Forum of International Development Studies. 37 (Sep. 2008)

New Trends in Inter-firm Relations in the Brazilian Automobile Industry

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Abstract

A trend towards the adoption of modularization can be observed in the Brazilian automobile industry from the mid−1990s onwards. As a result, automakers are focusing on *coordination* rather than *integration* in supply chain management, and although efforts are being made to enhance efficiency at the individual and organizational levels, the system level is being neglected. Fieldwork data shows that the lack of an integrative approach is the main problem in the relationship between the automaker and its first-tier suppliers. Nonetheless, for promoting a higher level of economic growth as well as to increase the degree of spillover of technologies and techniques within the automobile industry and to other industrial sectors, a more integrative approach is needed.
Keywords: Lean Production System − Modularization − Brazilian automobile industry

Introduction

The purpose of this paper is to discuss the implications of the new trend towards the adoption of modularization in supply chain management in the Brazilian automobile industry. In particular, this study shows that Brazilian automakers, by following the tendency towards the adoption of modularization, are emphasizing *coordination* and thereby moving in a different direction than Lean Practitioners, whose main concern is to promote *integration* in the supply chain. Evidence collected during field survey proves that, because of this approach, the Brazilian automobile industry is not optimizing the use of Lean Practices and thereby is not fully exploiting the opportunities in the domestic and regional markets.

This paper advocates for more integration between automakers and suppliers to raise productivity and enhance quality in this industrial sector. It adopts the Lean Production System as the reference model, since this approach presents better outcomes in terms of inter-firm collaborative efforts towards the improvement of the whole production process. Moreover, Lean Practitioners focus on building capabilities not only at the individual and organizational levels, but also at the inter-firm or system level.

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The Brazilian automobile industry, however, still lacks an integrative approach to supply chain management. The trend towards the adoption of modularization indicates that efforts are being made to enhance efficiency at the organizational level, but there is not much focus on joint efforts to improve the condition of all firms involved in the production process.

The present discussion is divided into three sections. The first section will present a theoretical background for an analysis and evaluation of the current situation of the automobile industry in Brazil. The main features of the Lean Production System and the UNDP three-level-framework for capacity building will be presented, in order to show the importance of an integrative approach for better outcomes in the industrial sector.

The second section will be devoted to a brief historical background of the evolution of the automobile industry as well as the new trends observed in this sector from the mid-1990s onwards in Brazil. It will also show that the adoption of Lean Practices in Brazil resulted in a type of inter-firm relationship closer to the western approach and thereby different from the Japanese integrated production system.

The third section will present the findings collected during field work in a Brazilian factory to illustrate the patterns of inter-firm relationships in the country. The role of the local government in attracting investment to the region will also be discussed.

1. Theoretical Framework

1.1 Why the Automobile Industry?

Before beginning the main discussion of this paper, it is necessary to explain why the automobile industry was chosen for study. First of all, this particular industry provides a good example of the importance of a close relationship among firms as well as the relevance of capacity building at individual, organizational and system levels for the success of the industrial sector as a whole. Moreover, concrete examples of successful inter-firm relations can be borrowed from the Japanese experience and there is a vast amount of literature about the Lean Production System, which is focused on creating conditions to jointly improve the efficiency of automakers and suppliers.

Another reason is that the automobile industry is considered to be one of the core sectors to promote industrial change in a given country because the technologies and techniques developed in this sector can spillover to other industries. Also, many other industrial sectors, such as steel and IT, have to improve their quality standards to supply up-to-date material for automakers. Moreover, a large number of small- medium- and large-size firms supplying components for vehicles have to enhance their productivity and efficiency to cope with the demands of automakers (Womack et al, 1991: 11; Shapiro, 1994: 39; Botelho, 2002: 58).

The automobile industry also generates many job opportunities. In 2005, 290,706 people, or

2.24% of Brazilian manufacturing workers, were directly employed in the automobile industry (IBGE, 2006: 113; Anfavea, 2006: 36; Sindipeças, 2006: 12). Moreover, job opportunities in other industrial sectors as well as in the services sector are intrinsically connected to the automobile industry.

The automobile industry also plays a vital role in promoting regional development. For instance, Teixeira & Vasconcelos (1999: 22) highlight that suppliers as well as other satellite firms came to Bahia following Ford's decision to build a new plant in this state. Senhoras & Dias (2005: 6–7) also affirms that, due to the partnership between Fiat and the state of Minas Gerais, this state was able to attract 20% of the total foreign direct investment in the country from 1971 to 1977.

On top of that, the automobile sector is one of the main industrial sectors for the Brazilian economy due to its strong participation in the Brazilian industrial GDP. As shown in figure 1, in 2005 the automobile industry was responsible for 11.5% of the country's industrial GDP.

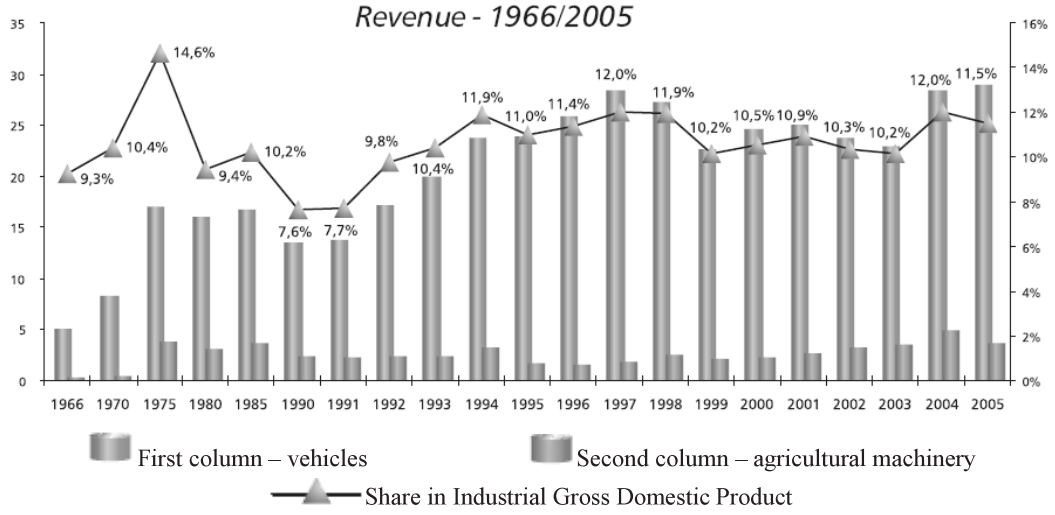
The Brazilian automobile industry is also significant regarding the number of automobiles produced. In 2004, Brazil was ninth in worldwide vehicle production, with 2,317,000 units. The country has also rapidly increased the number of vehicles produced since 1995 (Sindipeças, 2006: 40).

Thus, due to its relevance for the Brazilian economy and since it provides a rich ground for the analysis of the importance of inter-firm relations and capacity building at the individual, organizational and system levels, the automobile industry was chosen as the main focus of the present research.

1.2 UNDP Three-level-framework for Capacity Building

The UNDP defines capacity as "the ability of individuals and organizations or organizational units to perform functions effectively, efficiently and sustainably". This definition "implies that capacity is

Figure 1 – Revenue of the Brazilian Automobile Industry (US$ billion) 1966–2005



Source: Anfavea, 2006: 30.

not a passive state", but rather "part of a continuing process" of creating and maturing abilities (UNDP, 1998: 19).

The UNDP framework for capacity building was developed as a guideline to help managers and officials in charge of public, private or civil society organizations that are in the process of developing capabilities for promoting sustainable change and the achievement of development objectives. Specifically concerning strategic management, the UNDP guidelines emphasize the need for managers to take into account the relationship between their firms and other "entities or stakeholders within the broader system within which they function" (UNDP, 1998: 15).

Therefore, in order to create successful strategies and policies to enhance the capabilities of individuals or organizations, it is necessary to take into account the situation at a broader level. In other words, the strategies developed by an organization must observe not only its own objectives, but also the policy framework of government and civil society.

To be effective, capacity building efforts should address the individual level (individual skills, attitudes, qualifications, etc.), the organizational level (mission, strategy, organizational culture, management values, human resources, information resources, financial resources, and infrastructure such as physical resources), and the system level (policy dimensions, legal/regulatory dimensions, process dimensions — i.e., inter-relations and interactions among entities, etc.) (UNDP, 1998).

The Lean Production System successfully addresses the key factors highlighted in the UNDP guidelines, since it adopts an integrative approach to capacity building involving all firms in the supply network, and it also views capacity as a dynamic process that has to be constantly updated and improved.

1.3 The Lean Production System: The Japanese Integrative Approach

The high level of economic development observed in post-war Japan gave birth to a vast amount of literature that tried to point out the elements responsible for this successful growth. Much attention has been given to the practices adopted by Japanese automakers, since they were important in explaining their high levels of productivity and efficiency. The main practices used by Japanese automakers as well as their way of managing the supply chain became known as the Lean Production System.

Womack et al (1991) highlighted the vast superiority of the Lean Production System in comparison to the Mass Production System created by Ford. Fujimoto (1999) declared that Toyota had created an evolutionary system that constantly updates itself through a process of trial and error, standardization of practices and incremental improvements. Cusumano & Nobeoka (1998) affirmed that Toyota was proactive in implementing new organizational structures to improve its production system. Liker (2004: 4) highlighted that the annual profit of Toyota by the end of the fiscal year of 2002 was higher than the combined earnings of General Motors, Chrysler and Ford. Also, in the first

quarter of 2007, Toyota became the biggest seller of cars in the world (Gow, 2007), which can be considered evidence of the efficiency of the Lean Production System.

1.3.1 Lean Practices

Liker (2004: 28–29) defined eight major types of non-value-added activities in manufacturing processes: (1) overproduction: manufacturing items for which there is no order; (2) waiting (time on hand): workers having to stand around waiting for the next processing step; (3) unnecessary transport or conveyance: inefficient or unnecessary transportation or carrying materials over long distances; (4) Over-processing or incorrect processing: inefficient processing caused by poor product designs or taking unnecessary steps to process parts; (5) Excess inventory: stocking excessive finished goods or raw materials; (6) Unnecessary movement: the time workers have to spend searching for tools during their work; (7) Defects: producing defective components resulting in rework; and (8) Unused employee creativity: losing skills, ideas, and learning opportunities by not listening to workers.

Lean Practitioners are known for making use of certain tools or techniques that focus on eliminating such non-value-added steps from activities. Those techniques are meant to bring continuous enhancements to the manufacturing process, and aim to achieve an ideal situation of perfection. They are the so-called Lean Practices and, in fact, they should be considered principles that direct the way workers conduct their jobs, rather than simply techniques (Liker, 2004: 27–41). Moreover, those practices only achieve their optimum level when they are jointly implemented with all firms in the supply chain. Take the example of *genryo-seisan* (production plans based on a dealer's order volume). This practice focuses on reducing the gap between a dealer's orders and the production of vehicles to zero. Inasmuch as this perfect match could be considered ideal, genryo-seisan functions as a guiding principle that directs the negotiations between automaker and dealers, so that they can make a joint effort to constantly improve the system (Fujimoto, 1999: 289).

In this manner, Lean Practices can be defined as guiding principles focused on reducing non-value-added tasks which are optimized when jointly utilized by an automaker and its supply network. Some of the Lean Practices will now be discussed.

Through the practice of *kaizen (continuous improvements)*, workers on the shop floor are motivated to constantly try to improve the manufacturing process and work conditions by implementing minor changes in their daily work. (Porter et al, 2000: 71).

Lean Practitioners also try to develop *multi-skilled workers* on the shop floor. Workers are expected to rotate through different shop floors in order to acquire multi-skills to perform different tasks. Through on-the-job and off-the-job training, blue-collar workers develop skills to handle different jobs as well as intellectual skills which allow them to deal with unexpected or unusual situations and to provide a great contribution in terms of kaizen (Koike, 1988: 162).

Workers are divided into teams and are expected to collectively identify problems and suggest ways to improve the production process. These are the so-called *Quality Circles* and they play a

fundamental role in kaizen (Womack et al, 1991: 56; Porter et al, 2000: 71).

The *5-S approach* is a collection of simple things that should be followed by workers to maintain order, discipline and a clean environment on the shop floor[1]. Through the 5S approach, many sources of errors, defects and injuries can be eliminated (Liker, 2004: 36).

The *kanban system* is an inventory control system in which the downstream station obtains just enough components as needed and the upstream station produces just enough to replenish what has been used (Fujimoto, 1999: 40).

Just-in-time manufacturing is a synchronized delivery, implemented through the kanban system, in which components are supplied in exactly the same time as the body sequence in the assembly line (Fujimoto, 1999: 288; Porter, 2000: 71).

Jidoka, or automatic detection of defects, is related to the idea that problems should be detected and solved on the spot, instead of relying solely on inspection by specialists at the end of the assembly process. One example of jidoka is the Assembly Line Stop Cord adopted by Toyota, through which any worker who detects a problem and cannot solve it may stop the assembly line by pulling the Cord (Fujimoto, 1999: 291).

To achieve a higher level of productivity and quality standards, maintenance of equipment is done periodically not only by maintenance specialists and plant engineers but also by blue collar workers. This is the so-called *Total Productive Maintenance (TPM)*.

Visual Management is based on the use of various charts and signboards throughout the factory providing information about the production process not only for managers, but also for blue-collar workers (Fujimoto, 1999: 291–292).

As already stated, those practices are not only tools or techniques but a philosophy that guides the everyday work of all employees in a Lean supply chain. As Liker (2004: 36) points out, the Lean Production System "encourages, supports, and in fact demands employee involvement", and thereby it is "the people who bring the system to life, working, communicating, resolving issues and growing together".

The Lean Production System tries to integrate automakers and suppliers in order to enhance the effectiveness of the whole system (Womack et al, 1991: 188). Hence, although some of the Lean Practices, such as just-in-time manufacturing, the kanban system and kaizen, have a positive impact on productivity and quality standards, it is the comprehensive approach to production that is the key for their success and is difficult to emulate. Therefore, the close relationship between automaker and suppliers is a fundamental feature of the Lean Production System.

1.3.2 Supply Chain Management

Supply chain management in Japan is characterized by the creation of stronger and longer ties among firms (Dore, 2000: 35–36). This relationship involves close interaction between manufacturers and suppliers that begins in the very early stages of product development. The automaker provides

technical assistance to its suppliers and there is a constant exchange of information and technology.

Due to this collaborative manufacturing system, technicians from the automakers might be sent to the plants of its suppliers to jointly discuss the improvement of the whole manufacturing system or to solve certain problems. This high integration between automakers and suppliers is evident when one considers that reallocation of employees is not restricted to the automaker's plants; they are sometimes even sent to sub-contractors facilities (Dore, 1973, 40).

Although the number of first-tier suppliers is limited and they have a long-term relationship with the automakers, suppliers are constantly under pressure to improve efficiency, and they compete with each other to enhance quality and to gain component design capability (Fujimoto, 1999: 170). Lean Manufacturers usually have more than one supplier for the same component and they divide the orders among those suppliers. This system is meant to be an incentive for suppliers to maintain the level of quality, improve productivity and initiate constant efforts to reduce costs (Womack et al., 1991: 154).

One of the clearest advantages of such an integrative approach to supply chain management is the optimization of just-in-time manufacturing and consequent decrease of inventory costs. Moreover, production problems such as "machine failures, defective production, time-consuming machine setups, long transportation distances, unbalanced lines, and lack of coordination" might create the need for buffer inventories. Inventory reductions will make those problems visible and when they are solved, a rise in productivity and quality can be expected. Lieberman & Demeester (1999: 467, 484) present empirical evidence of an increase in productivity due to inventory reductions in a survey conducted in the Japanese automobile industry.

Also, Dyer and Nobeoka (2000: 346) affirm that "the cost and quality of a vehicle are a function of the productivity of a network of firms working in collaboration." Their research emphasizes the advantages of integration in Toyota suppliers' network for knowledge sharing and collaborative improvements. In fact, the close contact and face-to-face interaction between automaker and supplier is said to facilitate the transfer of tacit knowledge (Dyer & Nobeoka, 2000: 348), to reduce communication errors and make feedback more effective (Dyer, 1996: 274). Since this type of integrative supply chain management favors the accumulation and sharing of knowledge within the network, the automaker will not lose the expertise of an activity outsourced to its suppliers.

Regarding this topic, Takeishi (2002: 322, 323) distinguishes "task partitioning" from "knowledge partitioning." While the former indicates which organization is responsible for the tasks of manufacturing a specific component, the latter designates "who has knowledge for the tasks among organizations." He advocates that an automaker should "keep the knowledge of the outsourced task within the firm, rather than outsourcing the knowledge together with the task." This discussion is relevant for this current research because it illustrates the problem of focusing on coordination rather than integration in supply chain management. By focusing on coordination, automakers outsource

both tasks and knowledge to their first-tier suppliers. There are no joint efforts in problem-solving and knowledge is not shared. In an integrative approach, the automaker keeps the knowledge even when outsourcing the task. Integration, therefore, favors information sharing and creates conditions for enhancing productivity and the quality of the whole supply chain. This knowledge sharing and accumulation might become a competitive advantage[2] for the supply chain network (Dyer, 1996).

1.4 Methodology

The theoretical framework of this research was defined based on recent literature on the Lean Production System and capacity building. The analysis of secondary sources regarding the changes in the Brazilian automobile industry from the mid−1990s demonstrated two major trends in the country: an increasing use of modularization and a tendency to decentralize the industry from the metropolitan area of São Paulo.

A case study was also conducted in a domestic company which assembles Mitsubishi automobiles called MMC automotores do Brasil ltd. There are a number of reasons why this company was chosen for the case study. First of all, it illustrates the two aforementioned trends in the Brazilian automobile industry: it is a factory located far from the metropolitan region of São Paulo and most of its first-tier suppliers deliver subsystems, following the tendency towards modularization. Moreover, MMC assembles Japanese vehicles and therefore the researcher expected to find a high level of diffusion of Lean Practices in the factory. Finally, the role of the local government in attracting investment and promoting industrialization in the municipality could be observed.

For the case study, a visit was made to the MMC factory, located in the municipality of Catalão (Goiás), to observe the facilities and assembly process. Also, during the visit an in-depth interview was conducted with the logistics manager. Additional information was collected through informal communication by e-mail with MMC personnel.

The questions during the interview tried to gather information about MMC's initiatives concerning capacity building at all three levels. To analyze the initiatives of capacity building at the individual level, the logistics manager and MMC personnel were asked to provide information about recruitment, on-the-job and off-the-job training and the educational background of the blue-collar workers.

As for initiatives of capacity building at the organizational level, the author inquired which Lean Practices were adopted at the plant and about the level of commitment to those practices. The visit to the plant was particularly important in this context, since it was possible to compare the information obtained in the interview with what was observed in practice, at the assembly line. Section 3 focuses on four Lean Practices (multi-skilled workers, kanban system, 5S approach and visual management) since they were the ones more successfully implemented by MMC and widely mentioned during the interviews. Also, through the analysis of those four practices, one can observe the level of

commitment of the company to the two main features of Lean Practices: (1) efforts to reduce non-value-added tasks and (2) efforts towards the integrative adoption of those practices with the supply chain.

Finally, questions were asked regarding MMC's initiatives for capacity building at the system level. For this purpose, the logistics manager was asked about logistical problems faced by the company due to its geographic position and whether there were joint efforts to adopt Lean Practices such as just-in-time deliveries with its suppliers, and joint problem-solving initiatives. The answers as well as the observations made during the visit showed a low level of integration with first-tier suppliers. Also regarding capacity building at the system level, the manager was questioned about the reasons that led MMC to build a factory in that region, the relationship between the company and the local government, and the role of the factory in the regional growth of Catalão (number of jobs generated, tax payment, small and medium size companies attracted to the region, etc.). One should note that, although capacity building initiatives at the system level encompasses the relationship between the organization and any other entity within the external environment in which it functions, in this case study such entities are represented by: MMC suppliers, the local government of Catalão and the associative organization SENAI.

2. The Automobile Industry in Brazil: History and New Trends

2.1 The Early Years of the Automobile Industry in Brazil

In Brazil, state intervention was essential to attract foreign investment for the successful implementation of the automobile industry in the 1950s. Transnational companies were reluctant to start manufacturing automobiles in Brazil and, without incentives from the Brazilian state, they wouldn't have started assembling vehicles in the country so early. Governmental polices during Juscelino Kubitschek's administration (1956–61), which corresponds to the early stages of the automobile industry in the country, focused on forcing transnational companies to start manufacturing in Brazil on such a scale that they wouldn't be able to withdraw in the future even if economic or political conditions were to change (Shapiro, 1994: 20; Evans, 1995: 91–92).

In 1956, the Brazilian government prohibited car imports and established GEIA (Executive Group for the Automobile Industry), the governmental agency responsible for overseeing the automobile industry. In this period, many restrictions were imposed on auto parts imports and several incentives were given for the transnational companies to start manufacturing in Brazil (Shapiro, 1994: 51; Ó hUallacháin & Wasserman, 1999: 26). In fact, the introduction of the automobile industry was one of Kubitschek's main targets because he believed that this sector could lead to industrial transformation in the country (Shapiro, 1994: 82).

Consequently, the main concern of GEIA was to attract as many transnational companies as

possible. However, to protect the domestic automobile industry against the domination of foreign capital was not one of the priorities of the Brazilian government. As a result, by 1968 the automobile industry was completely dominated by transnational firms. Foreign automakers also opted to vertically integrate their factories until the mid-1970s (Shapiro, 1994: 70, 191-208).

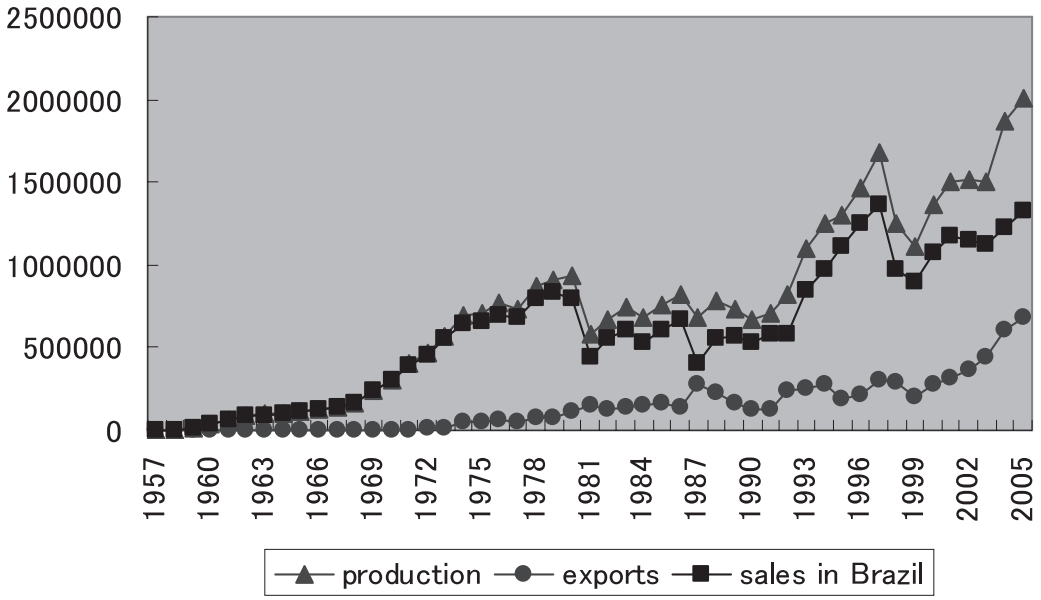
After the first oil crisis, in 1973, the Brazilian government started export-oriented policies, under the Special Fiscal Benefits for Export Program, BEFIX. However, due to an over-valuated exchange rate and the great uncertainty of the Brazilian economy, exports were not profitable and the main focus of the major automakers in Brazil continued to be the domestic market (Shapiro, 1994: 226). Figure 2 shows that most of the automobile production was absorbed by the domestic market, but exports also started to be significant from the late 1980s.

Although Brazil was successful in introducing a top-to-bottom automobile production in the country, the industry stagnated during the 1970s and 1980s. In fact, by the late 1980s, Brazilian's plants lagged "far behind the world pace in terms of productivity and product quality" (Womack et al, 1991: 269-270).

2.2 New Trends in the Brazilian Automobile Industry

In order to enhance the levels of productivity and quality up to global standards, in 1991 import tariffs on vehicles and components were reduced. Also, in the mid-1990s, incentives were given to stimulate the domestic production of automobiles, a new currency was adopted in Brazil (Real) and the

Figure 2 – Indicators of the Automobile Industry in Brazil - 1954-2005



Source: Anfavea, 2006: 52-72

economy was stabilized. Those incentives attracted new automakers and suppliers to the country and competition increased. Ó hUallacháin & Wasserman (1999: 25/28) contend that the opening of the Brazilian market to imports, allied to the Mercosur free trade agreement and the reemergence of the global car strategies towards the Latin American market were key factors responsible for the revitalization of the automobile industry in the country. From 1989 to 1996 the production of vehicles in Brazil expanded 295 percent.

As a response to the appreciation of the currency, Brazilian automakers gradually shifted the focus of their export strategy to South America (Senhoras & Dias, 2005: 3; Anfavea, 2006: 79). In fact, it was already a trend for western automakers to increase their intraregional trade and decrease the flow of products between different regions (Womack, 1991: 263–264).

Due to the macroeconomic changes of the 1990s and the low level of efficiency and quality standards of domestic auto parts firms, first-tier suppliers opted to vertically integrate their operations in Brazil. By purchasing or taking control of key domestic auto parts producers, a few first-tier suppliers dominated the Brazilian auto parts market (Ó hUallacháin & Wasserman, 1999: 24).

This vertical integration of first-tier suppliers was also motivated by the adoption in Brazil of a new production system called modularization. Under this production system, the role of first-tier suppliers became increasingly important, since they were expected to build and deliver subsystems rather than separate components. This new production system also resulted in the construction of new factories and in the relocation of automakers' and first-tier suppliers' plants to different regions of the country. These two major changes in the Brazilian automobile industry will be discussed in the following subsections.

2.2.1 Changes in the Distribution of the Automobile Industry in Brazilian Territory

In 1995, automakers' facilities located in São Paulo were responsible for 87 percent of all the components and 70 percent of all the passenger cars produced in the country. After a huge investment of many automakers in new facilities outside this state (Ó hUallacháin & Wasserman, 1999: 28–29), São Paulo's share of national car production decreased from 74.8% in 1990 to 45.8% in 2005 (Anfavea, 2006: 59).

The auto parts sector is following the same trend. Since automakers in Brazil are adopting modularization, focusing on single sourcing and demanding the delivery of subsystems, first-tier suppliers are building their factories closer to automakers (Ó hUallacháin & Wasserman, 1999: 33).

Automakers are mainly attracted by incentives given by Brazilian states, whose motivation is to bring investment to their region[3]. The most common incentives are tax exemption and donation of land, but in some cases, such as the Fiat's plant in Minas Gerais, the local government forms a partnership with the car assembler to nurture its growth in the state.

2.2.2 Changes in Organizational Structures

From the mid–1990s, western automakers started to radically transfer most production-related

activities to first-tier suppliers. (Teixeira & Vasconcelos, 1999: 22).

Following this trend, Brazil was one of the first countries in which transnational automakers started creating new organizational structures. For instance, General Motors' factory located in Gravataí (Rio Grande do Sul), gathered all but one of its first-tiers suppliers in the same plant. In Ford's industrial complex in Camaçari (Bahia), suppliers are located around the main facility (Teixeira & Vasconcelos, 1999: 21–22).

An organizational structure creating a higher level of interface between automakers and first-tier suppliers was implemented in 1996 by Volkswagen in Resende (Rio de Janeiro). Volkswagen transferred most of its production-related activities to eight subcontractors that share the same plant: Iochpe-Maxion, Rockwell, Remon, MWM, Cummins, Eisenmann, Tamet and VDO. The production system is divided into various stages, each managed by one of the subcontractors. Volkswagen only performs 15–20% of all the activities but is responsible for coordination and for testing the trucks in the final stage. The suppliers are not only responsible for manufacturing the subsystems, but also for directly assembling them on the assembly line (Pires, 1998: 226; Teixeira & Vasconcelos, 1999: 19).

All the aforementioned factories share several similarities. In all of them, the first-tier suppliers are responsible for manufacturing and delivering subsystems, rather than only components. Moreover, in all of them the automakers are attempting to have a limited number of first-tier suppliers capable of supplying those subsystems. These are actually the main features of a new production system that is being increasingly used by western automakers in Brazil, so-called modularization.

Modularization can be defined as "building a complex product (...) from smaller subsystems that can be designed independently yet function together as a whole" (Baldwin & Clark, 2003: 149). A subsystem or module is "a unit whose structural elements are powerfully connected among themselves and relatively weakly connected to elements in other units" (Baldwin & Clark, 2000: 63).

Therefore, in this production process, the product is divided into subsystems and each partner is responsible for manufacturing one of them. The connection between the modules is standardized, so that efforts can be focused on the improvement of each module and limited attention is given to their connectivity.

Due to this trend towards the adoption of modularization in Brazil, automakers are maintaining their main role as coordinators and focusing on single-sourcing while first-tier suppliers have to develop their capacities to deliver subsystems.

2.3 Inter-firm Relations in the Brazilian Automobile Industry

Due to the strong presence of western transnational firms in the Brazilian automobile industry, the pattern of the relationship between automakers and suppliers tends to follow the western approach.

In the early 1990s, American suppliers were skeptical regarding the changes in supply chain

management in the U.S. automobile industry. They believed that the introduction of the just-in-time system was not an attempt to promote integration in the supply chain, but only a way of shifting the burden of inventories from the automakers to them (Womack et al., 1991: 160–161).

A survey conducted by Arkader (2001: 90–91) in Brazil in the late 1990s, demonstrated a similar relationship pattern. While the suppliers asserted that the attitude of automakers during negotiations was intransigent, and based on a win-lose perspective and on lowering prices rather than improving productivity or building a long-term relation, the automakers stated that they were moving towards the creation of a Lean supply chain, focusing on nurturing long-term partnerships with their suppliers.

This clear discrepancy between the perspective of automakers and suppliers shows that supply chain management in the Brazilian automobile industry lacks an integrative approach. Brazilian automakers, like their western counterparts, are only adopting Lean Practices partially, as a way to reduce costs or transfer the risk to suppliers.

Correa (2001: 1; 6–7), in research conducted in the Volkswagen plant in Resende, contended that this automaker's decision to use modularization was a way to use the expertise of first-tier suppliers and at the same time share the investment and risk of the operation. Kotabe et al (2007: 100), based on interviews with managers of the biggest car assemblers in the country, also contend that automakers in Brazil are adopting modularization to share investment costs and reduce the risks of their operations.

Both the partial adoption of Lean Practices and the trend towards modularization show that Brazilian automakers are emphasizing capacity building at the organizational level and neglecting the system level. By doing so, however, Brazilian automakers are overlooking the issue of knowledge regarding components they are outsourcing. Knowledge partitioning is taking place at the same time as task partitioning (see subsection 1.3.2) and automakers are focusing on their role only as coordinators of the supply chain. As a result, there are no joint efforts for problem-solving and there is no accumulation and diffusion of knowledge in the supply chain network.

In particular, too much emphasis on coordination represents a threat for the Brazilian automobile industry, which is dominated by transnational automakers. If local factories focus on coordination rather than integration, they won't be able to create a competitive advantage and might be outrun by other developing countries with more attractive manufacturing conditions, and, in particular, lower labor costs.

3. Case Study: MMC in Catalão

3.1 General Information about MMC

The automobile assembler in which the case study was conducted is called MMC automotores do Brasil ltd, a Brazilian limited liability private company. Its relationship with the Mitsubishi headquarters

is only commercial and therefore, MMC does not receive any type of financial aid from the Japanese automaker.

MMC was founded in 1996 and is located in the municipality of Catalão[4], in the state of Goiás. MMC faces several logistic problems due to its location. Catalão is about 750 kilometers from São Paulo, where most of the suppliers are located, and 830 kilometers from the port of Santos, where the imported components are discharged.

MMC currently assembles 4 Mitsubishi models which are sold primarily to the upper classes in Brazil. The company is in the process of expanding through purchasing nearby land and building new facilities. Currently, its total area is 650,000 square meters (including approximately 60,000 square meters of constructed area).

Although blue-collar workers are hired in the local region, managers come from São Paulo. Marketing, finance, and product engineering departments and suppliers are all located in São Paulo.

The company has 1,135 employees, although the total number of workers inside the factory is around 1,500, including outsourcing. In 2005, the company assembled 20,153 vehicles (Anfavea, 2006: 123).

3.2 Lean Practices Adopted by MMC

3.2.1 The 5S Approach

At the time of the researcher's visit, on November, 17th, 2006, the 5S approach was one of the Lean Practices used by MMC. There was a big board inside the factory explaining simply the meaning and objectives of the 5S approach. There was also evidence that the 5S approach was being implemented in the plant. In fact, the overall impression of the company was quite good. Corridors were always cleared in order to allow the smooth flow of carts to transport materials from the warehouse into the various stages of the assembly line. The sections of the factory that needed to be kept totally clean — such as painting shops — were separated from the rest of the factory, isolated from dust, and access was restricted. Components were separated and organized in different boxes with memos explaining in what models each component should be used.

The logistics manager explained that the correct observation of this 5S approach had an impact on the salary of the workers on the shop floor and therefore, they tended to keep everything clean and well organized.

Nonetheless, a more detailed observation of the assembly line showed that the level of commitment to the 5S approach could still be improved. During the observation of the initial stage of the assembly line, next to the boxes containing the components to assemble the vehicles, there was a motorcycle helmet of one of the blue-collar workers. Of course, after noticing that, the supervisor admonished the employee and instructed him to put his helmet in the correct place. This incident shows that the 5S approach is not consolidated as a principle orienting the daily work of employees at

MMC. Liker (2004: 36) highlights that one of the components of the 5S approach is discipline (shitsuke), which is connected to the idea of sustainability. Therefore, workers have to use the 5S approach as a philosophy to guide their everyday job routines, constantly trying to reduce the sources of waste and improve their working environment.

3.2.2 Multi-skilled Workers

Another Lean Practice observed in MMC was the development of multi-skilled workers. The first stage of training of blue-collar workers is an off-the job course about quality control. After that, they work for one month side-by-side with a veteran. By the end of the one month period, they are supposed to take a practical test and, if approved, they can start working at a specific workshop. All the workers are supposed to rotate within one group (5 people work in each group) and after that, they are transferred to other shops in the factory to acquire a comprehensive overview of the production process.

The minimum educational requirement for the recruitment of blue-collar workers is a secondary education. Agriculture has a strong presence in Goiás, and there are also a number of local industries in Catalão, such as mineral extraction, ceramics and chemicals. As a result, it is not difficult for MMC to find secondary school graduates in the municipality (Ribeiro & Cunha, 2005: 13–14).

However, if MMC expects employees to contribute in terms of kaizen and internalize the 5S approach, more initiatives are necessary in providing training for the shop floor. A great level of involvement of blue-collar workers as observed in Toyota can only be achieved through a mixture of on-the-job and off-the-job training that goes far beyond the acquisition of basic knowledge of electronics and mechanics[5]. In fact, an automaker can only expect to obtain the serious involvement of blue-collar workers by investing in the improvement of their abilities.

3.2.3 The Kanban System

The kanban system is also implemented in MMC for synchronizing workstations. The researcher observed that in one of MMC's warehouses, small components were organized in various aisles, as in a supermarket. The workers receive a list containing the number, model and order of vehicles to be assembled. With that document in hand, the employee goes through the aisles collecting the necessary items. Those items are then loaded onto different carts and sent to the assembly line in the correct synchronization to the models being assembled. MMC is currently investing in the automation of this process, to facilitate information exchange with suppliers.

In this particular warehouse, however, the researcher also observed some workers waiting idly. The time blue-collar workers had to wait to proceed to the next task can be considered as non-value-added activities. The lack of commitment to the reduction of non-value-added steps shows that the level of adoption of Lean Practices at MMC is still low. The company is not making use of its workforce to create conditions for incremental and continuous improvements. MMC is utilizing Lean Practices as tools or techniques and not as a principle as defined by Liker (2004: 35–36). Moreover,

the system is not being jointly adopted with suppliers and thereby is not optimized.

3.2.4 Visual Management

MMC has a signboard at the end of the assembly line displaying the number of cars that should be produced and the number already produced at that time. In several sections of the assembly line there are boards with drawings showing the correct way to assemble parts and warning workers about common mistakes.

However, overall, information available to blue-collar workers is quite limited. In fact, the most valuable source of data regarding the conditions on the assembly line was an on-line system that could be accessed by managers through computer terminals. This on-line system shows everything that is taking place in the assembly line and provides relevant information such as the number of FTT (First Time Through) and defective cars; the stage that each car is at and the stage that it should be at on the assembly line, and the total number of cars produced.

However, blue-collar workers have limited access to this data. One important aspect observed by Fujimoto (1999: 266) concerning the Toyota manufacturing system is the sovereignty of the shop floor. In order to introduce continuous improvements, work towards the detection and avoidance of defects, actively participate in Quality Circles and perform the daily maintenance of equipment (TPM), the shop floor has to have real-time information such as the number of defective cars after final supervision, the nature of the defects and the problems that resulted in stops of the assembly line. By not providing the necessary real-time information to the shop floor, MMC is losing latent possibility for continuous improvements and defect prevention.

3.3 Supply Chain Management

The logistics manager highlighted several times during the interview that a huge problem MMC faces is the long distance between Catalão and São Paulo. Around 50% of the components come to Brazil by ship, imported from Japan and Thailand, arriving at the port of Santos (São Paulo). These components are delivered 120 days after they are ordered.

Even for components purchased from Brazilian firms, the order has to be made 45 days in advance, and they are delivered to a warehouse located in Osasco (São Paulo), approximately 750 kilometers from Catalão. Some suppliers, such as the tire supplier, deliver the parts just-in time to MMC but they are a minority.

For most of the suppliers, orders have to be made a long time before delivery and MMC has to keep a huge stock to avoid the risk of having to stop the assembly line. Since many parts are ordered several months before being utilized, the logistics manager reported that even if MMC decided to stop producing cars, it would continue receiving parts from Japan for about 6 months.

The case of MMC highlights one of the tendencies observed in the Brazilian automobile industry from the mid-1990s onwards, and that is the construction of factories in regions outside the

metropolitan area of São Paulo. Due to the long distance between the company and its suppliers, MMC has to cope with several logistics and communication problems.

It was mentioned during the visit, however, that despite those difficulties, the decision to build an MMC plant in Goiás had many financial advantages. MMC received fiscal incentives from the local government, in particular in the reduction of the import tax. Moreover, most of the consumers of Mitsubishi automobiles live in this state. The city in which Mitsubishi automobiles sell well is Goiânia (Goiás), due to the popularity of Mitsubishi vehicles in the agribusiness, which is particularly developed in this state.

Despite those advantages, because of the lack of integration with its supply chain, MMC is certainly losing opportunities for joint efforts to improve productivity, lower cost and enhance quality standards. The company has many warehouses that occupy a considerable part of its plant in Catalão and has huge inventory costs. Due to the long distance between the plant and its suppliers, efforts for just-in-time deliveries are difficult and risky and its kanban system is not working at an optimum level.

Following the trend of modularization in Brazil, MMC is demanding the delivery of pre-assembled subsystems from its first-tier suppliers, maintaining its main role as coordinator. The distance between MMC and its suppliers, however, results in a lack of information exchange which hinders joint problem-solving initiatives.

It is true that MMC is in the process of expansion, constantly increasing the number of cars produced. However, a higher level of integration with suppliers would result in faster enhancements in productivity and efficiency. Brazil has a huge domestic market that has not been fully explored, and the regional market of South America also represents a latent opportunity for MMC. According to data from Anfavea (2006: 104), until 2005 MMC had focused only on the internal market and has not exported.

The visit showed that MMC had, to some extent, successfully adopted some Lean Practices at the organizational level. It is necessary, as already stated, for more investment in developing the abilities of blue-collar workers, in order to get a higher level of commitment to practices such as the 5S approach. On top of that, the optimization of Lean Practices demands a greater integration with suppliers. A comparison between the data gathered during the visit and the classification of non-value-added activities (subsection 1.3.1) tends to show that MMC is not working towards the reduction of at least three non-value-added activities: (1) the factory has excessive inventory and, according to the logistics manager, is building more warehouses; (2) workers waiting idly could be observed at the warehouses; and (3) MMC is losing learning opportunities by not making use of its employees' creativity and ideas to improve the production process.

3.4 Relevance of Local Government Incentives for Decision Making on Plant Location in Brazil

The fiscal incentives granted by the local government were one of the key factors influencing the decision of MMC to build its plant in Catalão. In fact, those incentives were part of a broader governmental policy to promote the industrialization of Goiás, initiated in 1984 with the creation of a fund called FOMENTAR.

The Decree n. 3.822 enacted by the state of Goiás on July 22, 1992 regulated this fund and according to article 4 the local government could grant exemptions of up to 70% of a value-added tax on the circulation of goods called ICMS[6] and, in some cases, reduce the import tax of companies that set up businesses in the state. In Catalão, from 1985 to 1999, 8 companies received benefits from FOMENTAR, including MMC (Ribeiro & Cunha, 2005: 9).

Most of those firms were in the agribusiness. The only two companies not directly connected to the agribusiness were Tratores John Dear and Mitsubishi. However, Mitsubishi produces vehicles mainly used in the agribusiness and Tratores John Dear produces agricultural machinery and trucks. In fact, agriculture and agribusiness play a large role in the GDP of Goiás. In 1986, agriculture and the industrial sector respectively accounted for 20% and 31% of the state's GDP. Agribusiness made up a large part of the industrial GDP (Ribeiro & Cunha, 2005: 5). As a result of the implementation of FOMENTAR, in 2001 the share of the industrial sector in Goiás' GDP increased by 35% (Ribeiro & Cunha, 2005: 6).

To promote diversification of industry in Goiás and to further expand and modernize it, a new program was created in 2000 called PRODUZIR. This program maintained most of the incentives of the previous fund, but tried to support new entrepreneurs or private companies that wanted to diversify their businesses.

Those programs had a great impact on the industrialization of Goiás. In 2004, in the Center-West Region of Brazil, three out of five municipalities that had a higher level of participation in the national GDP were from the state of Goiás. The logistics manager of MMC also affirmed that the company was greatly attracted by the benefits of the FOMENTAR fund, in particular the reduction of the import tax and of the ICMS.

After the MMC plant was built in Catalão, many satellite firms were attracted to this municipality to provide services to the assembler, such as HPE－High Performance Equipment, Weldmatic automotive ltd, RCM - Engineering & Industrial Solutions ltd as well as many others.

Therefore, the initiatives of the state of Goiás to promote industrialization were successful. The participation of the industrial sector in the state's GDP has increased, and the example of MMC shows that many satellite firms were attracted to the state after large firms decided to settle in the local area.

Nonetheless, it is important to observe that none of the first-tier suppliers of MMC were brought to Catalão. The company imports around 50% of its components and its main first-tier suppliers are

located outside Brazil. The engines for the vehicles, for instance, are pre-assembled in Japan, shipped to the port of Santos, and finally transported to MMC. The distance between the automaker and its first-tier suppliers represents a great obstacle for the expansion of MMC, since it increases inventory costs and hinders the integrative adoption of just-in-time manufacturing throughout the supply chain and the promotion of joint efforts to lower cost and increase productivity. Consequently, although MMC is expanding, it is not growing fast and is not taking advantage of latent opportunities in both domestic and regional markets.

For faster and steadier growth, the intervention of the local government is necessary, as demonstrated in the aforementioned example of the partnership between Fiat and the state of Minas Gerais. The Brazilian domestic market and Mercosur's regional market show great opportunities for MMC's expansion.[7] Hence, although the fiscal incentives were important to attract investment to the region, they are insufficient to nurture the sustainable growth of this automaker in the municipality.

Policies for industrial growth demand "regular and extensive consultation, negotiation and coordination with the private sector" (Weiss, 1998: 48), especially in the automobile industry, which is characterized by a high level of competition and constant geographical relocation of plants to areas offering better social-economic conditions. Due to the relevance of the automobile industry to the municipality of Catalão and the limited financial resources of MMC, which is a Brazilian private company, a higher degree of cooperation between public and private sectors is essential in order to attract MMC's key suppliers to the region and enhance its productivity level by promoting more integration in the supply chain network.

3.5 The Role of SENAI in Promoting Knowledge Dissemination and Skill Development in Catalão

Due to agribusiness, workers at Catalão had at least a secondary education and some of them had working experience in the industrial sector before joining MMC. However, they did not have working experience in the automobile industry and therefore no technical skills to operate the machines. This problem was addressed through a partnership between MMC and SENAI, the National Industrial Training Service. SENAI is a private organization which is part of CNI, the Brazilian National Federation of the Industry, and whose main concerns are vocational training, technical and technological assistance and production and dissemination of information. Many blue-collar workers received scholarships from MMC to attend SENAI courses on electronics and mechanics. Moreover, this partnership resulted in the creation of a laboratory with machinery and equipment to provide practical training for the workers (Ribeiro & Cunha, 2005: 9).

SENAI was created in 1942 and is currently the largest organization for vocational training in Latin America. It is funded by a levy of 1 percent of the gross payroll of Brazilian companies and by its own financial resources. It has 707 branches throughout the country and offers over 1,800 courses on

various subjects related to vocational training (SENAI, 2007). According to information provided by the local government of Catalão, since it started providing courses in the region 15 years ago, SENAI has already taught almost 15,000 workers. Currently, the organization provides 100 courses in the municipality.

Due to the low level of information and technological exchange in the horizontal relations between firms in Brazil, organizations for vocational training and skill development such as SENAI play an important role in the diffusion of knowledge throughout the country. Many large first-tier suppliers in the Brazilian automobile industry are reluctant to exchange information with domestic small and medium-size domestic companies because they fear they might lose proprietary knowledge to opportunistic subcontractors (Ó hUallacháin & Wasserman, 1999: 24). In fact, the level of knowledge transfer through direct relations at the horizontal level in Brazil is not significant, since companies prefer to exchange information through associative organizations (Mesquita et al, 2007: 518), such as Anfavea and Sindipeças.[8] The role played by SENAI in its partnership with MMC in Catalão illustrates the importance of those organizations in skill development for industrial growth in Brazil.

Conclusion

Due to the trend towards modularization, automakers in Brazil are outsourcing most of their production-related activities and focusing on their role as coordinators. This new production process demands a high level of *coordination* and efforts to promote *integration* in the supply chain become secondary. Capacity building at the organizational level is emphasized, while the inter-firm or system level is neglected.

Data collected during a fieldwork survey at MMC illustrates the aforementioned situation. By adopting Lean Practices unilaterally, the automaker has made some progress, but the huge inventory costs, the lack of joint efforts in problem-solving and quality enhancement as well as the unexplored opportunities in the domestic and regional markets show that a more integrative approach to supply chain management is necessary.

In sum, these are the findings presented in this paper:

-The Lean Production System is based on close relationships between automakers and suppliers, facilitating cooperation, diffusion of practices throughout the supply chain and capacity building at the system level. However, due to the strong presence of western automakers in the country, the Brazilian automobile industry is adopting only some features of this system, as a way to reduce costs and raise short-term profit. The case study conducted in MMC shows this partial adoption of Lean Practices. The lack of comprehensive adoption of those practices throughout the supply chain and the distance between the automaker and its first-tier suppliers result in

huge inventory costs. A more integrative relationship between MMC and its first-tier suppliers is necessary to enhance productivity and reduce costs.

-There is a tendency towards the adoption of modularization in Brazil. Most of the major automakers in the country (GM, Ford and Volkswagen) are outsourcing the production of subsystems to a limited number of suppliers. Due to the adoption of modularization, Brazilian automakers are focusing on *coordination* rather than *integration* in supply chain management. This means that, although Lean Practices are being unilaterally adopted, the sector is not moving towards a comprehensive adoption of the Lean Production System.

-The case study conducted in MMC also shows the efforts of local governments to attract investment to their municipalities in order to promote regional growth. Due to subsidies offered by local governments from the mid-1990s, a tendency towards automakers' factories relocating to areas different from the state of São Paulo can be observed. MMC has benefited by two programs created by the state of Goiás: the fund FOMENTAR and the program PRODUZIR. Nonetheless, although those fiscal incentives were important to attract investment to the state, they are insufficient to promote a high level of industrial growth.

Notes

1 5S stands for initials of five words in Japanese connected to the idea of discipline and cleanliness: Seiri (整理): arrangement, Seiton (整頓): order, Seiso (清掃): cleanliness, Seiketsu (清潔): neatness, Shitsuke (躾): discipline.

2 Michael Porter defines competitive advantage in terms of the decisions made by a firm to specialize in a market segmentation or niche and therefore he does not consider operational effectiveness — improving quality and cost simultaneously — as a competitive advantage (Porter et al, 2000: 81). Nonetheless, as Hayes & Upton (quoted in Fleury & Fleury, 2003: 18) point out, operational effectiveness can be considered a competitive advantage when it is embedded in the organizational culture and operating processes to such an extent that it makes emulation by other firms difficult. Moreover, Dyer (1996) highlights that an integrated supply network characterized by a high degree of co-specialization can also be considered a competitive advantage.

3 One example of those incentives was the exemption of municipal taxes for the period of ten years, given by the municipality of Sumaré (São Paulo) to Honda. Also, the state of Paraná exempted Renault of the payment of the ICMS value-added tax for 8 years and donated the land on which the plant was built. In the case of Ford, the automaker suspended the opening of its plant in the city of Guaíba (Rio Grande do Sul), when the local government decided to renegotiate the incentives previously granted. Ford decided to give up the project and build a plant in Camaçari (Bahia), when the central government offered incentives of 180 million reais for 10 years (Botelho, 2002: 60).

4 According to IBGE—Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics)—the estimated population of Catalão in 2006 was 71,680 inhabitants (IBGE, 2007a). In 2004, the municipality was responsible for 4.60% of the total GDP of the state of Goiás (IBGE, 2007b: 40). The industrial sector has a great presence in the municipal GDP: 68% in 1998 (Ribeiro & Cunha, 2005: 7).

5 In fact, during the off-the-job training, blue-collar workers learn much white-collar work. Moreover, the wage system of Lean Practitioners is based on skill accumulation and tries to reward workers who develop intellectual skills (Koike, 1988: 162).

6 ICMS (Imposto sobre Operações Relativas à Circulação de Mercadorias e sobre Serviços de Transporte

Interestadual e Intermunicipal e de Comunicação, ainda que as Operações se Iniciem no Exterior - Tax on the Circulation of Goods, Interstate and Intercity Transportation and Communication Services, even when the Operation is Initiated Abroad) is a value added tax that applies to the exchange of goods and for transportation and telecommunication services.

7 The analysis of the Brazilian domestic market shows a low percentage of inhabitants per vehicles, which represents a latent opportunity for expansion. According to Sindipeças (2006: 44), in 2004 there were 8.1 inhabitants per vehicle in Brazil, which represents around 99 cars per 1000 persons. The rate is also low in other countries of South America (16.8 inhabitants per vehicle in Colombia, 10.3 in Venezuela, 7 in Chile and 6 in Argentina). Therefore, there is a great chance for Brazil to consolidate its leading position in the automobile industry in the regional market.

8 Anfavea is the Brazilian association of automakers and Sindipeças is the Brazilian association of auto parts producers. Both organizations have a national presence.

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