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Lara Göhner¹, Luiz Carlos Brasil de Brito Mello², and
Renata Albergaria de Mello Bandeira³

¹Hamburg University of Technology, Germany;
²Universidade Federal Fluminense, Brazil; ³Instituto
Militar de Engenharia, Rio de Janeiro, Brazil

Abstract

Multinational companies with production subsidiaries in Brazil are generally recognized as being highly productive companies. However, in large, their productivity potential is not fully achieved. Lean Manufacturing (LM) has proved to be a valuable aid to achieve competitiveness in the long run. In the light of the increasing importance of the successfully implementation of LM by multinationals in Brazil and an apparent lack of discussion regarding LM in Brazil, this paper aims to propose a comprehensive implementation roadmap, to enable multinationals to achieve an advanced sustainable LM system in a practical manner, based on a systematic approach. Findings from the literature and case studies are combined to develop the roadmap, to permit both companies that have, and have just started to implement LM to be able to use the roadmap. The roadmap was built on a broad empirical basis and it is impossible to consider all factors influencing LMI in multinationals operating in Brazil in a real world setting. Accordingly, it should not be regarded as a ready-made implementation plan, which has to be strictly followed, but rather a guideline to help multinationals develop their own, detailed and tailor-made plan to successfully implement LM and to establish a learning organization.

Key words: Multinationals, Lean Manufacturing, Implementation, Brazil, Roadmap, Stage Gate, Case study.

Introduction

Only a few years ago, Brazil was full of optimism as rising global demand for resources led to an export and consumption boom (Elstrodt, Manyika, Remes, Ellen, and Martins, 2014, p. 1). However, Brazil's gross domestic product growth slowed down dramatically, starting in 2012, bringing the longer term issues of weak income growth and productivity performance to the forefront (Elstrodt, Manyika, Remes, Ellen, and Martins, 2014, p. 1). After a decade of rapid growth, the Brazilian economy is losing its momentum. Productivity in Brazil has stagnated. The current economic crisis, intense competition and rising customer claims place high demands on industry in Brazil. The concept of LM forms a reliable basis that leads to top operative performance, with the objective to reduce inventory, enhance process efficiencies, eliminate waste, and increase value for the customer by increase productivity by providing more output with a minimized amount of an organization's resources (Shah and Ward, 2007, p. 791). However, in reality, many organizations are not able to transform themselves into LM organizations that can be recognized as being excellent companies. It has been reported that many Lean Manufacturing Implementations, even those undertaken with the best intentions, are often destined for failure at some point of their implementation (Nordin, Deros, and Rahman, 2012, p. 102).

Multinationals have an exceptionally large existing presence in Brazil. The current economic crisis affects them drastically (Elstrodt, Manyika, Remes, Ellen, and Martins, 2014, p. 10). To overcome the crisis, multinationals have to implement LM more effectively to continually and systematically improve their operations. Because the implementation of LM is loaded with many challenges, it is important to develop a roadmap, which is tailor-made in particular for multinationals with production subsidiaries in Brazil. If Brazil is able to adopt LM principles strongly in all industries, then it could have one of the highest growing rates in the world over the next few years (Glaser-Segura, Peinado, and Graeml, 2009, p. 2).

Lean Manufacturing Implementation (LMI)

The term LM, which is also known as lean production, was coined at the end of the 1940s, and is often used as a synonym for the Toyota Production System, which was evolved from Taiichi Ohno's experiments and initiatives over three decades at Toyota (Shah and Ward, 2007, p. 786). The term 'lean' as a new paradigm for structuring and managing business operations was adopted in the 1990s by Womack *et al.* They investigated differences between leading Western and Japanese automobile manufacturers and found that Toyota was able to do "more and more, with less and less" (Womack, Jones, and Roos, 1990, p. 49). The systematic approach of LM has a focus on quantity control to reduce cost, by eliminating waste or non-value-adding activities. It is built on a strong foundation of process and product quality, and is fully integrated, continually evolving, and is supported by a strong healthy culture that is managed continuously (Wilson, 2010, p.71).

A roadmap is a strategic plan that describes the steps an organization has to take to achieve its goals (van der Hoeven, 2014, p. 4). It clearly outlines the linkage between tasks and priorities for action in the short and long term. An effective roadmap also includes metrics and milestones to allow regular tracking of progress to reach the goal (van der Hoeven, 2014, p. 4). The development of a roadmap is useful to help reach a consensus about a set of needs and the tools and techniques required to satisfy these needs. A roadmap provides a mechanism to help achieve long-term goals, and it provides a framework to help, plan and coordinate the phases and steps. A LMI roadmap is a pathway to guide the transition from an existing operation to one that fully implements a LM philosophy and its best practices, and enables it to be sustained in the end (Crabill, 2000, p. 2).

Analysis of LMI in MNCs

The implementation of LM, like any other productivity improvement initiative, is often related with enormous implementation difficulties (Nordin, Deros, and Wahab, 2010, p. 375). For any change in an organization to take hold and succeed, the resistance forces, barriers or challenges need to be identified and understood (Jadhav, Mantha, and Rane, 2014, p. 126). An unsuccessful result of LMI, leading to a failed implementation, results in a significant waste of management's time, energy and resources.

Challenges in LMI

The literature review provides an overview of the main examined challenges when applying LM in manufacturing plants in Brazil. The challenges are enumerated from C1 to C18.

C1 Middle Management not giving enough support: Middle management in general spend little time on the shop floor. They do not spend time finding root-cause-solving-problem and standardization activities, or do not have confidence in LMI and in its results (Marodin and Saurin, 2015, p. 60).

C2 Lack of top/senior management involvement (commitment and support): To implement sustainable LM, strong leadership support at the top of an organization is needed. This includes both intellectual support and physical engagement (Jadhav, Mantha, and Rane, 2014, p. 127). A lack of commitment and managerial support may lead to limited access to resources, long decision-making processes and communication breakdowns (Scherrer-Rathje, Boyle, and Deflorin, 2009, p. 82).

C3 Lack of support on the shop floor: Lack of support on the shop floor leads to a lack of confidence on the shop floor in making suggestions for improvements. Shop floor supervisors often fear that they cannot reach targets with less resources, such as shop floor employees or machines (Marodin and Saurin, 2015, p. 61).

C4 Lack of persistence: There seems to be a decrease in interest in LMI by the employees involved after a few years, after the implementation process begun (Marodin and Saurin, 2015, p. 60).

Prevalently results are unemployment (Emiliani and Stec, 2005, p. 375). Consequently, people are demotivated in participating in future LMI activities.

C5 Lack of skills and technical knowledge of LM: Lack of skills and technical knowledge of LM leads to misunderstanding the concept and purpose of LM. The top and middle management is not secure enough in guiding the LMI, neither the continuous improvement activities. There is mostly no a lack of a clear statement about the future state of LMI (Marodin and Saurin, 2015, p. 62). Further, the educational level of shop floor employees and their limited experience of the discipline required for LM are ongoing problems (Wallace, 2004, p. 806).

C6 Lack of human/financial/technical resources: A lack in terms of how resources are managed and organized and a high level of inventory (Wallace, 2004, p. 809). In many cases, insufficient time is allocated for shop floor employees and management to train, be trained, to be encouraged, and to be part of the continuous improvement activities (Marodin and Saurin, 2015, p. 60). LMI may not reach its intended purpose if there are inappropriate training methods and knowledge transfers (Stadnicka and Antosz, 2013, p. 1380; Scherrer-Rathje, Boyle, and Deflorin, 2009, p. 80; Jadhav, Mantha, and Rane, 2014, p. 128)

C7 Lack of communication/engagement throughout the organization: Employees need to be properly informed of the changes that are being implemented. Lack of team autonomy, information transparency and lack of organizational communication lead to a failure of the LM concept (Scherrer-Rathje, Boyle, and Deflorin, 2009, p. 84; Calarge, Pereira, Satolo, and Diaz, 2012, p. 11845). Continuous improvement results, such as cost reduction, lead time reduction, and also activities being undertaken, objectives and next steps are often not communicated effectively at all levels of the organization (Marodin and Saurin, 2015, p. 60).

C8 Shop floor employees are insecure in carrying out new tasks: Shop floor employees often do not feel responsible for using LM practices and solving problems and for carrying out new tasks. A lack of participation by shop floor employees in the implementation process is common. Shop floor employees are often afraid of layoffs due to improvements and demand variation (Marodin and Saurin, 2015, p. 61).

C9 Lack of access to information system: In many instances, managers do not have safe and structured access to the information needed to promote initiatives to achieve LM objectives (Calarge, Pereira, Satolo, and Diaz, 2012, p. 11845).

C10 Weak customer/supplier and organization relationship: Customer/supplier and organization relationship represents the highest level of improvements accomplished to establish long-lasting partnerships (Calarge, Pereira, Satolo, and Diaz, 2012, p. 11845). Communication and flows between downstream customers and upstream suppliers are critical. Organizational structure can create barriers, as supplier management, training and operations are typically separate departments, which may have little, or no interaction (Jadhav, Mantha, and Rane, 2014, p. 130).

C11 Difficulties in seeing the financial benefits: Focus on strictly financial and short-term metrics, rather than focusing on LM continuous improvement features, such as people development, process control, systematic efficiency and long-term activities (Marodin and Saurin, 2015, p. 60). Performance measure and objectives are often still aligned to traditional metrics that do not point out LM principles. Financial capabilities are one of the critical factors for successful LMI (Achanga, Shehab, Roy, and Nelder, 2006, p. 467).

C12 Difficulties to keep the pace of ongoing LMI activities: There are sporadic follow-ups of ongoing continuous improvement activities. The schedule dates and objectives for the LMI activities are frequently postponed. The problem solving is frequently overcome by daily firefighting (Marodin and Saurin, 2015, p. 62). Lack of continual evaluation of LM. The results of productivity improvement are often unemployment, leading to lack of employee participation (Emiliani and Stec, 2005).

C13 Not sustaining lean as a long term journey: The philosophy of an operating LM should combine the goals of satisfying its customers and building confidence among its employees to achieve a long-lasting relationship (Deflorin and Scherrer-Rathje, 2012, p. 3958)

C14 Lack of team-based culture / culture of trust: Lack of cooperation and mutual trust between management and employees is a prerequisite to create a conducive environment for LMI. The difficulty of top management is to delegate, increase the decision scope of shop floor employees, listen to them, and establish a relationship of trust with them (Jadhav, Mantha, and Rane, 2014, p. 129). Problem solving and the elimination of the root cause of problems is a main pillar of LM. To enable employees to begin searching for these causes, a culture that supports continuous improvement is required (Emiliani and Stec, 2005, p. 370; Bhasin, 2012, p. 349; Hofstede, 2003).

C15 Facing a turbulent, dynamic and heterogeneous business environment: An excess of work-in-progress is a main problem during the implementation of LM (Stadnicka and Antosz, 2013, p. 1380). Lean environment is “troubleshooting to the developed environment around the methods generated from best practices to improve processes” (Salinas-Coronado, Aguilar-Duque, Tlapa-Mendoza, and Amaya-Parra, 2014, p. 30). These practices range from the formation of the mentality of the general management of the organization, through to the development of routine practices at all levels.

C16 Cultural differences: Doing business across national borders is more than just exporting a lean concept. Manager often think that LM is well-established and has just to be fitted and adapted to the regional environment (Calarge, Pereira, Satolo, and Diaz, 2012, p. 11849). However, this is mostly not the case, and it requires an inside-out structure. Cross-cultural differences create important barriers to intra-firm communication, negotiation and product standardization, which all lead to misunderstandings between employees and management, as well as between the organization and its suppliers, customers and partners (Jadhav, Mantha, and Rane, 2014, p. 129). A

common reason why LM initiatives perform poorly is that they fail to engage the work force in creating a culture of continuous improvement. Lack of organizational culture and ethical awareness is a main barrier (Calarge, Pereira, Satolo, and Diaz, 2012, p. 11840).

C 17 Lack of empowerment of employees: Managers resist giving up control, or delegating decision-making to the shop floor employees and providing support for what gets decided (Jadhav, Mantha, and Rane, 2014, p. 127). Management domination, order and control of the administration of the workplace does not support and sustain LM (Jadhav, Mantha, and Rane, 2014, p. 127). LM needs managers with the vision to give shop floor employees the freedom to experiment. Shop floor employees should be empowered, so that they move away from repetitively fulfilling tasks to actively improving processes, machines and equipment (Deflorin and Scherrer-Rathje, 2012, p. 3960).

C 18 Problems with machines and plant configuration: Facility layout and modernization of plant and equipment is important for LM. LM requires machines that are reliable and efficient. LM needs flexible layouts that reduce movement of both materials and people, minimizes material handling losses, and avoids inventories between stations (Jadhav, Mantha, and Rane, 2014, p. 132). A poor layout may lead to high material handling costs, excessive work-in-process inventories, and low or unbalanced equipment utilization (Wong, Wong, and Ali, 2009, p. 466).

The literature lacks detailed descriptions and evaluations of the challenges. Most authors do not evaluate many of the abovementioned challenges in much detail. Only a few explain the course or the wider background and consequences of these challenges, but without providing strong evidence. Several authors researching specifically about Brazilian cases place emphasis on the cultural influences which lead to lack of top management support for change, lack of clear communication and lack of interest in LMI (Calarge, Pereira, Satolo, and Diaz, 2012, p. 11849; Jadhav, Mantha, and Rane, 2014, p. 129; Wallace, 2004, p. 811; Jabbour, Junior, and Jabbour, 2013, p. 1081; Lucato, Calarge, Junior, and Calado, 2014, p. 532).

It is evident from the literature survey that the most frequent-cited challenges are lack of top/senior management involvement (communication and support) and lack of skills and technical knowledge of the employees. This is followed by cultural differences, lack of communication/engagement throughout the organization and shop floor employees who are insecure in carrying out new tasks.

Misunderstandings of the concept and purpose of LM is one of the main barriers of LMI. Reasons for this misunderstanding are due to cultural differences. This misunderstanding of the concept leads to various major issues, such as the piecemeal adoption of tools and techniques, misapplication of tools, and a lack of lean culture development to support LM within the organization. Researchers are primarily concerned with the lack of top/senior management involvement regarding commitment and support. The key to successful implementation is total commitment by everyone, especially top and senior management, as it is they who are the force to drive LM initiatives. All levels of the organization have to be involved, from team members to

senior management, to be aware of the fundamentals of LM, and to make the best effort to practice and improve them day-by-day.

Case Study of LMI at MNCs in Brazil

Procedure of data collection and analysis

The field research took place during the period from August until October 2015. In the field research, a qualitative research method was chosen as the main method of data collection. Direct onsite plant visits were conducted to obtain relevant behaviors or conditions in the real life context of the studied phenomenon. The observation can range from formal to casual data collection activities and might involve different levels of participations of respondents, ranging from full involvement to full detachment of LM knowledge. All of the companies were visited during a full day. In all companies, the main contribution to the visits was through visits of the production facilities. Questions were directed to the respondent during the visits. The main feedback from the plant visits, applied in this study, is based on the instructions for evaluating the degree of implementation of LM operations, using the Rapid Plant Assessment (RPA) approach. RPA is a method to evaluate efficiency and leanness, as well as the strength and weaknesses of a production plant with minimum resources, and is a relatively fast method, which can be undertaken in one day, or a few hours. RPA uses two valuation tools: The RPA rating sheet with eleven categories for evaluating the leanness of a plant, and the RPA questionnaire, which provides twenty associated 'yes-or-no' questions to ascertain if the plant uses best practices in these categories (Goodson, 2002, S. 4). The assessments and ratings are indicative of the leanness or adherence to the TPS. All aspects of the plant's environment were observed during the visit and adherence and execution of the plant to LM best practice was analyzed through talking to shop floor employees and managers. The eleven categories of the RPA Rating Sheet that were evaluated (Goodson, 2002, pp. 4-11) are:

1. Customer satisfaction,
2. Safety, environment, cleanliness, and order,
3. Visual management deployment,
4. Scheduling system,
5. Use of space, movement of materials, and product line flow,
6. Levels of inventory and work in process,
7. People teamwork, skill level, and motivation,
8. Condition and maintenance of equipment and tools,
9. Ability to manage complexity and variability,
10. Supply chain integration,
11. Quality system deployment.

To ensure that cutting edge information protects the identities and privacy of all the visited and surveyed companies, the companies are not named. Blinding is a critical device that allows survey respondents to comfortably provide accurate data and information for research such as this one. Onsite plant visits were conducted at three MNCs with production subsidiaries in Brazil, with members representing different hierarchical and functional levels to assess the leanness of a plant.

The three companies were selected based on their willingness to participate and share information about LM. The companies are located in the State of Rio de Janeiro and the State of São Paulo, in Brazil. All three surveyed companies have already implemented LM. The profile of the companies that were visited are characterized as MNCs, with the number of employees ranging from 27,000 to 106,000 globally.

Adoption and implementation of LM at Company A

Company A's headquarters are located in the USA. The main business of Company A is the production of various industrial gases. The production plant visited in the city of Rio de Janeiro produces equipment for industrial gas manufacturing, such as storage tanks and trailers, as well as the performance of field assembly and field repairs. Customers are mainly internal customers in South America. At the production plant, around 300 employees are employed in an area of around 35,000m². The respondent of Company A is a quality manager, who has been employed at Company A for the last seven years.

Company A began adopting LM during their high boom of production, using tools like Kanban and a one piece flow in their standard lines. Employees are well skilled and able to perform different steps in different cells or lines. The employees took care about the quality of the product and solved engineering related problems by themselves. Nowadays, due to the economic crisis that has affected Brazil, LM is not a main issue for the company, and the awareness of the benefits of LM both at the shop floor, as well as by management does not exist. This was affirmed during the shop floor visit.

Company A sets a focus on the supplier relationship and supplier improvement system, with development, evaluation and qualification systems. This initiative comes from the headquarters in the USA. The company established global agreements that are driven by the headquarters, and the local supplier lists managed by the regions.

When asked about which LM practices are presently carried out in the company and what are the further processes regarding LM, the respondent stated that, in practice, there is no investment and focus on LM. The frustration about the crisis, and an absence of orders was clearly seen throughout the employees. Employee reductions had been carried out to overcome the crisis. Around five years ago, approximately 1,500 people were employed at the production site of Company A, but nowadays only 300 employees work at company A. One production line was shut down and the production building was sold. Therefore LM was not a highly priority and was not adopted in this

company. There was no established team-based culture and no regular meetings were held for up-to-date processes and problem discussion.

Adoption and implementation of LM at Company B

Company B produces vehicles on an area of 1,000,000 m², located at a strategic point between São Paulo and Rio de Janeiro. At the production plant, more than 1,500 people are employed. Company B already has an established culture of quality around which the national reputation of the company was built. However, it was necessary to develop new ways of working and perceptions about continuous improvement. Pre-LM initiatives started in 2007 with KAIZEN practices. The first step towards a strong implementation of LM started in 2010. The respondent of Company B was a supervisor of logistics operations and transport, who had been employed at Company B for 12 years. During the visit, the LM activities and lean philosophy were shown and explained in detail. The structure and layout of the plant has been growing over the years, with improvements and an expansion of demand. The production space is currently limited and is difficult to expand. Therefore, many LM initiatives have to be undertaken regarding the reduction and optimization of space. A system of visual management and team working environment has been introduced at Company B to enable everyone involved in the process to understand which problems are occurring and how to solve them.

During the economic crisis production flow was reduced. At the time of the company visit, only 25 percent of workload of the maximum capacity was produced. When asked about the long term strategy and when production will increase, the answer was “*We don’t know how to solve this. However, when our feed burn we think about this, react and start to make improvements.*”

Quality problems with supplied material is a big hurdle at Company B. Poor quality of parts and missing parts result in much waste, such as scrap and rejects at the production line. Not all suppliers of Company B are practicing lean, and are not aware of the need for a high standard of quality at the right time, the right material specification, and the right quantity. This leads to a lean barrier, which is a big waste. A supplier must act as a seamless extension of the refined LM system.

According to the respondent, a major problem is the cultural thinking in Brazil, regarding order and trust. Using lean tools and techniques in Brazil is not easy. Orders and standards are not implemented by the employees. The culture was created with the start of LMI in 2010 and there has been a strong cross-work team culture, motivation amongst the employees and incentives, awards and events were provided by the company. After a few years employees became demotivated, fell back into their old working behavior, and the strongly-implemented team culture collapsed. Today, Company B is trying to tackle these challenges with encouraging new rating sheets to constantly evaluate and improve the main principles, the production system and its tools. According to the respondent, the biggest failure was not to give employees a plan and a standard of how to produce. The employees will see the plan and think about how to change it and how to

make it better, produce it easier, which will always lead to a different result. To achieve a highly productive LM system, the respondent said that this could be only be obtained through a strong cross-functional team culture and a bottom-up perspective. Company B has to further improve LM to keep manufacturing in Brazil. The need to react to market condition and a drop in sales makes LM become an even more important factor. Therefore, a long-term strategy and a quick response to changes can be partly overcome by a strong implementation of LM.

Adoption and implementation of LM at Company C

Company C opened its factory in 2002 in the state of São Paulo, Brazil. Company C mainly produces solutions, as well as liquid and dry concentrates for medical treatments on an area of 20,000 m². Currently, Company C controls 80 percent of the Brazilian market in its field as a provider of products and services. The production demand has increased rapidly in the last years.

The respondent, a supply chain manager who has been employed at Company C for three years, has no specific training regarding LM, however, his knowledge about LM was good - he clearly stated that LM is not his main task. As Company C is complying with strict quality guidelines and pays attention to hygiene standards, we were not allowed to go inside production. Before the shop floor employees enter production, they are obliged to go through a strict cleanliness and dressing procedure. Production is well-visible from a hallway separated from the production by a glass front. The manufacturing integrated modern production technologies and has a high level of machines. When the production plant was established in 2002, Company C had already started to introduce LM approaches, such as Kanban-cards and supermarkets to foster a pull-production. In 2008, Company C started its second attempt to improve LM approaches. An Information Center and Visual Management were introduced. The Information Center represents the documentations to consolidate the current state of the plant's production line performance regarding quality issues and issues at the production lines.

Company C has established a routine interaction and engagement between workers to solve a problem when it arises. The introduced LM approaches are visual and simple. Therefore, all employees have good knowledge about the implemented principles. However, over the years trainings and the philosophy were neglected. Workers lost their motivation, became frustrated and no incentives existed for further LM initiatives.

In 2011, a formal initiative from the headquarters in Germany was the introduction of Six Sigma in all plants around the world. The production site in Brazil was geared towards a lean Six Sigma management system that combines LM and Six Sigma approaches. The function of a lean Six Sigma project manager was established to implement specific LM techniques. The main aim is to increase productivity and in particular to reduce defect rates and shorten manufacturing times. Further training sessions were held to recreate and increase the awareness of the employees about LM and Six Sigma. In the past, continuous improvement programs triggered results, but these were not

sustainably maintained. With the implementation of Six Sigma, the goal of Company C is to maintain LM and its results in the long term.

LMI is a useful approach to mobilize the internal leaders to adopt the concept of LM. However, the respondent stated that in Company C, LMI is more about making pilot implementation to demonstrate results, and afterwards expand it throughout the whole processes. Implementing LM simultaneously will lead to a piecemeal adoption of relevant tools and techniques in Brazil. It is important to train and motivate employees. Educational training in Brazil has to be more supported by practical trainings. Setting a standard is not the way workers in Brazil will be able to produce, as they would think about how to change the process and improve it for their own convenience.

Data analysis and results of case studies

The data analysis is based on the plant observations and the subsequent evaluation that was carried out of the RPA approach, as well as important quotes and questions answered by the respondent. The analysis of the companies visited yielded interesting results, and gave important insights into challenges and barriers within the LMI process.

The challenge most emphasized during the plant visits is the economic crisis, which has a huge lever on multinationals in Brazil, and leads to cuts in production, and therefore less investment. The advantages of becoming lean are comprised when demand fluctuates and customer orders increase, for it is then that investments can be made to perform LM. However, from the case studies it can be concluded that companies fail to perform LM when demand increases or, as is the case now in Brazil, when it decreases. A well-designed LM system allows for an immediate and effective response to fluctuating customer demands. In the plants researched, the focus on customer needs, supplier involvement and safety are relevant aspects.

Further, the case studies highlighted the missing cultural problems regarding team building. Standardization, order and trust are a huge challenge, as workers are not trained to follow standardized work instructions. To find their own solutions of how to produce better and easier leads to incremental mistakes during production. During the plant visits it was pointed out that, there is a lack of influence over suppliers' involvement in the actual LMI. It was highlighted that some suppliers avoid implementation of LM because improvements would mean cutting through the detection of non-value added activities and therefore less involvement in the supply chain. A lack of involvement of suppliers disrupts the LM schedule, and a lack of influence over the supplier makes it difficult for multinationals to implement LM throughout the whole supply chain. This was especially the case for Company B, where suppliers are active in the production process, and it is necessary to implement LM practices to the whole supply chain. Therefore, Company B is focusing on a long-lasting relationship with highly competent suppliers.

No	Measure	Related questions in the RPA questionnaire	Score		
			Company A	Company B	Company C
1	Customer satisfaction	1, 2, 20	3	7	5
2	Safety, environment, cleanliness, and order	3-5, 20	5	9	5
3	Visual management deployment	2, 4, 6-10, 20	1	9	7
4	Scheduling system	11, 20	5	7	5
5	Use of space, movement of materials, and product line flow	7, 12, 13, 20	3	7	5
6	Levels of inventory and work in process	7, 11, 20	3	5	3
7	People teamwork, skill level, and motivation	6, 9, 14, 15, 20	1	5	5
8	Condition and maintenance of equipment and tools	16, 20	3	7	5
9	Ability to manage complexity and variability	8, 17, 20	5	9	5
10	Supply chain integration	18, 20	5	9	3
11	Quality system deployment	15, 17, 19, 20	5	7	5
Totals score for 11 categories (max 121)			39	81	53

Rating scores

- 1 poor
- 3 below average
- 5 average
- 7 above average
- 9 excellent
- 11 best in case

Source: own representation based on (Goodson, 2002, p. 6).

Table I- RPA Rating

Table I shows the rating of the companies for specific factors of LM. Category 6 - levels of inventory and work in process consistently received the lowest ratings. People teamwork, skill level of employees, and the motivation in all three companies is rated as average or below average, due to a high reluctance by employees. Visible evidence of teamwork, problem solving activities and employee empowerment is usual in lean environments. This was not the case in all three companies.

No	RPA Questionnaire	Company A Yes/No	Company B Yes/No	Company C Yes/No
1	Are visitors welcomed and given information about plant layout, workforce, customers, and products?	yes	yes	yes
2	Are ratings for customer satisfaction and product quality displayed?	no	no	no
3	Is the facility safe, clean, orderly, and well lit? Is the air quality good and noise levels low?	no	yes	yes
4	Does a visual labeling system identify and locate inventory, tools, processes, and flow?	no	yes	no
5	Does everything have its own place, and is everything stored in its place?	no	yes	yes
6	Are up-to-date operational goals and performance measures for those goals prominently posted?	no	no	no
7	Are production materials brought to and stored at line side rather than in separate inventory storage areas?	no	yes	yes
8	Are work instructions and product quality specifications visible at all work areas?	no	no	no
9	Are updated charts on productivity, quality, safety, and problem solving visible for all teams?	no	yes	yes
10	Can the current state of the operation be viewed from a central control room, on a status board, or on a CRT?	no	yes	yes
11	Are production lines scheduled off a single pacing process with appropriate inventory levels at each stage?	no	yes	no
12	Is material moved only once as short a distance as possible and in appropriate containers?	yes	yes	no
13	Is the plant laid out in continuous product flow lines rather than in "shops"?	no	yes	yes
14	Are work teams trained, empowered, and involved in problem solving and ongoing improvements?	no	yes	yes
15	Do employees appear committed to continuous improvement?	no	yes	yes
16	Is a timetable posted for equipment preventive maintenance and continuous improvement of tools and processes?	no	yes	no
17	Is there an effective project management process, with cost and timing goals, for new product start-ups?	no	no	no
18	Is a supplier certification process--with measures for quality, delivery, and cost performance--displayed?	no	no	no
19	Have key product characteristics been identified and fail-safe methods used to forestall propagation of defects?	no	yes	no
20	Would you buy the products this operation produces?	yes	yes	yes
Total number of Yeses		2	15	10

Source: own representation based on (Goodson, 2002, p. 7).

Table 2 - RPA Questionnaire

The plants total score of the rating sheet and the number of 'yesses' on the questionnaire provides a fairly accurate assessment of plant efficiency (Goodson, 2002, p. 11). "Scores in six of the 11 categories and 16 of the 20 associated questions are based almost solely on highly visible elements in a plant's environment" (Goodson, 2002, p. 11). An average plant should receive a score in the Rating Sheet of between 50 and 55 (Goodson, 2002).

Regarding the RPA evaluation, Company A has implemented and is practicing LM below average and LM approaches could hardly be seen and there was a high lack of employee knowledge and skills. Company B scored above average, with LM practices in evidence throughout the company which have been implemented successfully. LM has been averagely implemented in Company C, which has high inventory, and management support, knowledge and the cultural difficulties have to be overcome. In all three cases, a sustainable implementation roadmap had never been implemented in the companies.

Through the RPA evaluation, it can be concluded that in all three cases the companies have not yet successfully implemented LM. The data analysis mainly shows results for the adoption and *status quo* of LM practices, and does not specify the challenges of the LMI. Among others, this is due to the low knowledge of the respondents and the low level of communication throughout the company. The visited MNCs have only implemented LM approaches over the years, and there is no strategy regarding how to implement LM. That means that there is a need for a common roadmap to implement sustainable LM.

The main problems that were encountered during the case studies were the absence of clearly-defined processes, standards and interrupted directory chains. LM seems difficult to implement in Brazilian manufacturing systems, because of a different company and labor organizational and social culture. The concepts related to LM have been frequently misunderstood, due to poor employee training and educational programs. These obstacles are not insuperable, but they require long-term education and training about the importance of managing an organization's resources. LM is not seen as a long-term strategy in Brazil and the necessity of LM is under-evaluated, due to an absence of knowledge and skills. People are an inherent integral component of LMI (Mostafa, Dumrak, and Soltan, 2013, p. 60). LM is often seen as a set of tools. A successful LM is a learning organization.

Due to a small number of plant visits, it is difficult to derive general conclusions regarding challenges. However, the findings regarding culture and economic problems were similar for all three case companies. The challenges detected from the plant visits and the impact rating of how each plant is affected by this challenge are summarized in Table 3.

Challenges	Company A	Company B	Company C
Lack of investments through the economic crisis	++	++	++
LM improvements and implementations are only made when problems occur/are necessary	-	++	+
No support of top/senior management	++	-	++
No support of middle management to shop floor	+	+	+
Lack of commitment of shop floor employees	++	+	+
Lack of skills and technical knowledge	++	+	+
No LM agent/LM promotion office	+	+	-
Difficulties to keep the pace of ongoing LMI initiatives (many attempts of LMI failed)	++	++	++
Lack of process standardization due to cultural behavior	+	++	+
Not sustaining LM as a long term journey	+	++	+
Difficulties in seeing the benefit of LM/low awareness of benefits	-	+	+
Cultural differences	-	++	++
Lack of team based culture and culture of trust	-	++	+
Not aware of the current state of LM and where to go and what to achieve	++	++	+
Simultaneous implementation of many initiatives leads to a piecemeal adoption of LM, need of a step by step implementation	--	++	+
No consistent roadmap for implementing LM exists	++	++	++
Quality problems with supplied material	+	+	++
	--	-	++
this challenges is not an issue in the company			this challenge is a highly issue in the company

Source: own representation, 2015.

Table 3 - Summary of challenges from plant visits

Deduction of requirements for MNCs operating in Brazil

The requirements are derived from the previous analysis of both the literature review as well as the plant visits. It was identified that the challenges detected in the literature review were also emphasized during the plant visits. The findings during the plant visits furthermore strengthen the findings in the literature review. The lack of commitment of top and senior management, as well as the skills and knowledge about LM hinders a successful implementation of LM. However, there is a gap between what challenges were detected in the literature review and the findings in the case studies. In the literature review, the economic crisis was not considered. The results from the literature review and case studies to successfully implement LM highlight the importance of the total commitment on the part of everyone to perform LM. Culture and change are therefore main levers.

Resistance to change is a natural tendency of the vast majority of people (Jadhav, Mantha, and Rane, 2014, p. 133). MNCs face the inability to create a culture that will sustain LM processes for organizational improvement. Currently, the attention is focused on the technical aspects of LM, rather than the competence to create a self-sustaining LM culture, where change is seen as the norm and where resistance to change is never an option (Jadhav, Mantha, and Rane, 2014, p. 138). Change is a behavioral, emotional and political process (Jadhav, Mantha, and Rane, 2014, p. 133). Change is based on people and their motives and dealing with friction, the management of egos and the escalation of conflict overflow into unhelpful behavior. To implement LM is not an easy task. For any change in an organization to become accepted and successful, the resistance forces, barriers, risks and challenges need to be identified and understood (Jadhav, Mantha, and Rane, 2014, p. 126). The LMI challenges are analyzed based on the previous sections. The main challenges are: a lack of LM understanding, lack of senior management and middle management attitudes and employees' attitude.

From the case studies, it can be derived that long-term improvements of LM are best achieved via a bottom-up approach, because a bottom-up approach engages workers using specific working routines, thereby forming the culture and using the appropriate LM tools and techniques where it is necessary to improve. From the reviewed literature it can be derived that long-term improvements of LM are best achieved by a simultaneous bottom-up and top-down approach. A simultaneous top-down approach implies that top management sets the goals of project performance and is directly involved in the commitment of the top/senior management to LM. It is mandatory to build an expert team and a promotion department to provide advice and manage the LMI process. The LM expert team is a main lever in the process. Another dimension for the transformation to LM are people and partners, learning and the development of human talent.

An assessment of the current situation of an organization has to be undertaken. An external assessment scans the political, economic, social, technological and competitive environment, whereas an internal assessment focuses on all organizational attributes, such as personnel, facilities, location, products and services to identify the organization's strength and weaknesses to implement LM (Mostafa, Dumrak, and Soltan, 2013, p. 51). Culture and strategy have to go in parallel to reach a LM system. It is a journey, not an end process, which has to be reached after a certain time. The desire is to build a shared vision, planning and design for change, managing the change and continuous improvement.

Proposal of a LMI roadmap for MNCs in Brazil

During the plant visits it was highlighted that MNCs are missing a comprehensive LM implementation, thus reinforcing the need for a roadmap. This will combine the requirements derived from the challenges gained in the theoretical and practical findings in a single unique

roadmap for the implementation of LM in any MNC operating in Brazil. This roadmap is developed and could be a standard for all MNCs of different industry segments operating in Brazil.

Logic and features of the proposed roadmap

The proposed roadmap is designed as a project-based roadmap with five stages. It achieves the practicality of LMI for effective LM outputs or outcomes of the organization. Project processes aim for a satisfactorily delivery of outputs of each stage, passing them on as inputs to the next stage.

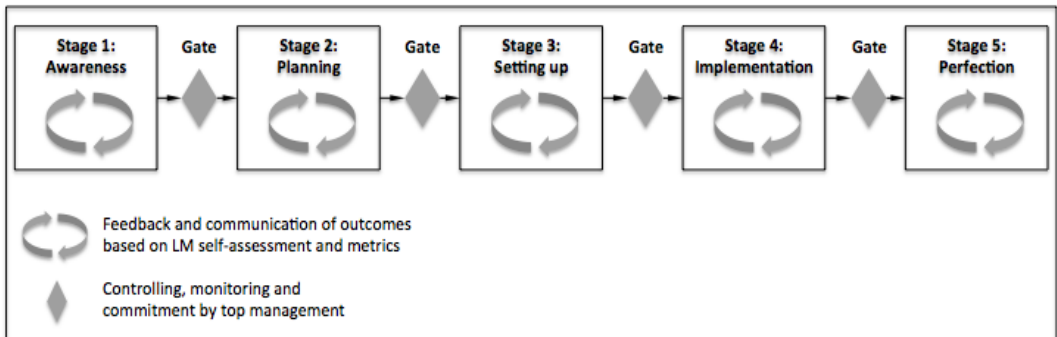
The highlighted features in the proposed roadmap are the setting up of a LMI expert team and promotion department to enhance the success of LMI, to train the employees consistently during each phase, to integrate a work environment and to develop a culture of trust. A roadmap helps LMI practitioners to identify and address waste and its drivers, as well as to understand how and when to apply the various LM approaches in the organization in order to achieve business excellence. A roadmap would also help LMI practitioners to use the full suite of tools to realize the greatest benefits. Different models of roadmaps should be applied to diverse manufacturing industries. The same roadmap of LM tools, techniques and methods often cannot be applied in each industry sector. Furthermore, the roadmap is dependent on, and differs from the type of production and volume of production, because the processes as well as the required LM tools, methods and techniques can be varied. The approach of this paper is to propose a variable, but stable comprehensive roadmap to achieve continuous improvements in the long-term. The following proposal should be a model for a roadmap, which is flexible and can be adapted in any kind of multinational operating in Brazil.

The roadmap is developed to implement a successful sustainable LM system from the existing status of the company to one that fully implements LM and its practices. Therefore, the current state of the company and its desired state have to be understood. A LMI roadmap provides a systematic implementation process: specific actions in order of precedence that are milestones in the journey to a fully LM. The high complexity and a long-standing implementation period of LM can lead to a lack of integration of all tasks. The roadmap should contain the description of the tasks during the LM implementation allocated by stages, with steps for implementation. The roadmap helps companies plan adequately and avoid failures during the LMI. A roadmap has been developed which determined the tools that need to be implemented in the company, based on its current state.

Therefore, the roadmap is built upon a Stage-Gate approach, which is a standardized process to develop a conceptual and operative strategy to enable a company to systematically, effectively and efficiently perform LMI. The stage-gate-approach is split into phases called 'stages' and 'gates', from awareness to the perfection, see Figure 1. In each stage, the LMI team has to fulfill certain tasks, such as gathering information, designing, analyzing and so forth. At the end of each stage there is a 'Go/Kill' decision, which is performed by the so-called 'gatekeepers'. The gatekeepers are a cross-functional group of the top management. At each gate, decisions are made regarding

which resources are necessary to process further if the LMI project will be financed further and will be passed to the next stage, or if it has to be revised. Furthermore, at each gate the top management has to commit themselves to the LMI. The gate is therefore a checkpoint to control and monitor the previous stage by the commitment and authorization of the top management. The more stages the project passes, the more expenses are incurred with a reduction in the level of uncertainty regarding the success of the LMI project. The stage-gate-approach is a system or process, which supports the mapping out of what needs to be done, stage by stage, gate by gate as well as how to do it – in order to succeed in LMI. (Cooper, 2008, p. 214)

The Stage-Gate approach empowers a MNC to be flexible, adaptable, and create stability, and thus to control the dynamic and complexity of the manufacturing processes. Hence, a structured procedure to implement LM is developed in a usually unstructured process. The LMI process becomes more transparent and a common understanding is developed. This relieves the communication in the team, as well as with the top management. A measurement system, with feedback of outcomes and continuous improvement in all stages, processes, and internal steps is required to achieve a dynamic system in a highly variable environment. Measurement performance is founded on LM self-assessment indicators and metrics. Figure 1 shows the roadmap, clustered into five extensive stages and gates.



Source: own representation.

Figure 1 - Stages of the proposed roadmap for LMI

Stage 1: Awareness

The initial phase focuses on the awareness regarding the environment and the commitment of top management to LM. Through the economic crisis, it is important to first consider the environmental aspects of the organization. Is there an economic crisis? In addition, influences such as governmental regulations and political issues have to be scanned. Does the current situation of the economy and the environment permit to invest? Is there a need to enhance productivity due to market growth

and potential for the future? If so, then this need would likely translate into higher investments in LM. The benefits of LM practices during crisis, as well as without crisis have to be considered here. A crisis helps businesses in getting started with LM. If these questions are addressed and clarified, then the LM journey can begin, otherwise the LM process cannot be started. Different companies will show fundamentally different starting points for their journey towards a LM.

Stage 2: Planning

The commitment to LM by the top management is the start of the preparation phase. This is the LM project kick-off phase, which selects, widens scope and trains all people involved in the LMI. The top management names the persons who are in charge for LM planning tasks and installs a LM steering committee. Their task is to promote the LM activities. LM experts and people are involved. The principals, information and knowledge regarding LM are transferred to the team. Are LM experts available and does a LMI team exist? If yes, go to the next step, if not, LM knowledge has to be transferred and trained properly to build up a LMI team to promote LM and involve LM experts. During this phase, a strong LM work environment focusing on cultural aspects has to be developed. Establishing a working environment, addressing plant specific cultural issues and overall build up culture of trust and teamwork is a main task in this phase. Create a bottom up top down approach. The bottom up approach applies workers using specific working routines, therefore forming the culture and using appropriate LM tools and techniques where it is necessary to improve. The top-down approach simultaneously achieves commitment and involvement by the top management, who set goals of project performance. Furthermore, design-thinking activities for strategic planning of LM are carried out. Advantages of LM and the current state of the existing LM rules, methods, and tools of the process have to be analyzed and understood. For the enhancement of mindset and understanding of the LM concept, it is necessary to analyze the resources (human, financial and technical), limitations and organizational structure to determine the vision, mission, values, strategic objectives and to define the LM goals. The external assessment scans the political, economic, social, technological and competitive environment. Internal assessment focuses on all organizational attributes, such as personnel, facilities, location, products and services to identify the organizations strength and weaknesses to implement LM (Mostafa, Dumrak, and Soltan, 2013, p. 51). *“Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.”* (Liker, 2004, p. 169).

Stage 3: Setting-up

Cultural change has to be made initially at the implementation of LM. LM must be anchored in the corporate culture and not be seen as an isolated project. In this phase, a LMI team and the steering committee are installed and implementation teams including shop floor employees are established. To build up a culture, it has to be ensured that the top management sets a good example for the workforce. All involved have to be provided with the right information and qualification. The cooperation between the management and the shop floor employees must be flawless. In addition,

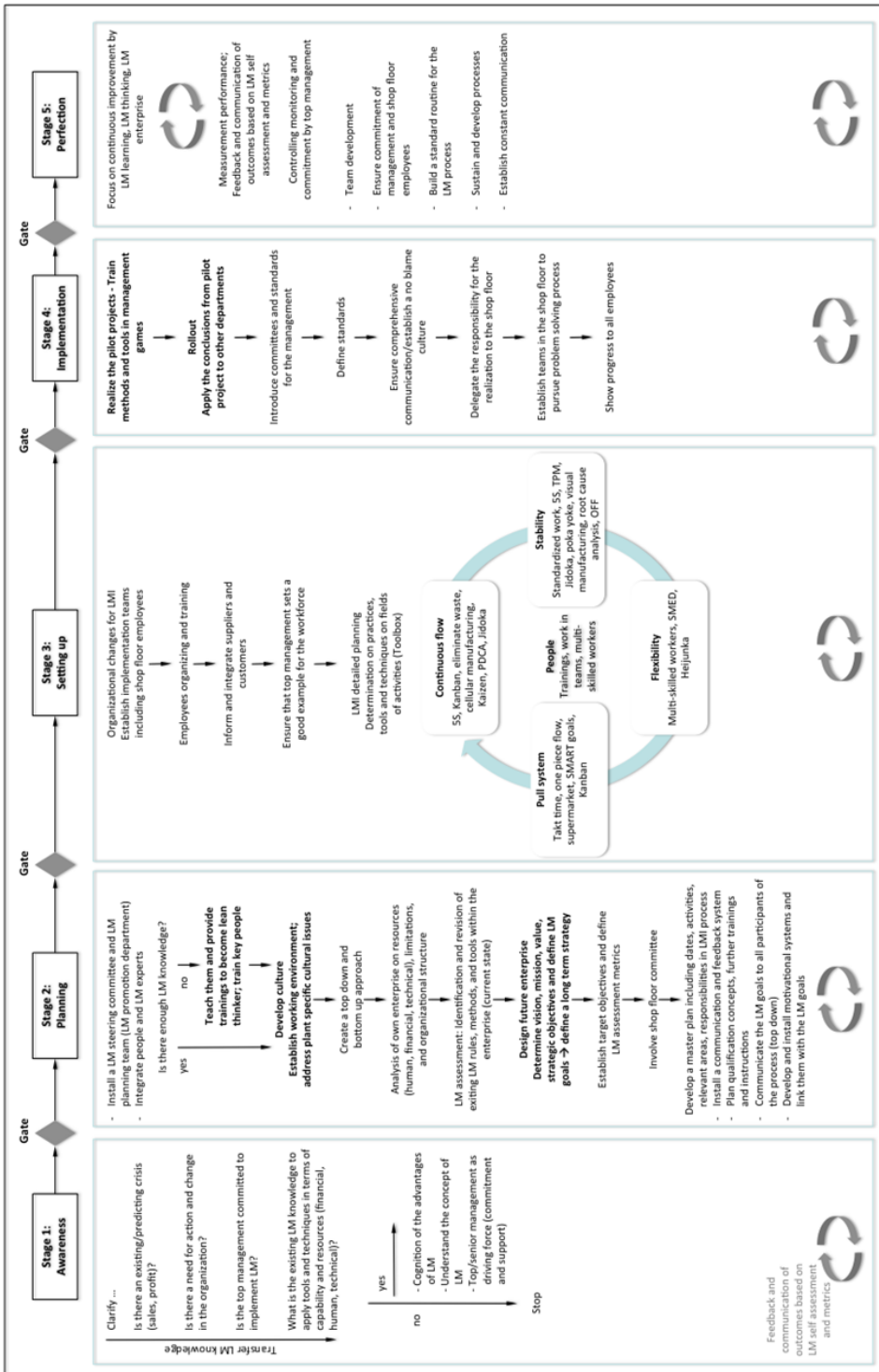
customers and suppliers should assist during the setting-up phase in order to prevent barriers in further implementation. The detail determination of field activities is a main part of this stage to build up the LM system. At the heart of the LM are the people. People bring the knowledge, intelligence and desire to improve and lead the company to new levels of continuous improvement. The practices, tools, methods and techniques are specified here and are tailored to the needs of the company.

Stage 4: Implementation

The LM planning team has to develop detailed LMI plans and strategy for the realization of LM. The assignment of financial, technical and human resources has to be done. To inform the employees about the implementation plan and strategy, kick-off meetings should be conducted, whereby the employees should take responsibility and influence decisions concerning the implementation of methods and tools. Focus on a specified pilot project is the first step to set up the implementation and to identify the interdependencies and the mutual support of the methods and tools as soon as possible. Methods and tools should be trained in management games to experience the practical use and support the understanding. Ongoing trainings have to be performed with full employee participation of direct and indirect areas of the module. Those workers who did not participate in the pilot teams, will receive trainings on the philosophy of LM. Teams in the shop floor have to be established to pursue problem-solving processes. *“Build a culture of stopping to fix problems, to get quality right the first time.”* (Liker, 2004, p. 128). The rollout has to be undertaken by a comprehensive communication, in order to support and adjust the progress of the implementation.

Stage 5: Perfection

Because the implementation of LM is a continuous process, the transition from the rollout to the perfection phase is fluent. The efficiency and effectiveness of the implemented LM elements have to be ensured by audits and be controlled with specific KPIs. Besides audits and KPIs, best practices should be compared and implemented. All processes have to be improved continuously. Sustain and develop standards. Ensure that the management keeps the commitment and standard. LM is a journey about thinking, learning and the process to achieve perfection, which never ends. Measurement system, feedback of outcomes and continuous improvement in all phases, processes and internal steps are required to achieve a dynamic system in a highly variable environment. Measurement performance is founded on indicators and metrics. The proposed roadmap covers aspects such as allocation, scheduling, checking, analyzing and leading.



Source: own representation, 2015.

Figure 2 - The proposed roadmap for LMI

Critical appraisal of the roadmap

A LMI roadmap is not a cookbook of actions that must be followed for every implementation, because every LMI will be unique, as every company has its own culture, and home-grown policies and systems, which will either support or delay the LM pathway. A successful implementation of LM will be costly and time-consuming. Hence, a LMI roadmap is therefore a difficult approach when the economy is already in crisis. However, in times of crisis it is vital to apply the concept of LM in order to reduce costs and increase productivity. The proposed roadmap manifests a dynamic structure, which determines the tools that need to be implemented, based on the individuality of the company and is adapted to the volume, type of industry, repetitiveness and so forth. The roadmap above contains some shortcomings regarding LMI. For example, the roadmap was developed emphasizing the current state of the company. It cannot be fully excluded that the chosen case study companies' results led to a biased answer, due to the individual perception of the respondents, as well as that of the authors of this paper. When developing the roadmap, great care was taken to follow a systematic approach. The roadmap proposed is based on the current understanding of the challenges derived from the literature review, as well as the plant visits. It should be noticed that it is impossible to consider all factors influencing the LMI in foreign Brazilian MNCs in a real world setting.

Conclusion

The purpose of this paper was to explore the extent of LMI at MNCs with production subsidiaries in Brazil and to propose a comprehensive roadmap that is tailored and valid for all MNCs operating in Brazil with different initial situation/conditions regarding the implementation of LM. The primary objective was to study the challenges and to make an analysis of the adoption of LMI at foreign MNCs in Brazil. The reviewed literature exposes the challenges which MNCs operating in Brazil are facing during their LMI. Most researchers emphasize the lack of top management commitment and lack of skills and technical knowledge. Misunderstandings of the concept and purpose of LM is due to cultural problems. The researchers did not emphasize external challenges.

An analysis was made of how LM is performed and implemented at three MNCs in Brazil. The current state, as well as the adoption and implementation in the past were identified. The daily activities and practices implemented were described and a rating was conducted, which showed the result of the differing extent of the adoption of LMI at MNCs in Brazil. The implementation and use of LM practices in Brazilian MNCs raises issues about its application within a different cultural context. Currently, MNCs operating in Brazil are facing a high economic issue where they are not able to invest in LM. Particularly, the manufacturing industry in Brazil is hard hit by the crisis. Furthermore, the cultural problem that they face is a huge lever in the failure of LMI. Poor mindset and misunderstanding of the concept strongly resists the LMI and reduces the expected benefits of the organization with regards to LM. LM has been implemented in different approaches but not as

a completely consistent process with a guideline to LM. There is a lack of an applied roadmap guiding companies towards LM.

Further, the requirements needed for a project-based LMI were identified, and in the next step it is translated into a comprehensive LMI roadmap for successfully and sustainable LM implementation for multinationals operating in Brazil. Multinationals require proper design, planning and ongoing management to realize the attainment of goals. The LM roadmap proposed can be used in a high variability environment. It can cover all MNCs operating in Brazil. Five stages and many steps for a successful implementation of LM were proposed. The proposed model will determine the tools and techniques that need to be implemented in a company, based on its current state, ranging from no adoption of any LM initiatives, through to intermediate adoption of LM. The success of LMI will not be entirely based on applying appropriate tools and techniques alone, but also on the interaction between the managers and shop floor employees. The top management however plays a significant role in how the strategy is understood, implemented and deployed effectively throughout the organization.

Concluding the paper, some starting points for potential future work are pointed out. These may further contribute to a better understanding of LMI in the Brazilian environment and support MNCs in their efforts of LMI. Only companies from the south east of Brazil, in the state of São Paulo and Rio de Janeiro were visited. These are the richest states of Brazil. Therefore, it is necessary to carry out more research in different geographic locations where the culture is different. Consequently, further field studies of multinationals operating in Brazil should be conducted to validate and intensify the findings. Further research should also be carried out to test the roadmap practically, in order to refine the model presented. Therefore, the roadmap evokes extension and field application.

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