Motion, Defects (Niu, Lau and Pech, 2010).

According Werkema (2011), Lean Manufacturing is based on five basic principles, including :

- Create Value for the Customer: the starting point for Lean Manufacturing is to define what is value, which must be defined by the customer and not the company.

- Map the Value Stream: consists of identifying the value stream, which means detailing the production chain and separate the processes into three types: those that add value, those who do not add value but are important for the maintenance of processes and the quality and end those that do not add value and should be eliminated immediately.

- Create Flow: is to give fluidity to the processes and other activities, which requires a cultural change.

- Pull Promote Production (Production the customer pulls) the continuous flow reversal allows the production flow, ie the consumer begins to pull production, inventory and eliminating value giving the product.

- Pursue Perfection: Perfection should be the objective of all involved in the value stream.

Among the benefits of Lean Manufacturing are: cost reduction, more productive work force, shorter delivery times and better quality. Losonci and Demeter (2013) identify the relationship between heavy use of Lean Manufacturing tools and operational performance, resulting in business performance. The main tools used for the implementation of Lean Manufacturing are:

- Value Stream Mapping
- Lean metrics
- Kaizen
- Kanban
- Standardization
- 5S
- Setup Reduction
• Total Productive Maintenance (TPM)
• Visual management
• Poka-Yoke (Mistake Proofing)

In order to implement Lean Manufacturing, Mostafa, Dumrak and Soltan (2013) proposes a framework with the following steps: Conceptualization phase; Implementation phase design; Implementation and evaluation phase and Complete lean transformation phase.

Six Sigma

Six Sigma is a management concept that aims to increase the performance and profitability of companies. Initially introduced by Motorola in 1980, focuses on achieving the strategic goals of the company, determined by senior management. Among the benefits of Six Sigma are: cost reduction, optimization of products and processes, increase customer satisfaction and consumers (Werkema, 2011).

The main tools used for the implementation of Six Sigma are (Niu, Lau and Pech, 2010):

• DMAIC: Define, Measure, Analyze, Improve and Control. This process eliminates unproductive steps and non-value search and deploy continuous improvement process.
• DMADV: Define, Measure, Analyze, Design and Verify. It is a systematic methodology utilizing tools, training and measurements to enable the organization to design products and processes that meet customer expectations and can be produced at Six Sigma quality levels.

As a way of implementing Six Sigma, Kumar, Antony and Tiwari (2011) proposes a framework consisting of five distinct phases: Readiness for Six Sigma; Prepare; Initialise; Institutionalise and Sustain.

Lean Six Sigma

The integration of Lean Manufacturing and Six Sigma favoring companies to use the strengths of each methodology. Lean Manufacturing identifies steps that do not add value and provides tools to eliminate these steps, while Six Sigma improves the ability of the steps that add value, improve them and allowing the elimination of additional steps and time reduction (Werkema, 2011).

Organizational Resilience

The organizational environment is always changing originate from several sources such as customers, suppliers, competitors and government. According Ates and Bititci (2011), Managing change to adapt to an uncertain future is a challenge requires resilience - the capacity of an organization to survive, adapt and sustain the business in the face of turbulent change. Resilience is seen as a key organizational capability for sustainability in the current turbulent environment. Also according Ates and Bititci (2011), for organizations to be more sustainable
and resilient, the delivery of innovative responses to the market through continuous change and improvement is necessary.

According to Burnard and Bhamra (2011), the concept of resilience has a firm grounding within the realm of ecology and gained considerable recognition through the work of Hollings (1973, 2001) and Walker et al. (2002, 2004) and resilience resides in both the individual and organizational responses to turbulence and discontinuities.

The strategic role of information and information technology

According to Beal (2008), information is an essential element in the creation, implementation and evaluation of any strategy and strategic planning of information is the management of information resources of an organization from a strategic and planning must be derived from strategic organization.

Information technology (IT) is an integral and fundamental to support, sustain and grow a business (Mohamed and Singh, 2012). Several perspectives are defined for the governance of information technology, among them the activities and structure to align business and information technology that targets principles to organize activities, use of resources, risk management, governance structures and performance measurement. The relationship between business and information technology should be made through strategic alignment, value delivery to the business through information technology, performance management, risk management, policies and procedures and control and accountability (Ward and Peppard, 1996, Webb et al., 2006).

The relationship between information technology and business management changed over time. In the early stages of automation, the primary objective of information technology in relation to the business was the establishment and improvement of organizational efficiency and effectiveness and in a second stage companies realized that information technology plays an important and crucial to organizational success in support of the business and management strategies and emphasis on (Klouwenberg et. al., 1995).

Some authors emphasize the importance of the use of IT in the business environment (Ho, 1996; Daniels, 1998; Klouwenberg et. Al., 1995; Petros, 2003). An architecture for the dismemberment of the business strategy, through business architecture, design of IT architecture and design of the IT infrastructure, until the design and development of systems is proposed by Klouwenberg et. al. (1995).

The literature on information technology presents a mechanism for integration of telecommunications, data processing, information systems based computing. Information technology has enabled organizations to access more information than they can use, and also to control strategic processes, such as production functions (Dibrell et. Al, 2009).

From the late 1960s, the production function has to be perceived as a strategic asset and new approaches to better understand its strategic role began to emerge. The content of manufacturing
strategy consists of a pattern of decisions regarding the structure and infrastructure of a manufacturing organization. The decisions include the following: product scope, process technology, manufacturing alliance and competence production (Gianese and Correa, 1993). The alignment between manufacturing strategy and IT strategy must be considered by industrial enterprises, where IT plays three key roles: administrative, operational and competitive. The administrative function means the automation and control of organizational functions on the part of IT. The operational function is an extension of the first function and is distinguished by the creation and use of a single IT platform for all organizational processes and not only administrative. Finally the function competitive, which is an important point where the use of IT is outdated and not only restricted to automation and efficiency of organizational processes, but also contribute to the information necessary for the pursuit of competitive advantage (Ho, 1996).

In this context, the use of information technology arises as a response to assist in various business processes, data quality, information and decision making. Some concepts and solutions are presented below:

**Enterprise Resource Planning – ERP**

The beginning of the concept of enterprise management systems (ERP) can be identified in the early 1960s, where this time the first solutions - software - were responsible for inventory control for production systems. In the following decade, 1970, the production systems demanded more refined controls, then the emerging systems of material requirements planning (MRP) that helped control the master production plans and needs for raw materials. In the 1980s, emerged the manufacturing resource planning (MRP II) that in addition to controlling the production of master plans and needs for raw materials also allow the calculation of equipment needs and labor-intensive. Subsequently, other organizational areas such as purchasing, finance, sales, among others, were added to MRP II, thus creating the concept of enterprise business systems - ERP (Yen et al., 2001). The need to improve the organization, control and management of data and information in its internal processes, motivated many companies to implement systems for enterprise resource planning - ERP (Davenport, 1998, 2000).

ERP systems allow an organization to automate and integrate business processes, share common data and practices across the enterprise and can produce and access information in a real time environment. The ultimate goal of an ERP system is that the information should only be entered once (Marnewick and Labuschagne, 2005). Furthermore, they need to simplify, streamline, integrate and boost productivity in the various organizational processes. Some studies seek to analyze the selection of ERP systems for companies or even analyze success by business managers and information technology (Ihineido, 2007; Ziaee, Fathian and Sadjadi, 2006).

**Manufacturing Resource Planning**

MRP (Material Requirements Planning) and MRP II (Manufacturing Resources Planning II) systems are the administration of large production which has been used by companies and have as main objective the calculation of resource requirements productive order to meet delivery deadlines of customer orders, with minimum stockpiling, production planning and purchasing
components for items that occur only at such times and quantities required (Gianese and Correa, 1993).

The MRP / MRP II is an IT-based approach to deal with uncertainty and complexity that arise in the manufacturing environment. It is a highly sophisticated information system which controls the complexity and uncertainty that occur in a production environment. It uses the schedule of planned production to design requirements for individual parts or subassemblies. These requirements are compared with the levels of inventory and scheduled receipts for the batches can be scheduled to be produced or received as needed (Ho, 1996). It has five modules, as follows:

- Module production planning (production planning): Helps decision to aggregate levels of inventory and production period to period, also based on forecasts of aggregate demand.
- Module master production planning (master production schedule): It is a plan for the production of end products items, period to period.
- Calculation module need materials (materials requirements planning): Based on the list of materials (sheet) is made the explosion of materials needed for the production.
- Calculation module capacity requirements (capacity requirements planning): Locates infeasibility of a given master production plan in relation to productive capacity.
- Control module factory (shop floor control): Responsible for production control at the factory level, making the production of notes held.

Sales Force Automation – SFA

The use of solutions with sales force automation (SFA) is becoming more common for companies and according to some authors, Speier and Venkatesh (2002) and Brambilla (2009) use is being increasingly seen as supporting the strategies for Customer Relationship Management (CRM).

The time of the customer at the time of sale is increasingly scarce and therefore the information products and differentials of a company must be shown with agility and in order to generate curiosity and enchantment. Currently many vendors even with the use of traditional solutions SFA also take orders manually in front of the client stubs and type printed later in the system. The use of new technologies, such as tablets, is becoming a trend since the advent of tablets, has created a new category of mobile devices and smart phones to notebooks intermediate (Mazini and Novaes, 2012).

Business Intelligence

The application of Business Intelligence (BI) are decision support tools that allow the analysis and manipulation of data from various sources, both internal and external, including the principal's own ERP system used in the company. Advanced tools BI provide a complete view of the business and help in uniform distribution of data among users, no matter where these data are (Baptist, 2004).
BI tools allow users to construct queries needed for a more efficient and friendly and can strengthen the decision-making capacity of leaders and managers. BI tools can be used to generate various aspects of business views through manipulating existing data captured by company's information systems. BI can be used for any organization to structure its ERP information and other data repositories, for fast and effective decision-making. (Chou, Tripuramallu and Chou, 2005).

**Lean Six Sigma and the contribution to the resilience and organizational competitiveness**

**Methodology**

In order to capture information on the Lean Six Sigma contribution to the resilience and organizational competitiveness, we conducted an exploratory research, operationalized by a qualitative approach / case study. The exploratory nature is justified because, although there are numerous publications on Lean Six Sigma and resilience, there is a lack of research on this topic considering the contribution the information technology to this subjects (especially when referring to the Brazilian scenario). The unit of analysis for case study research presented in this paper were 06 companies in the furniture industry sector on Araçatuba, state of São Paulo, Brazil and information was collected through semi-structured interviews made with an manager industrial on each company.

**Cases Studies**

The research aimed to identify whether organizations know the concepts of Lean Manufacturing, Six Sigma and Lean Six Sigma and also understand the contribution of these concepts to organizational resilience and competitiveness.

We found that some concepts and principles of Lean Manufacturing and Six Sigma are known by companies such as eliminating waste, quality management and cost reduction. Other concepts and principles with Lean Six Sigma is not already broadcast by the business.

Despite the companies understand the importance of these concepts and principles and their importance to resilience and organizational competitiveness, they have difficulties in implementing these methodologies because of several factors such as cultural issues, difficulties in managing projects, staff turnover.

The strategic role of information and information technology are also identified by enterprises as an important factor for organizational resilience and competitiveness. Enterprise Resource Planning – ERP systems - provide companies among other benefits the organization of the flow of data and information between various organizational processes , which contributes greatly to the speed, efficiency and elimination of waste proposed by Lean Six Sigma.

Among some important to monitor the production process and that ERP systems can contribute information , we can highlight :
• The appointment of the planned manufacturing orders versus the pointing of manufacturing orders made.
• The appointment of inputs provided versus the inputs used to supply the production process.
• Production lots that are in arrears in the production process.

Compared to Six Sigma, ERP systems can also contribute to the continuous improvement process that reduces the variability by identifying and pointing rework caused during the production process.

Another important factor for the development of Lean Six Sigma aspect is the establishment and monitoring of a set of metrics - performance indicators (KPIs), which guide the efforts and resources used by companies as well as the adoption of corrective or preventive measures. In this sense the BI solutions help to monitor these performance indicators that can be used at strategic, managerial or operational level.

Conclusions

The systematic application of the concepts proposed in this paper will allow businesses the opportunity to improve their performance, adding concepts and tools that will contribute to improvement in organizational processes and organizational culture. Identifying areas for improvement, eliminating processes that do not add value and always seeking continuous improvement process.

Currently, the major challenge to put this proposal into practice, is the communication problems between the various organizational areas, as well as the actions taken between levels strategic, managerial and operating that are not in accordance with the strategic objectives defined. The involvement and support of senior management of the company is paramount to success factor in implementing Lean Manufacturing, Six Sigma or even Lean Six Sigma.

Resuming the research questions proposed, was identified through the analysis of the research presented and the literature review, concepts such as Lean Manufacturing, Six Sigma and Lean Six Sigma will raise improvement of organizational processes, waste disposal and also for the quality of processes, products and services and the information technology and its various solutions add value if used in conjunction with the concepts presented.

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