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Extending lean manufacturing in supply chains: a successful case in Brazil

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Abstract

Purpose – The purpose of this paper is to present the results of a success story involving the extending of lean manufacturing practices between a focal firm and its supplier, both located in Brazil, thereby configuring a case of excellence.

Design/methodology/approach – An in-depth case study was conducted involving two companies: Company A, focal, leader in its segment, located in Brazil; and Company B, Company A's supplier, also located in Brazil.

Findings – Results indicate there are several mechanisms for extending lean manufacturing practices in the supply chain, such as workshops, training, and integrated teams. These mechanisms are shown and guidelines are also introduced for companies seeking to successfully extend lean manufacturing practices.

Originality/value – An original use of define, measure, analyze, improve, control for structuring the extending of lean manufacturing practices to suppliers and, consequently, the importance of the lean six-sigma relationship in this context. Furthermore, the guidelines introduced serve as a benchmark for other companies interested in the topic.

Keywords Supply chain, Brazil, DMAIC, Dissemination, Benchmarking, Lean manufacturing, Lean production, Extending

Paper type Case study

1. Introduction

Operations management has undergone transitions in its paradigms for production organization in recent years as a result of changes in market requirements, going from a perspective of mass production to one of mass customization. In this sense, companies are obliged to compete in various dimensions of performance (price, quality, flexibility, delivery, etc.), therefore using, for example, strategies and techniques such as lean manufacturing and supply chain management to respond to these changes (Gunasekaran and Ngai, 2012).

In this sense, the lean manufacturing system is an important paradigm for current production. The main pillars are thus: produce only what is necessary, at the necessary quantity, and at the necessary moment (just-in-time (JIT) philosophy); and autonomation (empowerment for employees) (Ohno, 1988; Holweg, 2007), aimed at maximizing value for the client by eliminating waste in the production flow (Womack *et al.*, 1990; Dennis, 2008).

Besides lean manufacturing, supply chain management is also a current paradigm for operations management. That is because organizations have structured themselves as supply chains – as interdependent organizations that share information to enable material flows between raw material suppliers, component suppliers, manufacturers, clients (retail), and consumers. Thus, an organization depends on the supply of various



inputs from various other organizations to produce its products and, thus, it is fundamental to manage not only internal production flow, but also external flows.

Therefore, lean manufacturing philosophy and the perspective of supply chain management can be combined (Scherrer-Rathje *et al.*, 2009; Ozelkan *et al.*, 2007; Cagliano *et al.*, 2006). However, according to Panizzolo (1998), this is one of the most critical factors for complete implementation of lean manufacturing principles, that is, it is extending to organizations external to the focal organization (such as clients and suppliers). Thus, the challenge is to understand the impact the decision of a tier in the chain can have on another (Lamming, 1996).

In terms of an analysis of the state-of-the-art on the theme, there are some qualitative studies that dealt with the extending of lean manufacturing practices between the focal firm and its suppliers, but they were conducted in the 1990s and they have not been properly updated since then (Macduffie and Helper, 1997; Dyer and Nobeoka, 1998). More recent studies are of a quantitative nature and deal with other aspects, such as the impact of adopting lean manufacturing practices on quality performance (Agus and Hajinoor, 2012), the influence of relation, cooperation, and integration aspects between the focal firm and the supplier in adopting lean manufacturing practices (So and Sun, 2010; Moyano-Fuentes *et al.*, 2012), among others. It is also understood that most of these studies were developed within the context of developed countries, with a lack of studies on emerging countries.

Therefore, this paper is motivated by the following question: how does the extending of lean manufacturing practices from the focal firm to the main supplier occur within the context of an emerging country? Thus, the main objective of this study is to describe and analyze a successful case of extending lean manufacturing practices between a focal firm and its most important supplier in the Brazilian context. The selection of Brazil is justifiable because this country is the largest in Latin America. It is responsible for 7 percent of this region's gross domestic product (Jabbour and Jabbour, 2014), and as a consequence, a successful case from this country could serve as a benchmark for other developing countries.

This paper is structured as follows: Section 2 introduces the theoretical background, with the presentation of elementary concepts on lean manufacturing and supply chain management, a review of the main means of extending lean manufacturing in the supply chain, and finishes with a conceptual framework of the study; Section 3 introduces methodological procedures that justify the relevance of companies that comprise the chosen case and explains how the study was conducted; Section 4 presents the results; Section 5 the discussions, which analyze the case in accordance with literature; and Section 6 presents the main research conclusions and proposes guidelines.

2. Theoretical background

2.1 *Lean manufacturing and supply chain management*

In this study, lean manufacturing is an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability (Shah and Ward, 2007). The main practices that support lean manufacturing objectives are (Shah and Ward, 2003, 2007; Bhasin and Burcher, 2006; Pettersen, 2009; Agus and Hajinoor, 2012):

- Continuous flow – with a reduction in production lot size it is possible to better control production flow for it to be continuous and, thus, avoid waste generation.

- JIT – with the use of “kanban” cards, it is possible to plan and control production line flow so that only the necessary is produced, when needed, and in the necessary quantity.
- Reduction in setup time – with the SMED technique (Ohn, 1988), for example, it is possible to reduce machine setup time and provide a combination between production volume and variety.
- Total production maintenance (TPM) – with minor daily repairs, it is possible to avoid unplanned stops in the production line, that is, waste.
- Employee involvement – one of the pillars of lean manufacturing is autonomation, which provides for employee involvement in troubleshooting and in proposing suggestions, through *Kaizen* and teamwork.
- Continuous improvement – using quality management techniques (PDCA, 5S, TQM, etc.) it is possible to identify the root cause and propose solutions to create a cyclical process. More and more, companies are using an integrated approach between lean manufacturing and six sigma. Six sigma is based on the cycle of define, measure, analyze, improve, and control (DMAIC), and is an approach to control the quality of the production process. DMAIC tries to avoid variations in the production process pattern (Naslund, 2008; Arnheiter and Maleyeff, 2005).
- Supplier development – according to Liker (2005), this is one of the principles of lean manufacturing, that is, to respect the partner and supplier network by challenging them and helping them to improve.

Most especially, this last lean manufacturing practice, supplier development, can only be achieved with the collaboration of several tiers in the supply chain. Thus, it is important to conceptualize the supply chain management.

Harland (1996) defines supply chain management as the management of supply relations, encompassing the dyadic relationship between the supplier, supplier's supplier, client and client's client, aimed at providing products and services in accordance with end-user requirements.

Supply chain management precepts involve: activities, benefits, and components of the supply chain (Stock *et al.*, 2010). According to Stock and Boyer (2009), supply chain activities enable material, service, information, and financial flows among chain members, achieving intended benefits. These benefits are the creation of value and efficiency to satisfy the consumer. This occurs through components of the chain, such as the manufacturing, retail, distribution, and logistics organizations that are part of the supply chain.

Synergy can be identified between lean manufacturing and supply chain management benefits, thus creating value for the client, and both are achieved by observing the production flow (materials). Additionally, developing suppliers is a lean manufacturing practice, which is one of the components of the supply chain. Thus, working with supply chain suppliers is one means of extending lean manufacturing.

2.2 Extending of lean manufacturing practices

In this study, there are two main means of extending the adoption of lean manufacturing practices in supply chains, with a focus on suppliers: first, when the supplier, voluntarily and with its own resources, begins to adopt lean practices; or second, when the focal firm for the supply chain begins to pressure suppliers to adopt lean manufacturing practices.

In these processes, according to Boyle *et al.* (2011), access by the supplier company to external sources of information that can support the process for improving lean manufacturing practices is fundamental and could occur through: conferences/events involving industry members; training sections; visit to other companies' plants for verifying best practices; benchmarking at other plants of the same company; and holding internal workshops on the theme with the supervision of external consulting.

According to Arkader (2001), the supplier's role is very important for reducing waste throughout the supply chain. Wu (2003) adds that suppliers that adopt lean manufacturing practices achieve a greater competitive advantage in logistics than those that do not adopt lean manufacturing. So and Sun (2010) specify that the selection and integration of suppliers has a positive influence on the adoption of lean manufacturing.

For the focal firm, in turn, generally a manufacturer, in its role as main client in the supply chain, it is also important for suppliers to seek lean manufacturing practices. Whether by suggestion of the manufacturer, or due to mandatory issues, suppliers must follow the requirements imposed, which can include, for example: high quality of products, high control of the quality process, and quality certification system (D'Angelo and Amato Neto, 2008).

Simpson and Power (2005) suggest that the results obtained with lean manufacturing depend on the dissemination of knowledge and sharing of lean manufacturing principles in the focal firm-supplier relationship. Some information is shown below on how lean manufacturing practices can be extended to tiers in the supply chain.

MacDuffie and Helper (1997) report that Honda used multifunctional teams between the manufacturer and the supplier that worked in a focussed manner for weeks on improvement projects at the supplier plant.

According to Dyer and Nobeoka (1998), Toyota has some routines to facilitate the transfer of technology and knowledge, which are useful for promoting lean manufacturing actions to suppliers:

- supplier association – aimed at exchanging information between Toyota and its suppliers;
- operations management consulting division – the objective is to maintain a high level group of internal consultants to provide assistance in troubleshooting at Toyota as well as at supplier plants;
- voluntary learning teams – voluntary study groups that help each other in improving productivity and quality;
- troubleshooting teams – teams created for solving emerging problems at one or more suppliers;
- inter-firm transfer of employees – for purposes of troubleshooting; and
- feedback from process performance and monitoring – seeking the continuous improvement of suppliers.

Marksberry (2012) reaffirms the aforementioned extending mechanisms, that is, mainly the relevance of work by multifunctional teams in improvement projects, and open communication between the manufacturer and supplier.

Thus, in a supply chain, the supplier as well as the focal firm plays an important role in the extending of lean manufacturing practices. In this context, extending mechanisms such as work teams, exchanges of information, and improvement projects stand out.

2.3 Conceptual framework of the study

Based on the main concepts presented in Sections 2.1 and 2.2 of this paper, Figure 1 represents the conceptual framework for this study, underscoring that the analytical cutout resides in the relation between the focal firm (manufacturer) and its main supplier (first tier supplier), and it is a successful case in terms of the upstream extending of lean manufacturing practices. Based on the description and analysis of the successful case (in Section 4) and in accordance with the main arguments in the literature (Section 2), guidelines will be proposed to support, through benchmarking, the extending of lean manufacturing in supply chains in emerging countries.

3. Methodology

3.1 Object of study

The case is comprised of two companies: Company A, the manufacturer and focal firm in the supply chain; and Company B, Company A's main supplier (first tier supplier). A brief report follows to justify the relevance of this case.

Both companies operate in the state of São Paulo, the richest and most important industrial city in Brazil. Company A is a multinational subsidiary and a world leader in construction and mining equipment, natural gas, diesel motors, gas turbines, etc. This Company began adopting lean manufacturing practices in 2007 and it has its own Lean Manufacturing System (in this study called "APS" – Company A Production System).

Company B is Brazilian. It is considered a large company (based on a company roster of more than 500 employees), specializing in the production of metal parts, systems, and assembled subsystems, starting with cutting and folding processes. It has ISO 9001, 14001 and ISO/TS 16949 certification. In 2010, it was awarded the title of "Company A World Class Supplier." In 2010, Company B began seeking training in lean manufacturing.

Company A has the most modern industrial plant of the sector in Brazil. This company has an operational excellence certification which makes it world-renowned. Company A is the principal client of Company B. Thus, Company A is the most

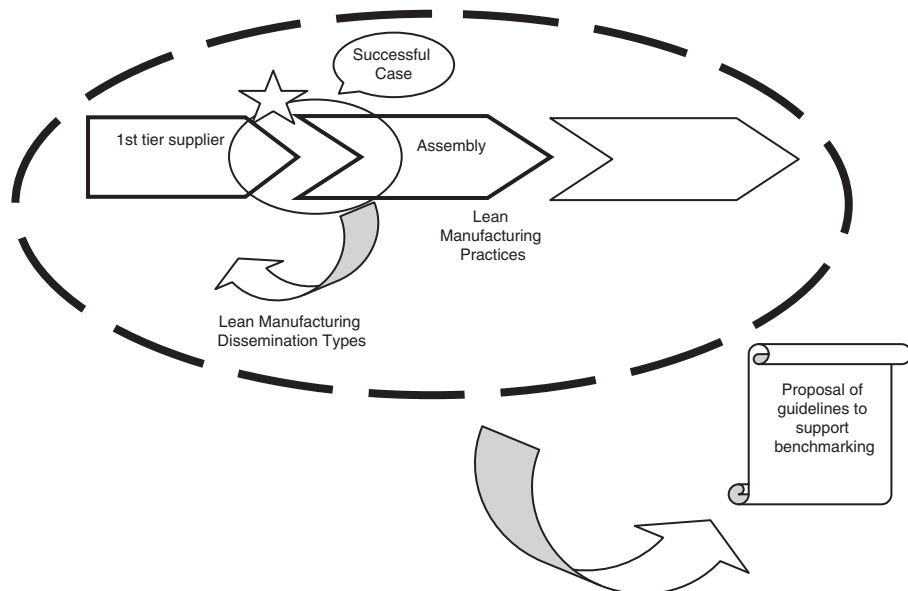


Figure 1. Conceptual framework of the study

relevant player in Company B's improvement process. The relationship between Companies A and B is based on the search for operational excellence and long-term collaboration.

3.2 Procedures for data collection and analysis

A case study approach was adopted. In the field of research on extending lean manufacturing in supply chains, there are many works with a quantitative approach and only a few works with a qualitative approach. The case study approach is relevant to understand contemporary issues in its real context (Woodside and Wilson, 2003). In this study, the case study approach was adopted, aiming to describe a real and contemporary organizational issue: how does the extending of lean manufacturing practices from the focal firm to the main supplier occur within the context of an emerging country?

Data triangulation has been adopted, based on direct, in-plant observations, interviews with professionals, and document analysis (Yin, 1994). Table I summarizes the information obtained.

By gathering the information obtained on Company A and Company B, and comparing the collected data from the companies, it was possible to analyze the results on how lean manufacturing was extended in this successful case.

4. Results

4.1 Mechanisms for the extending of lean manufacturing practices (Company A)

Company A has a team responsible for the extending of lean manufacturing practices in the supply chain. It is comprised of professionals trained in six sigma (Master Black Belts, Black Belts, Green Belts, and Yellow Belts) with additional training in the fundamental characteristics of Company A's production system (called the APS). All work for developing suppliers is accompanied by a team with two collaborators: one Master Black Belt APS and one Black Belt APS.

The process begins with the choice of suppliers. The choice of suppliers that participate in improvement processes based on lean manufacturing practices is the responsibility of the purchasing department and mainly follows the criteria of delivery performance (punctuality), product quality, and delivery volume. Suppliers are invited and can opt not to participate in improvement projects.

The methodology used in extending lean manufacturing practices focusses on holding value flow transformation (VFT) workshops for the supplier. It uses the

Company	Observations	Interviews	Data
A	Onsite visit to the factory to check the production line for the adoption of lean manufacturing practices	Black Belt specialists who are part of the APS team (a production system)	PowerPoint presentation of the APS program to suppliers Company data – company site
B	Onsite visit to the factory to check the production line for the adoption of lean manufacturing practices	Lean supervisor at the company	Handout provided at Company A workshops Value flow maps to monitor the current and future situation Timetable for adopting lean manufacturing practices

Table I.
Information obtained at analyzed companies

DMAIC process improvement method, which lasts up to 100 days. The description of the objectives for these workshops for each step corresponding to the DMAIC is shown below:

- (1) Define: leadership workshop:
 - defines the supplier/manufacturer value flow;
 - designates the person responsible for the VFT;
 - understands the initial focus for implementing improvements through project graphics; and
 - understands pre-work.
- (2) Measure: pre-work VFT workshop:
 - finalizes the project graphics;
 - collects operational data;
 - documents common goals between manufacturer/supplier; and
 - updates employees through specific training.
- (3) Analyze: VFT workshop:
 - completes the core training;
 - conducts group activities on project details;
 - completes the map of the current state of value flow;
 - designs the map of the future state of the value flow; and
 - develops action plan for achieving the future state.
- (4) Improve: improvement implementation workshop:
 - formation of the manufacturer/supplier team at the supplier factory;
 - implementation of 5S;
 - identifies the size of the parts supermarket and its location; and
 - improves production line response time.
- (5) Control: monitoring of VFT workshop:
 - reviews project implementation progress;
 - discusses lessons learned;
 - exchanges experiences with other suppliers; and
 - defines the next area/opportunity for improvement at the supplier's plant.

Figure 2 summarizes the extending process of Company A's lean manufacturing practices.

After the monitoring VFT workshop, which is the last phase of the project, Company A, the focal firm, projects the accompanying of results obtained to be kept by monitoring delivery and quality performance indicators.

With the VFT program for suppliers, the manufacturer seeks to continuously improve delivery performance indicators of products supplied and the quality of products supplied.

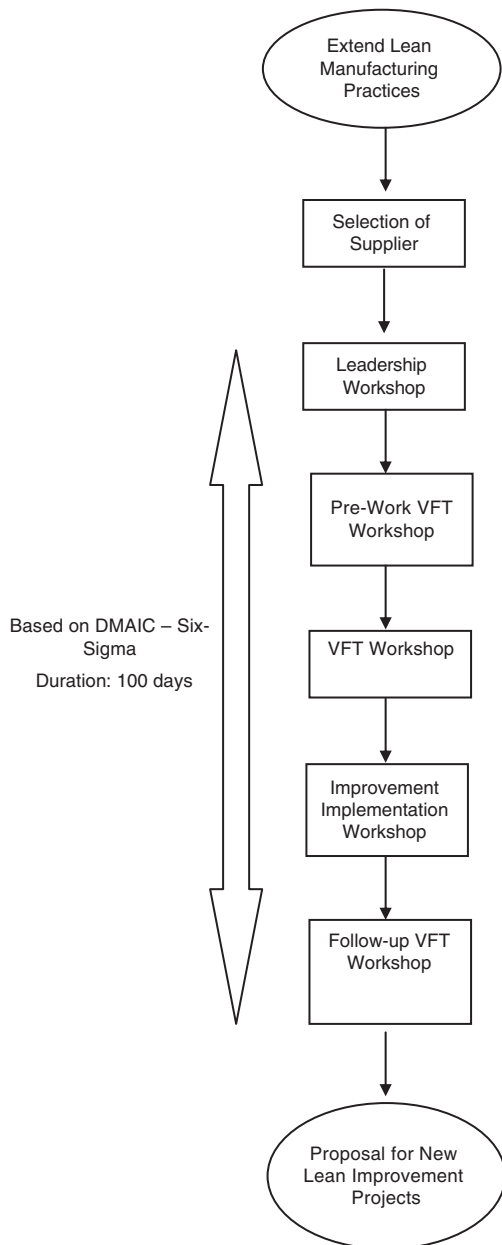


Figure 2. Extending process of Company A's lean manufacturing practices to Company B and other suppliers

The main lean manufacturing practices extended in the VFT for suppliers are: Value Flow Map; 5S; Standardized Work; Reductions in Setup Time; Pull Systems; *Kaizen* Events, and TPM.

Company A's policy is to not demand a portion/percentage over gains obtained by suppliers with the adoption of lean manufacturing practices

or to demand short-term reductions in production costs as a result of improvements obtained.

4.2 Adoption of lean manufacturing practices at Company B

The supplier under analysis (Company B) did not adopt lean manufacturing practices, with Company A the main inducer in this process. Company A, focal firm and manufacturer in this supply chain, was already adopting lean manufacturing practices, so it advised its suppliers to adopt the same.

Since Company B had no knowledge of lean manufacturing, it was necessary to hire an outside consultant, a specialist in lean manufacturing. This consultancy was indicated by Company A.

With the consultancy, the supplier (Company B) began the process of implementing lean manufacturing practices in July 2010. The consulting work was conducted for 18 months, and after that period, the work was given continuity in an autonomous manner with Company B's in-house team.

During the consulting period, lean manufacturing tools were incorporated in the productive process, such as: 5S, Value Flow Mapping, Visual Management, Pull System, Setup Time Reduction, Continuous Flow, and *Kaizen* Event.

The actions adopted for sustaining and giving continuity to the concepts and techniques implemented were: monthly audits; meetings for the presentation of action plans; continuous improvement teams and periodic accompaniment by focal company (Company A) employees.

With lean manufacturing, Company B obtained significant improvements in the following aspects:

- improvement in supplied product delivery indicators;
- improvement in supplied product quality indicators;
- greater agility (reduction in lead time);
- greater flexibility;
- smaller inventories; and
- improvement in process productivity.

4.3 Mechanisms for the extending of lean manufacturing from Company A to Company B

The process for promoting lean manufacturing practices from Company A to Company B began with the invitation from Company A's purchasing department to be part of a supplier development program. After an explanation of the project, Company B management decided to participate in the project. After accepting the invitation, all steps defined in the A Productive System (APS) for suppliers, elaborated by Company A, the focal firm in this supply chain, were followed.

The leadership workshop was held at the manufacturer's plant and lasted three weeks. Training was conducted for Company B executives concerning the specifics of Company A's Production System (APS) for suppliers; the project team was formed; and the scope and goals of the supplier's development project were defined:

- improve the welding process for a specific line of products;
- maintain 100 percent efficiency in the line's delivery performance; and
- meet quality indicators.

This scope was defined since it would provide an increase in Company B business with Company A and it would also meet Company A's outsourcing strategy.

The pre-work VFT workshop was held at the manufacturer's plant and lasted three weeks. The second training for the project team was conducted on APS for suppliers, defining the current value flow map.

The VFT workshop occurred at the supplier's plant and lasted three weeks. The future value flow map was defined; the Spaghetti graph was proposed; and workstations were balanced.

The improvement workshop occurred at the supplier's plant and lasted three weeks. The pull system was implemented, improving internal movement and 5S use.

The follow-up VFT workshop was held at the manufacturer's plant and lasted one week. Project results were presented and the next steps defined.

The main benefits achieved with the extending of lean manufacturing in partnership with the client were:

- improved layout of the process;
- improved process organization;
- increased in-line productivity;
- improvement in supplied product delivery indicators;
- improvement in supplied product quality indicators; and
- greater agility (reduction in lead time).

After the follow-up VFT workshops, the manufacturer and supplier accompany the results obtained in the project by monitoring delivery performance and quality performance indicators.

5. Discussion

The case presented permits the discussion of aspects of the literature, such as: the use of external resources, such as training, workshops, and consultancy support to adopt and improve lean manufacturing practices (Boyle *et al.*, 2011); the positive relation of the importance of supplier selection when adopting lean manufacturing (So and Sun, 2010); the manufacturer as a vector in adopting lean manufacturing practices (D'Angelo and Amato Neto, 2008); and the use of multifunctional teams between the manufacturer and supplier in improvement projects at the supplier's plant (MacDuffie and Helper, 1997; Marksberry, 2012). On the other hand, it brings new evidence, such as the use of DMAIC for structuring the extending of lean manufacturing practices to suppliers and, consequently, the importance of the lean six-sigma relationship in this context (Figure 3).

Below, the main conclusions from this study and the implications for managers are shown.

6. Conclusions

6.1 Final remarks

This study presented a successful case of the extending of lean manufacturing practices between an important multinational company located in Brazil, a focal firm in a supply chain (Company A), and its main supplier (Company B). It thus achieved the proposed objective for the study by illustrating how this successful case developed.

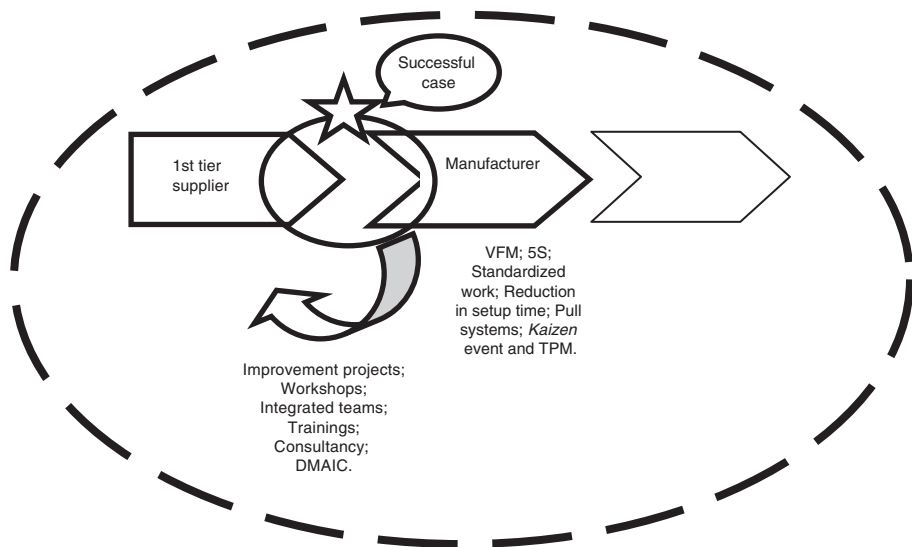


Figure 3.
Illustrates the study's
main result

This study adds the Brazilian perspective to the state-of-the-art on the dissemination of managerial practices in supply chains. These studies were conducted more intensely in the 1990s and focussed more on the reality of developed countries. Furthermore, this paper presents an in-depth study as a counterpoint to the quantitative studies that have been dominating this field of research more recently.

Finally, even with the limitations of having studied a single case, it presents several guidelines for success that can be useful, such as benchmarking of the extending of lean manufacturing practices between focal firms and suppliers in emerging country supply chains. These guidelines are presented below.

6.2 Managerial implications – guidelines for facilitating the dissemination of practices

The case presented can serve as a benchmark for focal firms and suppliers interested in adopting lean manufacturing practices. This case has several mechanisms for the extending of lean practices between Company A (focal) and Company B (supplier) that could be useful for managers interested in this topic.

Below are some guidelines to support the extending process of lean manufacturing practices in the supply chain based on the reported success case:

- lean six sigma – the combination of lean manufacturing practices and six sigma philosophy (near zero errors) for the quality control of processes permits structuring workshops in the extending of lean manufacturing practices among suppliers;
- supplier qualification – choosing to whom to extend lean manufacturing practices is something very important on which to focus manufacturer actions. selected suppliers should have prior experience in lean manufacturing for a more effective process;
- based on projects – it is necessary to elaborate a joint improvement project for a more effective extending of lean manufacturing practices;
- workshops and trainings – frequent meetings and training are means to enable an exchange of experiences and for proposing goals for the extending of lean manufacturing projects;

- dedicated and integrated teams – it is important to have qualified people who are focussed on improvement projects and who are responsible for achieving the goals of the main company and its supplier;
- monitoring of performance – without establishing common goals between the manufacturer and suppliers, the extending process could have a short-term effect;
- focus on continuous improvement – proposing improvement projects through lean manufacturing should be cyclical so there can be a culture of continuous improvement at the supplier's plant;
- importance of a volunteer and invitation process – inviting suppliers to qualify themselves can have longer-lasting results in continuous improvement than carrying out this process in an obligatory manner without manufacturer support;
- support from a consulting group – external resources in the form of a consulting service can be a way to extend lean practices in a supply chain environment; and
- focal company – the focal companies with a high operational performance are relevant to share and incentivize managerial improvements in all supply chains.

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