

## A STRATEGICAL APPROACH ON HOSPITAL MANAGEMENT UNDER *LEAN SIX SIGMA* METHODOLOGY VIEW

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### ABSTRACT

*The increasing concurrence in business world has been forcing companies, regardless segment or size, to being continually improving their processes. Seeking for quality tools which enable organizational efficiency and efficacy is struggling. Considering hospital service segment, a proposal is Lean Six Sigma - LSS, that corresponds to a joint of Six Sigma methodology and Lean Production. The central point of this study is to show by field research, important factors for LSS establishment, as well as present some well succeeded cases. For that, two hospital centers of national reference were investigated. Data collection were taken through semistructured interviews by Black Belts responsible for each hospital's project management. The research focus will be quality, with descriptive approach. By data analysis, it was identified that one of the main obstacles to LSS establishment is related to human resources. Due to be a wide and developing area, this work provides subsides for further researches.*

**Keywords:** *Six Sigma, Lean Production, Services, Hospital, Strategic management*

### 1. INTRODUCTION

Globalization phenomenon propitiated among other consequences, the stirring of business world concurrence. According to Calarge (2001), the strategical view for customer satisfaction has lead many organizations to adopting a management focused on ongoing quality in their processes and products.

There is a trend for building models of management focused on efficacy in manufactural processes. However, due to the strong concurrence, service segment are seeking for tools which are able to optimize their processes, reducing costs and conferring a higher level of quality to the provided services.

Amongst the large field of service segments, this research will aim to approach health field, specifically hospital management. Such motivation is mainly related to the rare theoretical essays linked to that area, as well as the tool for this study's core analysis, the *Lean Six Sigma*, is to have it employed in hospital field as an innovative symbol.

*Lean Production* and *Six Sigma* are methodologies for processes' optimization, which were initially cogitadas para a utilização de modo segregado. For Antony (2011) *Lean Production* focus its strength on efficiency, aiming

more production at the possible lowest cost, eliminating losses. On the other hand, Pande, Neuman, Cavanagh (2001), believe that *Six Sigma* represents an understanding on customers' needs, allowing some enhance or even a reinvention of business processes, based on statistical data.

With rapid technological, economical and social changes, in the 1990s decade, the hypothesis of jointing both tools aiming major efficiency and less loss, in a process called *Lean Six Sigma-LSS* arose. For Antony (2011), o LSS works better, because it is capable to unit human aspects, like leadership, focus on client, cultural change, with aspects of process nature, management and statistical thought.

By through qualitative approach, this study is based on the methodology of descriptive nature. For technical procedures, bibliographical researches were made. The theoretical content example resulted from cases of study on two distinct hospital centres of reference in country, one situated in Northeast and other in Southeast, which, aiming preserve the identity, will not have their names revealed. According to Miles and Huberman (1994), the data analysis were taken analitically, under two views, one intracase, and other, intercase from the investigated hospitals.

## 2. THEORETICAL REFERENCE

Facing the competitive environment where organizations are immersed, searching differentiation of concurrence and improving enterprise performance constitute crucial factors for survival. [...] Thus, for keeping themselves competitive, organizations employ different management practices, that, if used with rigorous criteria and discipline methods, can surpass concurrents, providing better products and quality services (LINDERMAN et al., 2003).

This constant need of adaptability from organizations front of consumers' needs, requires a management system that not only guarantees high productivity, but also enables an increase of provided products and/or services' quality. In this way, the proposal for *Lean Six Sigma* has been highlighted. This tool corresponds to the integration of two methodologies of wide knowledge. One is *Six Sigma*, that focus on reduction and/or elimination of defect incidence, mistakes or even process failures; the other is *Lean Production*, that is based on losses elimination, in all of their dimensions. All of those tools will be approached in details throughout this research.

### 2.1-Six Sigma

What is currently called *Six Sigma* program came out in the beginning of 1987, when professionals from Motorola company started a series of studies on concepts established in relation with variability of production processes, aiming to improve the performance by analysis and such variations' reduction (ANDRIETTA; MIGUEL, 2007). Werkema (2002) proposes that at that time, Motorola was seeking for a solution to minimize claims regarding electronical products' fail, even within the expire date.

Klefsjo (2001), in his studies, proposes that the name Six Sigma is given because the ' sigma ' is regarded as a statistical measure of the change in the discretionary process or its standard deviation, i.e., represents the ability to produce parts without defects. Thus, seeks to optimize the processes ensuring up to twelve standard deviations (six for each side) within the required specifications.

*Six Sigma* methodology follows DMAIC structure, that in its turn derives from ISO 9000 and PDCA cycle that was developed by Shewhart in the 1920s decade and launched by Deming in 1950. Below, the five stages of DMAIC:

- *Define* (Definir): to precisely choose scope and project processes;
- *Measure* (Medir): by through tools, like the cause effect matriz, problem localization and focus is determined;
- *Analyze* (Analisar): to determine problem root causes and their impacts;
- *Improve* (Melhorar): to propose and implement solutions for the problem aiming the reduction of defect numbers;
- *Control* (Controlar): by measures and monitoring, the statistical control for long term objectives' accomplishment guarantee is promoted.

*Six Sigma* has been pointed out due to the systematic way to promote quality, having as preceitos variabilidade and losses reduction in processes. For that, promotes the processes' control by using statistical means, thus conferring concrete and reliable data to support decision making.

According to Hahn et al. (2000), *Six Sigma* can be considered a management practise, that seeks alavancar companies' profitability, promoting a larger participação in market, as well as cost reduction and operation

optimization. Consequently, this tool promotes defect reduction, customer retenção de clientes and reduction of process activities' time. Added, Pande, Neuman, Cavanagh (2001), propose that *Six Sigma* is a wide and flexible system that can be employed to reach, sustain and maximize success in organizational performance.

Pande, Neuman e Cavanagh (2001), point out that *Six Sigma* may present three levels of objectives,

1. Business change: Related to changes in organizational structure and culture.
2. Strategic improvement: Identify threatens and opportunities, acting so that would limit or maximize them, respectively.
3. Problems' solution: Identify areas which are highly cost symbol, retrabalhos or even não cumprimento dos prazos estabelecidos in the process.

Comparing to the previous approaches on Quality Management, *Six Sigma* is mainly different according to Watson (2000) by two factors:

- 1- Regarding human factor;
- 2- The use of statistical tools for obtaining results.

However, *Six Sigma* presents some limits and disadvantages. It may be highlighted the fact of being considered a complex methodology by some and therefore not indicated for fails and defect at low cost. Added, the given tool presents as strong obstacle to the need of workers' high availability, once demands long periods of training and adaptability.

Considering the tolls of Quality Management, other methodology, *Lean Production*, must be studied.

## 2.2. *Lean Production*

*Lean Production* is a philosophy of production, based on the Japanese production system from Toyota, developed by Taiichi Ohno along with Eiji Toyoda, that besides aiming to rise productivity, abolishing production line losses. *Lean Production* uses several tools, among them, Werkema (2002) points out: *Kaizen*, *Kanban*, Standardization, 5S, *Setup* reduction, TPM (*Total Productive Maintenance*), Visual Management, *Poka-Yoke*, Generic Drawn Systems, Reset of Pulled System, Production Line Balancing, *Lean Metrics* and Value Stream Mapping.

Added, Werkema (2002), considers that *Lean Production*, in the 1950s decade, mainly aimed to identify and eliminate losses, aiming to reduce costs and increase quality and speed of deliverance of product to customers. Tending to process optimization, Womack and Jones (1996) identified seven sources of classical losses that must be defeated. Namely: overproduction, delay, exceeding transportation, inadequate processes, unnecessary inventory, unnecessary move, and defected products.

Nowadays, *Lean Production* spread their concepts, and adheres to a systemic approach, involving all the organization processes besides production line. For Antony (2011) *Lean Production* focus on efficiency, aiming the production of products and services at lower cost as soon as possible.

Notwithstanding the competitive advantages offered by *Lean Production*, it should be considered that this tool can present some limitations. It is considered the fact that demand high upfront costs, since generally to their deployment it is necessary the rearrangement of the production cells for its implantation. Continuing, it is important to note that the *Lean* requires a restructuring of the organizational human resources, in order to demand greater collaboration, involvement and confidence between employees and management.

## 2.3. *Similarities and differences between Lean Production and Six Sigma*

Considering the presented characteristics, it is possible to note similarities and differences between tools. Antony (2011) is one who defends *Lean Six Sigma* – LSS methodology, that represents an integration of the two previous approaches. Even being distinct methodologies, the referred author reports some similarities between *Lean Production* and *Six Sigma*, to be considered:

1. They are approaches that incorporate the principles of TQM (*Total Quality Management*);
2. They are core organization's processes and aim excellence;
3. Its applicability is not restricted to manufactural segment only;
4. They need support for management and multifunctional teams;
5. They focus on approach on top down leadership;
6. They focus on customer, etc.

The points of differentiation between the referred tools also deserves to be pointed. For being better viewed, such points of differentiation are depicted on table 1.

Analysing table 1, it is verified that *Lean Production* owns a superficial coverage, seeking for a whole understanding. It aims to improve process speed, by means of flow and time analysis. Consequently, it focus on the analysis of value chain, while *Six Sigma* presents a deep coverage, once seeks to understand the details of current situation, mainly concentrated on defect elimination and reduction of processes' variation.

Added, Antony (2010) presents other differences between tools:

- *Six Sigma* demands more intensive training when compared to *Lean Production*;
- *Six Sigma* requires more investments in terms of implantation, than *Lean Production*; and,
- *Six Sigma* focus on efficacy increase, whereas *Lean Production* aims the solution for process inefficiency.

By upon similarities and differences, when combined *Lean Production* and *Six Sigma* enable formation of a impar tool for process analysis and monitoring, constituting *Lean Six Sigma*'s methodology.

#### 2.4. *Lean Production and Six Sigma – LSS integration*

As shown, *Lean Production* and *Six Sigma* are tools which have already brought good results when working separately. But, when integrated provide strength and result optimization, once the strong points of a tool are capable to suppress each others' deficiencies. Nesse sentido, Lee e Wei (2009) affirm that *Lean Production* focus on loss elimination and activities which does not aggregate value in the organization as a whole, since *Six Sigma* focus on adoption of statistical control for improving the level of processes performance. So, *Lean Six Sigma* integration, or simply LSS is fundamental, because *Lean* is not able to conduct a statistical analysis of process, while *Six Sigma* alone is not adequate to improve process speed.

Harrison (2006) is one of integrated *Lean* and *Six Sigma* use's defenders, believing that when apart such tools can cause the appearance on scene of two subcultures within organization, and consequently, generate a concurrence for same resources.

*Lean Six Sigma* reflects changes on orgaizational structure, therefore requires a cautious establishment. Since it is a practise from high management, it needs leadership involving for adopting strategical objectives in accordance with the new practises, as well as the establishment of guidelines to mativate subordinates. Such variants are example of factors which may decide between LSS projects success or failure.

Knowing the differences between *Six Sigma* and *Lean*, a depict of both methodologies, as well as an additional illustration of their integration, it can be verified on picture 1 .

Interpreting the picture 1, it is noticed that from a certain interval, LSS tool tends to be the best solution. That, because *Six Sigma* which was providing a continuous competitive advantage, based on the reduction of costs at processes' activities, becomes uninteresting, because its focus does not accomplish with a value flow to client. In this same period, *Lean Production*, which keeps its individualized focus on each process activity, starts not to provide satisfactory benefits related to organization costs.

##### 2.4.1. Critical factors of success for *Lean Six Sigma-LSS*

Like all tools, *Lean Six Sigma* presents key points which define the success our failure in their implantation and, therefore serve as guides for organizational management planning.

Table 2 was created to introduce the critical factors of success for *Lean Six Sigma* tool. By analysing it, it is noticed a convergence regarded to factors introduced amongst the studied authors.

By knowing the factors of success, Management must lead the organizational planning strategically in order to maximize the opportunities and minimize the threats.

#### 2.5. *Hospital strategic management and Lean Six Sigma- LSS*

There is no universally accepted strategy definition. Mintzberg (2004) believes that strategy may be placed as an integrated and coordinated unit, of actions and attitudes which when exploring the business competences result in competitive advantages. Reinforcing, its is said that "The process for strategical management is a sequential unit of analysis and choices which may increase the probability that a company may have to choose a good strategy, that is, a strategy which generates competitive advantages" (BARNEY, 2010). For Hitt (2008), generating competitive advantages should be linked to financial returns above the industry average.

In addition to the technical assistance activity/paramedic, is also common to find sectors such as catering, laundry, pharmacy, and restaurant. On the heterogeneity of processes, managing a hospital is a major challenge.

Thus, the quality management tools, such as the Lean Six Sigma, are being used strategically to assist hospital managers to conduct the operation of these companies so harmonious, efficient and focused on cost reduction.

The use of Lean Six Sigma tool in healthcare is a growing new, mainly in Brazil, however, already has shown important results in several hospitals. To get an idea of how new is the use of tools like this in the health sector, has been the fact that it was only in the 2000 years, that the start of application of Six Sigma methodology in the area of Healthcare in the United States and Europe, occurred.

### 3. METHODOLOGICAL PROCEDURES

This study introduces a qualitative approach, because it considers the environment as the data direct source and has the researcher as key instrument for researching. Since it presents a major concern with the phenomena interpretation, on qualitative research, the researcher's theoretical thinking, according to Bryman (1988), occurs during or almost in the end of collection process. Reinforcing "[...] the qualitative research is characterized mainly by the lack of numerical measures and statistical analysis, by examining the more deep and subjective aspects of the studied theme" (DIAS, 1999).

According to the objectives, this research can be classified based on Gil's criteria (2010), as descriptive. Thus, this is related to the phenomenon description in cases of LSS methodology establishment at hospital centers, having as its main objective the precise characterization of the variables involved in these events.

Also focusing on Gil's guidelines (2010), the technical procedures followed the perspective of the bibliographical research. The main used sources were books, journals, the own internal materials provided by the studied companies.

For conducting the research on practical stage, study case approach was adopted. According to Bryman (1988), this methodology enables an approach from researcher on circumstances which involve the phenomenon to be studied, widely, once multiple sources for data collection are used.

The methodology based on case study enables a wide situational approach, permitting the researcher to approximate to junctures which involve the phenomenon to be studied. In this way, case studies at two national reference hospital centers were conducted, one in the Northeast and other in the Southeast.

The procedures used for data collection were semistructured interviews directly conducted with *Black Belts* responsible for project management in each company. The interviews lasted approximately 100 (a hundred) minutes each. Initially, it was proposed that the interviewed briefly featured *Lean*, *Six Sigma* and LSS, followed by explanations on how the cited tools were being employed in organizational processes, pointing benefits, limitations and reasons which lead the company to adopt such methodologies.

After data collection, their analysis by using methods and qualitative data techniques of analysis in an inductive general logics were proceeded, according to Andrade (2002). Such data were contrasted with the theoretical reference. Following Miles and Huberman's guidelines (1994), data were analysed in two distinct manners. On, by individual exploring of information from each studied hospital center (intracase analysis), and other by crossing the acquired data from the two hospital (intercase analysis), so verifying similarities and differences.

Aiming companies' confidentiality, their respective names will not be informed. Thus, the nomenclatures Company C1 and Company C2 has been adopted, whose features, along with their respective results will be explained in the following session.

### 4. DISCUSSION OF RESULTS

This session will be introduced the results obtained by data collection. Initially, there will be an individual analysis of each hospital center and further a cross analysis of the obtained data, along with theoretical aspects of the studied theme.

Company C1 is situated in the Northeast region of Brazil, and is more than 150 (a hundred fifty) years. With approximately 5.000 cooperators and a huge technological structure, it is considered a reference as hospital center in Brazilian North-Northeast. The company C1 has been awarded Quality Certificates of ISO since 2005. These Certificates are result of cooperators and managers' commitment with institutional quality politics.

Focused on the continuous enhance on service rendering *Lean Production* methodology has been implanted in some of their processes, since 2012. Initially, aiming to provide a better satisfaction to customers, upon the

“reduction” of bureaucracy due to processes which do not aggregate value, focused on the administrative area. However, due to resistance from cooperators and no support from the high management, the projects were submitted to bottlenecks that caused their correct implantation to be difficult.

Besides aiming productivity increase, also increase efficiency and efficacy and, mainly, quality of their processes as a whole, it decided to adopt *Lean Six Sigma* methodology since 2013. In order to maximize the results, as well as the interference from human factor, it started the formation of 30 Executive on *Black Belts*, in the beginning of 2014.

A large company EC1 dissatisfaction related to their performance in the process of liberation of the rooms after medical surgeries. This, because of the too much delay for the release of the beds by hygiene team, represented beyond the significant presence of beds idle for a period of time, a significant financial loss as a result. Moreover, this fact also had repercussions in the loss of customers, once they ended up addressing the contestants by the need for the provision of services.

Thus, in order to reduce this obstacle in organizational performance, operated the *Lean Six Sigma* methodology in the process of release of hygiene after the medical surgeries. According to one of the *Black Belt* project, when performing the first analyses of the process, there was an inconsistency in the cleaning standards. This fact in addition to providing an excessive delay in the provision of services, also had repercussions in a deficit of quality.

After setting new standards for hygiene and the adoption of new materials and equipment, the sector's employees received the training and consequently were due to perform the services with greater promptness and efficiency. Along with adjustments in administrative processes and the support of upper management successfully implemented this project. Through established control mechanisms has been possible to obtain the information gain of 40 (forty) minutes in the process of liberation of the rooms after surgeries. This outcome besides enabling a gain of approximately 10 (ten)% of the company's revenue, has also increased consumer satisfaction, since more patients can be met and with best quality.

Upon the success of the project described, earned himself a greater confidence on the part of other contributors. Currently, the Company C1 has other C1 13 (thirteen) projects in phase of study and implementation, among which, 05 (five) present the intention of being put into practice even during 2014.

- **Company C2**

The company E2, is a traditional Hospital Center located in the southeast of the country. In view of its infrastructure, its body qualified human resources as well as its focus on technology and innovation, allowed the company to reach the level of being one of the most highly regarded hospitals Latin America. Since the 1990s decade, the company C2 has many certifications, being some of them in the implementation phase. Examples: Joint Commission International, ISO 9000 and ISO 14000, OHSAS 18001, AABB (Program of accreditation of blood banks), CAP (Program of accreditation of laboratories and blood banks), among others.

With the motto of offering, a humanized care to their patients recommends that its function is not to treat diseases, but rather in taking care of people. This reinforces its concern with quality in the provision of the services offered. Making use of tools such as the PDCA cycle, and in the face of increased business competitiveness, the company realized the need to adhere to E2 new quality tools that could act as a guarantee of greater efficiency and effectiveness in its processes. One of the proposals was the *Lean Six Sigma* methodology, implemented in 2008. The initial goal consisted of application and provision of an increase in capacity use of hospital resources, also leveraging the quality and customer satisfaction, and acting as a key element in the engagement of the employees by making them understand the importance of the tool.

The implementation process of the LSS on company E2, came about by stages, in order to achieve the planned institutional maturity. It is considered that from 2009 to 2010, was the period of establishment of the organizational culture. Thus, in 2009 there was the participation of thirty *Lean* that number *Belts*, doubled in 2010, being added twenty *Green Belts* and two *Black Belts*. Following, the biennium 2011 and 2012, represented the deployment phase. There has been an increase in the number professionals, being eighty *Lean Belts*, sixty *Green Belts* and three *Black Belts*. Already at the stage of support in the subsequent biennium remained the number of *Lean* professionals *Belts*, increasing only the *Green Belts* to eighty and the *Black Belts* to four employees. In front of the data submitted, it is realized that the company C2 was technically qualified for the development of projects using LSS tool.

Through LSS methodology, several positive results were obtained. A case cited in the interview was the ward of exams. Prior to application of the tool, there were on average 5,000 examinations late, and after the project, that number was reduced to 200, representing an increase of efficiency in more than 90 (ninety)%. To obtain this result, as well as increase Laboratory productivity quality, the times of the setups process of analysis and release of results, focusing, in particular, the classic Lean Production wastes were also reduced.

This project also needed to consider your starting point, i.e. the activities of the administrative area for the marking of examinations. This, as a factor of dissatisfaction for customers was waiting in too. With the analyses is implied that one of the reasons for such hopes related to the fact that the employees have difficulties in framing a proper prescription in the categories of existing tests in the system. In this way, one of the procedures adopted was a readjustment of processes with the creation of standards. Health professionals (doctors and nurses) received instructions on how to describe a standardized exams. From the time of implementation of this reclassification was possible to obtain a gain of time in relation to the attendance of customers around the 55 (fifty-five)%, since a process that took on average some 40 (forty) minutes, considering the time spent waiting for a range of 19 (nineteen) minutes.

Synthetically, they obtained information about results of other LSS projects implanted so far. One of them relates to the Ready Availability for emergency patients. Through application of LSS, unnecessary handling and reduction of setups, reverberating in a reduction of permanence in 37 (thirty seven)% of these patients.

The Company C2 recognizes the importance of high Management for LSS projects success. For an ongoing follow-up, the high executives meet other involved in the projects at least once a week. According to one of the involved managers, that fact is a highly satisfactory mechanism, because *“it is noticed the proximity between the higg management and the operational level, highlighting the importance of cooperation.”* Nowadays, the company has more than a hundred whose study object is directed to the use of installed capacity, aiming clients' attendance and satisfaction and, also, the leverage the levels of productivity and efficiency.

#### • **Cross Analysis**

In this topic, it is intended to take a cross analysis with the obtained by the case studies at the the two companies, correlating them to the theoretical aspects. It is important to take in account that due to the study on two companies pertaining to the same working sector, it is possible to infer the most reliable conclusions. Since both organizations are considered large and their organizational structure are relatively similar, it is possible to infer that may have similar limitations and advantages.

It was verified that a bottleneck for LSS methodology implantation in both companies is related to the organizational culture. Added, Shein (1992) affirms that the organizational culture refers to the establishment of basic premisses shared between the group, in order to help in solving of matters of external adaptation and internal integration, in such a way to be easily taught to the new members, like the correct way of notice, think and feel those problems.

For being traditional organizations, in which the bureaucratic regimen prevails, there is a massive resistance from the cooperators in accepting the new guidelines on such tool. For proving such fact, it was possible to listen to project manager, in both companies, cooperators' sentences, which depicted situations like: *“I have been done this service for more than twenty years and now someone comes who wants to command the way I do my work!”*. Assertions like this demonstrates clearly the resistance to change and conflicts looming in case of forcing the acceptance of new procedures.

Robbins (2010) proposes six tactics which can be used by agents of change aiming to solve resistance, being considered:

- Education and communication: establish a frequent communication between employees and their managers, so that they are aware of the events.
- Attendance: attract the resistant to an active operation;
- Facilitation and support: use of advice and support to the battered acquire confidence to agents of change;
- Negotiation: is the establishment of a relationship of exchange, like win-win;
- Manipulation and cooptation: handling refers to the attempt of domination in disguise, and represents the integration of the co-optation manipulation with the participation; and,
- Coercion: use of force and threats to intimidate the resistance.

In theoretical inferences, it can be affirmed that in case studies, if the agents of change had promoted an effective communication with employees to be affected with the projects possibly would have prevented their resistance, might as well acquire their voluntarily engagement to projects. Consequently, initial projects as reported would have their chances of failure minimized.

Other critical factor of success which was not regarded by both studied companies refers to the frequent communication of obtained results. This, because during the interviews with the responsible was possible to verify that the obtained results from LSS projects implantation generally become data exposed and analyzed only by high management. This monopoly of information, is not beneficial, because it does not allow the developer to know how your performance is being significant or not for a particular purpose.

For the two companies, LSS provided beyond money income, a continuous improvement of services' quality, see table 3. Consequently, such variables reflects in major customers' satisfaction and increase reliability/credibility of the services.

The studied companies intend to spread the use of LSS, mainly aiming a continuous quality of their services and their customers' satisfaction.

## 5. CONCLUSION

As noted in the search results to the *Lean Six Sigma* methodology – LSS, there is the generation of several competitive advantages, especially being featured on hospital management as it is able to potentially raise its performance. The research objectives were achieved, since it was possible to see how the LSS tool has been characterized as a potential to leverage business performance.

With the bibliographical research, it was possible to review the main approaches behind the *Lean Six Sigma - LSS*, also highlighting their distinct concepts referring to the Toyota *Lean Production* and *Six Sigma* at Motorola. It is concluded that LSS emerged through the increased competitiveness in the business world, not only as a means of increasing productivity and reducing costs, but also by the high quality bias in organizational products and/or services. This was only possible because the quality is in constant evolution, passing from the age of product, processes and customers, reaching the age of knowledge.

The current research presents limitations. Some required data could not be provided by the studied companies due to confidentiality. Despite this circumstance, the obtained results can be considered positive, meeting the proposed objectives. It is noticed that LSS use for hospital management is a propitious area. So, it is fundamental to keep on investigating, in order to focus on possible aspects of correlation between employment of quality tools and approach on organizational learning.

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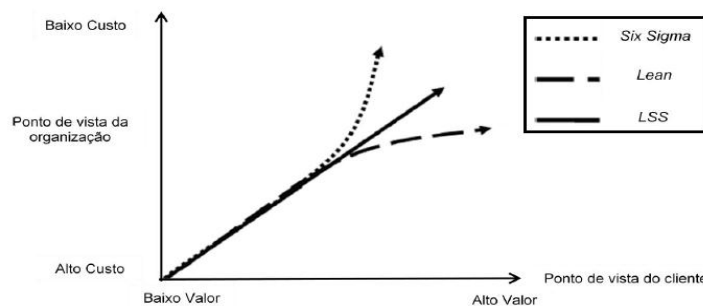
**ANNEXES**

Table 1. Comparative Demonstration between *Six Sigma* and *Lean Production*

	<i>Six Sigma</i>	<i>Lean Production</i>
Origin	Motorola (1980s decade)	Toyota (1970s decade)
Focus	On problema	On flow
Goal	Maximize results	Maximize productivity
Theory	Reduce variation	Eliminate losses and increase profit
Structure	Manage projects by improvement plan, DMAIC methodology. Thus, should it: 1.Define; 2.and 5.Controle.	Manage projects, implementing improvement by MFV (Value Stream Mapping). Thus, should it: 1.Specify value; 2.Identify value flow; 3.Flow; 4.Pull and 5.Seeking perfection
Deficiencies	Don't consider the interdependence of the system; Independent processes' improvements	It does not use statistical tools or analysis systems; Focus restricted on losses
Participants	<i>Green belts, black belts, masters black belts and champions</i>	Leader on <i>Kaizen, Sensei</i>

Source: The authors

Figure 1. Individual and integrated approach on *Lean* and *Six Sigma* methodologies



Source: Pepper and Spedding, 2010

Table 2. Critical factors of success for LSS, according to several authors

Critical factors/ Author	Andrietta and Miguel (2007)	Jeyaraman and Teo (2010)	Pepper and Spedding (2010)
Commitment and dedication of leadership	X	X	
System of recognizing and awarding	X	X	
Organizational culture	X	X	
Effective training on LSS	X	X	X
Frequent communication on obtained results	X	X	X
Master Black Belts and Black Belts competence	X	X	X
Required financial resources	X	X	
Prioritization, selection, review and follow-up of the programme	X	X	X
Sharing of best practices of the project		X	
Control Panel of set up pointers	X	X	

Source: table built by authors based on the pointed bibliographical references.

Table 3 – Summary of company data

Cases		
	C1	C2
Implementation of <i>Six Sigma</i>	2010	2005
Investment <i>Six Sigma</i> (R\$)	Unavailable information	≈ 800.000
Feedback <i>Six Sigma</i> (R\$)	> 500.000	Unavailable information
Some tools applied	Cause and Effect Diagram, Pareto Diagram, Dispersion Diagram	Cause and Effect, PDCA, DMAIC, Hypothesis Test
Implementation of <i>Lean</i>	2012	2006
Investment <i>Lean</i>	≈ 300.000	Unavailable information
Feedback <i>Lean</i>	>1 million/year	>2 millions/year
<i>Six Sigma</i> and <i>Lean</i> integration	High, since 2013	High, since 2008

**Source:** table built by authors, based on data obtained from case studies.