Reis, José Salvador da Motta
Silva, Dayana Elizabeth Werderits
Cardoso, Ronald Palandi
Barros, José Glenio Medeiros de
Sampaio, Nilo Antonio Souza
Santos, Gilberto
Barbosa, Luís César Ferreira Motta

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Supply Chain Analysis Through Partner Suppliers: A study of a small-medium sized company in Brazil

José Salvador da Motta Reis[1*], Dayana Elizabeth Werderits Silva[1], Ronald Palandi Cardoso[2], José Glenio Medeiros de Barros[2], Nilo Antonio Souza Sampaio[2], Gilberto Santos[3], Luís César Ferreira Motta Barbosa[1]

[1] Centro Federal de Educação Tecnológica – RJ
Rua General Canabarro, 485, Maracanã, Rio de Janeiro – RJ, CEP: 20271-204
jmottareis@gmail.com, daywerder@gmail.com, luiscesarfmb@gmail.com

[2] Universidade do Estado do Rio de Janeiro
Rod. Pres. Dutra, km 298, Polo Industrial, Resende – RJ, CEP: 27537-000
ronaldpalandi0805@gmail.com, glenio.barros@gmail.com, nilo.samp@terra.com.br

[3] Gilberto Santos – Research Institute for Design, Media and Culture, ID+
School of Design, Polytechnic Institute Cavado Ave, Campus do IPCA,
Vila Frescaínha S. Martinho, 4750-810 Barcelos, Portugal; gsantos@ipca.pt

Abstract. With the process of globalization of economies, companies have been suffering increasing competition in the search for and maintenance of customers. Thus, opportunities that represent competitive advantage have been analysed and, many times, adopted. In this context, the supply chain can be a competitive differential, as it favours cost reduction and quality improvement of production resources. On the other hand, delays, and shortages of inputs in the production chain generate losses of resources and damage the company's image with its customers. Within this perspective, the supply chain of a heavy machinery and equipment manufacturer, addressing the indicators

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[*] Corresponding author.

Supplier Potential (PF), Supply Conformity Index (ICF) and Service Index (AI). The objective of this research was to identify the delays and shortages of inputs, arising from the company's supply chain, as well as from the purchasing and parts collection process. To this end, the fundamentals of Taker ship and Management by Indicators were adopted, aiming to achieve the proposed objectives. The work sought to collect data from the root year of the analysed process so that a picture could be made of how the process happened in the beginning, in the year 2008 and these data reflect the current reality of the company 2021. The study indicated the need for a new purchasing and parts collection system that could contribute to the elimination or reduction of the identified losses. The results obtained showed the successes in the supply chain integration strategy, using partner suppliers, as well as the implementation of a Milk Run type parts collection system.

Keywords: Supply chain; Milk run; Just in time; Materials management.

1. Introduction

The economies of different countries have been going through a process of integration and expansion of their commercial relations. Companies, in general, no longer operate only in their domestic markets. They have started to operate in the most diverse countries, with increasingly intense commercial exchanges, via imports and exports, progressively internationalizing their activities. Trade and tariff barriers have been overcome as the need for new markets has emerged. [1–3].

Economies are becoming increasingly globalized, making it necessary for companies to manage them more efficiently. In this process, the so-called globalization has favored the improvement of companies' competitiveness as it exposed the organizations to competitors anywhere in the world. This fact has encouraged companies to maintain or obtain high levels of competitiveness through the permanent search for better conditions related to quality, productivity, reduction of delivery times, technological modernization, qualified labor, innovation and productive efficiency, cost reduction, among other competitive elements. In this context, globalized logistics has been gaining a prominent role with the acquisition of better quality supplies, at a lower price and within an appropriate timeframe. This fact has been determining the search for better ways and strategies to apply logistics as a competitive differential [4–7].

The objective of this study was to analyze the process of input supply in a production line of a machinery and equipment company, seeking to identify opportunities for improvements that could contribute to the delivery of inputs in the right place, in the

right quantity, at the right time and with specified quality. All this to favor a better integration of suppliers and the synchronism with the supply chain.

2. Theoretical background

Applying the concept of Just in Time, which is a philosophy of planning, manufacturing control and inventory management, which aims to meet customer needs with a lower cost.   This work seeks to show the existing partnership relations in a supply chain, as well as the benefits that can be generated through the integration of the participants, that is, suppliers and the client company, it is necessary to obtain theoretical support on the subject [8–10]. In this sense, the aspects involving logistics play an essential role for production, due to the supply chain, which is under constant pressure to reduce costs and inventories, among others. Thus, throughout this chapter a detailed theoretical review of the essential elements for the development of this dissertation will be presented [10, 11].

As time went by and with the globalization process of the economy, the organizations realized that consumers had changed, they no longer valued products only for their brand, it was necessary to add value. Logistics must meet the final consumer in an adequate manner, managing the company and its logistics agents globally in an integrated and harmonious manner [12–14]. The supply relations with a medium- and long-term vision, aiming at improving quality and reducing deadlines and costs, provide competitive advantages for companies, thus strengthening the partnership relationship between the links in the supply chain. This relationship becomes more lasting between the business partners [15–18]faced with a wide-ranging array of products that might fit specific needs, customers usually buy according to expectations about value and satisfaction. When customers are satisfied with a purchasing experience, they are more likely to buy again and share their experiences with others. Hence, companies are concerned about increasing customer value and service satisfaction to develop and manage customer relationships. This maintains a company's competitive edge and can improve its market share. In this article, we incorporate the frequency of advertisements and the cost of customer relationship management (CRM. Transportation is one of the most important logistics activities for companies, because it is an element that spends an average of two thirds of the logistics costs. More than half of the cargo transportation in Brazil is done by road, this means of transportation is the least productive in terms of cargo per operator hour, and its labor cost is high. This makes it necessary for companies to search for an ideal transportation system to reduce costs generated by this activity [19–21].

The companies use several forms of transportation, one of them is the Milk Run collection system, for the integration among companies in the search for benefits,

agility in the delivery, increase in the added value and market participation, the Milk Run programmed collection system aims to meet at the exact time and at the lowest cost. This concept originated in the manufacture of milk on farms, after it has been extracted it is collected and treated by the plants. The Milk Run collection system started with the milk trucks in which the "milk route" originated, where there is a pre-established route (route) and with determined quantities to be collected or unloaded [22–24]. A Milk Run route is one in which a truck either makes deliveries from a single supplier to multiple destinations, or goes from multiple suppliers to a single destination, strictly respecting the pre-established time windows for collection and/or delivery. The Milk Run collection system can be performed by the company itself, which must manage the best collection route, determining the quantity of parts to be collected [25–27].

3. Research Method

This work can be classified as an applied research and the research procedure used was the case study to analyze and describe a phenomenon [28–30] in order to comprehend the context, to analyze and be more familiarized with the problems identified in the company making it more explicit. To achieve the objectives proposed in this work, the approach of analysis by performance indicators used in the company were adopted. These fundamentals were applied to a large company in the industrial sector of assembly and manufacturing of heavy machinery and equipment and its suppliers. The company under study and its suppliers did not allow their identification, so the denomination "FRN" was used to identify each supplier within the supply chain and relate their collected data to the company's indicators. The processes involved were analyzed in the company through the monitoring of internal indicators. Indicators allow a scientific quantification and consist of a way to assign numbers and properties to provide useful information. Using the company's indicators, it was possible to ascertain the results of its operations regarding the flow of input delivery by its suppliers. These results were essential for management decisions, aiming at the integration of the supply chain. For this, data was collected for a certain production period, so that before and after the implementation of a new system for the integration of suppliers to the company could be compared. For this, the following indicators were applied. The supply conformity index is generated by assessing the quality of the supplies (parts) delivered and inspected, according to the company's internal standard, which prioritizes the dimensional, functional, finishing, chemical composition, chrome layer, painting, among others. ICF calculation is presented by Equation (1).

$$ICF = \left(\frac{\text{Nº of Scheduled Parts} - \text{Nº of Delayed Parts}}{\text{Nº of Parts Scheduled}}\right) \bullet 100\% \quad (1)$$

To calculate Equation 1, the number of inputs received in the month by the company (delivered by the supplier) is considered, subtracting from this receipt the number of parts that may present quality problems (non-conformity). This value is then divided by the number of supplies received in the month, multiplied by 100, expressing the result in terms of index (%.) According to Table 4, the company's goal is to reach ICF = 100%, that is, to have quality assurance assured by its suppliers. The service index is related to the logistics performance of the supplier in relation to the orders generated by the company. The orders are sent electronically to each supplier on the first business day of each month, in which the supplier must meet the customer company's request. For a better analysis of the AI, Equation 2 is used.

$$AI = \left(\frac{\text{Nº of Scheduled Parts} - \text{Nº of Delayed Parts}}{\text{Nº of Parts Scheduled}}\right) \bullet 100\% \quad (2)$$

To calculate Equation 2, the number of parts programmed in the month by the company (delivered by the supplier) is considered, subtracting from this programming the number of delayed parts. This value is then divided by the number of parts scheduled for the month, multiplied by 100, expressing the result in terms of index (%). When facing the AI indicators - Index of Attendance - below the company's goal, these values show a panorama of delays in the flow of inputs delivered by partner suppliers. These delays and/or lack of parts impair the functioning of the assembly operations of machinery and equipment within their initial schedule, because when faced with the shortages, some assembly operations are left aside, this action impairs the following operations due to the lack of parts. These shortages directly impact the assembly of machinery and equipment, contributing to a decrease in efficiency of operations is less than programmed, generating losses for the company, delays in the delivery of the finished product, extra expenses with logistics, and the reallocation of internal assembly operations. To calculate the PF, Equation is used: PF= (0.5 * ICF + 0.5 * AI), substituting ICF and AI, we have. After evaluating the suppliers' FP, it is possible to classify them, according to Table 1. For suppliers with FP below 80 points, the company's supply area must evaluate the need to open an action plan.

4. Results and Discussion

For suppliers who did not reach the required score PF $\geq$ 80 the company's supply department chooses whether to open an action plan, a decisive factor for opening this plan is the repetition of the evaluation, resulting from the subsequent months' PF, if it

falls below the desired score. Table 2 shows the different values for the PF, ICF and AI indexes established by the company for its suppliers.

Table 1. Supplier Classification.

Supplier Classification	
$90 \leq PF \leq 100$	Excelent
$80 \leq PF < 90$	Good
$70 \leq PF < 80$	Regular
$60 \leq PF < 70$	Disabled
$PF < 60$	Inadequate

Table 2. Target Key Figures.

INDEX	TARGET VALUE
PF	≥ 80
ICF	$= 100$
AI	≥ 90

Where: PF = Supplier Potential ICF = Supply Conformity Index AI = Service Index. The objective indexes, presented in Table 2, do not follow the corporate standards of the group, they were adapted to the reality of the company in the domestic market, due to the low production volume and the great complexity to manufacture the parts. The work sought to collect data from the root year of the process analyzed so that a picture could be made of how the process happened at the beginning. In 2008, facing a scenario of global economic crisis, which also plagued the Brazilian industries, the company's management conducted surveys and sought opportunities for reducing losses, improving quality and customer service, which would even contribute to maintaining the jobs of its employees. From this scenario, several meetings were held with the objective that each department could contribute with actions to reduce costs and increase quality and productivity, increasing the chances of economic survival of the company. The Supply department started then to hold weekly meetings, which were named "Criticality Meetings", among other issues, they also analyzed the logistics indicators such as: PF, AI and ICF. Through Brainstorming and Benchmarking sessions, it was possible to arrive at the criteria adopted for the choice of suppliers that would be studied to improve the integration of the company's supply chain. The first criterion that contributed to the choice of suppliers was the financial amount of the supply from the 06 suppliers (FRN-1 to FRN-6) that represent about 16% of the company's annual expenditures. The geographic location criterion was also taken into consideration, since it favored the Milk Run programmed collection system to be implemented.

Counting on the collaboration of suppliers, these systems brought better results for the company, as captured by the monitoring indicators used. In this sense, we present below the results achieved and evidenced by these indicators. Table 3, presents the results of the semester and annual averages of the ICF for the years 2008 and 2009, being possible to observe that the supplier FRN-6 had a bad result in the 2nd semes-

ter of 2009, presenting a negative delta of 69.52%, the reasons for this fall, already explained above, is due to the development of new parts. Only suppliers FRN-2 and FRN-5 managed to improve their ICF indexes, improving the quality performance of the products delivered.

Table 3. Semiannual and Annual ICF Average.

	2008	2009		2008	2009		2008	2009	
ICF	Average 1° Week	Average 1° Week	**Δ%**	Average 2° Week	Average 2° Week	**Δ%**	Average Year	Average Year	**Δ%**
FRN – 1	97,00	95,50	**-1,57**	99,67	98,83	**-0,85**	98,33	97,17	**-1,19**
FRN – 2	99,83	100,00	**0,17**	99,33	100,00	**0,67**	99,58	100,00	**0,42**
FRN – 3	99,00	96,50	**-2,59**	99,33	99,67	**0,34**	99,17	98,08	**-1,11**
FRN – 4	99,50	99,00	**-0,50**	100,00	99,83	**-0,17**	99,75	99,42	**-0,33**
FRN – 5	98,33	99,83	**1,52**	99,50	100,00	**0,50**	98,92	99,92	**1,01**
FRN – 6	89,00	52,50	**-69,52**	96,83	95,17	**-1,74**	92,92	73,83	**-25,86**

Table 4 shows the results of the semester and annual averages of the AI for the years 2008 and 2009. One can observe that the supplier FRN-4, was the only supplier to have a negative result with a variation of 0.78%, but this same supplier obtained better results in the 2nd semester of 2008 and 2009, respectively, closing the annual average with a positive delta of 0.10%.

Table 4. AI Mid-Year and Yearly Average.

	2008	2009		2008	2009		2008	2009	
AI	Average 1° Week	Average 1° Week	**Δ%**	Average 2° Week	Average 2° Week	**Δ%**	Average Year	Average Year	**Δ%**
FRN – 1	67,67	86,33	**25,57**	64,67	76,50	**18,29**	66,17	81,42	**23,04**
FRN – 2	91,33	100,00	**9,49**	88,67	100,00	**12,78**	90,00	100,00	**11,11**
FRN – 3	83,83	100,00	**19,29**	88,33	100,00	**13,21**	86,08	100,00	**16,17**
FRN – 4	85,33	84,67	**-0,78**	87,33	88,17	**0,96**	86,33	86,42	**0,10**
FRN – 5	70,00	97,33	**39,04**	66,83	95,17	**42,41**	68,42	96,25	**40,68**
FRN – 6	82,83	100,00	**20,73**	92,17	100,00	**8,49**	87,50	100,00	**14,28**

The annual average of 2008 suppliers FRN-1, FRN-3, FRN-4, FRN-5 and FRN-6 failed to get the results desired by the company. For the 2009 annual average, suppliers FRN-1 and FRN-4, were not able to get the AI results within the desired by the company (AI ≥90). With highlight to supplier FRN-5 that obtained the best annual

result with a positive delta of 40.68%. Table 5 presents the results of the half-yearly and annual averages of FP for the years 2008 and 2009. It can be observed that in the comparison of the half-yearly average of the 1st semester of 2008 and 2009, suppliers FRN-4 and FRN-6, could not reach the values desired by the company (PF≥80).

Table 5. Average FP Half Year and Yearly.

PF	2008 Average 1° Week	2009 Average 1° Week	Δ%	2008 Average 2° Week	2009 Average 2° Week	Δ%	2008 Average Year	2009 Average Year	Δ%
FRN – 1	82,33	90,83	10,32	82,16	87,50	6,50	82,25	89,17	8,41
FRN – 2	95,50	100,00	4,71	94,17	100,00	6,19	94,83	100,00	5,45
FRN – 3	91,17	98,33	7,85	93,83	99,67	6,22	92,50	99,00	7,02
FRN – 4	92,50	92,00	-0,54	93,83	93,67	-0,17	93,17	92,83	-0,36
FRN – 5	84,33	98,67	17,00	83,33	100,00	20,00	83,83	99,33	18,49
FRN – 6	86,00	76,17	-12,91	94,50	97,50	3,17	90,25	86,83	-3,94

For the annual averages, all suppliers were able to reach the target set by the company, with FRN-2 achieving 100% in the 2009 average and FRN-5 being the one with the best performance, with a positive delta of 18.49%. The costs generated by the non-compliance of the deliveries of inputs by the supplier's partners are accounted for and subsequently analyzed the responsibility, to make or pass on these costs. The monthly quantity of RNC (nonconformity reports) and the values expressed in R$. The total value is R$ 86,408.00 which corresponds to all the RNC's generated in 2009 (national and import), of this presented value 26.68%, i.e., (R$ 23,060.00) belongs to the 06 suppliers Business Partners studied in this work.

The number of RNC's from previous years, in the year 2006 29 RNC's were generated, in the year 2007 (44), in the year 2008 (28) and in the year 2009 (24). The company opted to debit the amounts of the incidents (RNC) whose responsibility is the supplier, at the end of each month, to avoid the accumulation of values to be negotiated at the end of a longer period (semester or year). To compose the RNC values it is considered the value of R$ 140.00 that corresponds to the opening of the document, which value is an average of the administrative costs involved in the process, plus the value of the rework hour R$ 82.00. Comprising labor, equipment, resources, displacements, etc. Not included in these values are the inputs that may be necessary for their use. In Figure 1, we can observe the costs generated by the ICF of the 06 suppliers under study, during the years 2007, 2008 and 2009. In 2008 there was an increase of 115.84% in costs compared to 2007, and for 2009 there was an increase of 70.35% compared to 2008.
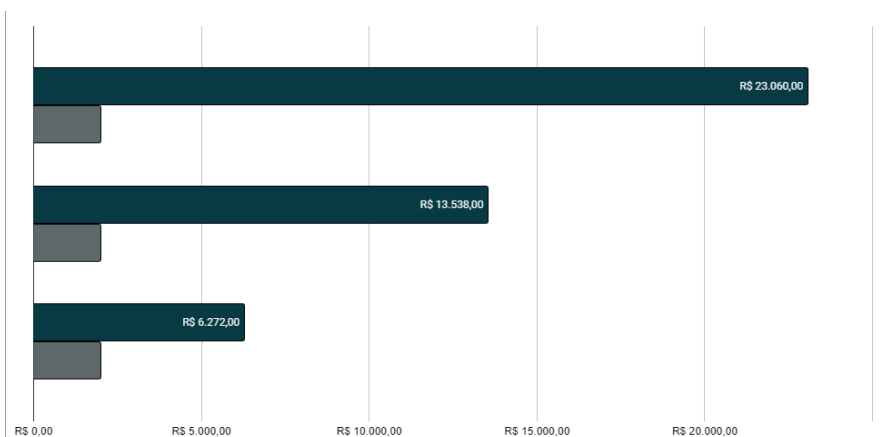
Figure 1. Costs Generated by the ICF.

The AI costs related to shortages and/or delayed deliveries of inputs, were considered negligible, due to the low value, totaling only R$ 2,012.00 in the first half of 2009, i.e., about 4% of all costs generated by suppliers for the company during the period indicated. This value refers to air freight costs, as a corrective action for the lack of parts, it was decided to import from the matrix the items that were not delivered on the date of their planning, burdening the logistics process in the indicated value, these costs were passed on to the partner supplier. However, this cost generated by the AI, in periods prior to the present study reached more significant figures involving the passing on by the customer companies to the partner suppliers, involved in the failure of the input flow. Figure 2 shows the percentages of the AI costs generated in 2007, 2008 and the first half of 2009 compared to the ICF costs. The AI costs are lower compared to the ICF.
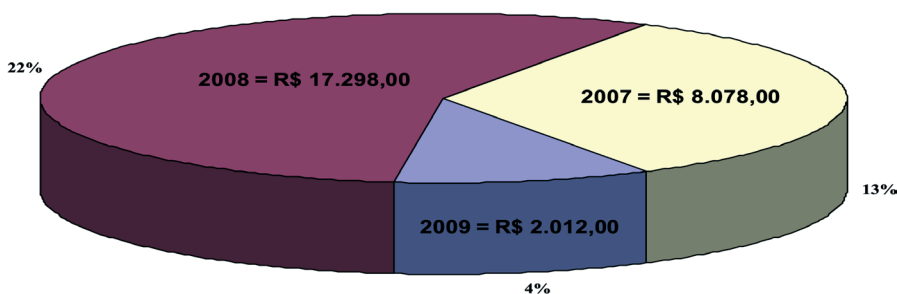

Figure 2. Costs generated by IA.

5. Conclusion

Based on this information, a study was developed to improve the supply of inputs, in quantitative and qualitative terms, through the consolidation of partner suppliers. After analyzing the company's internal indicators, it was possible to identify the need to change the organization's purchasing system, favoring the reduction of delays in the flow of inputs, and contributing to the integration of the supply chain. The implementation of the new purchasing system required the replacement of the conventional collection system for the collection system known as Milk Run, thus favoring a greater commitment from suppliers to meet the delivery deadlines of inputs. According to the results presented, the average time spent by suppliers to adapt to this new work system was approximately 2 months. The results obtained showed that 66.7% of the suppliers involved in the study improved their logistics performance, contributing to the improvement in the reliability of suppliers within the company and consolidating the much desired partnership. An improvement in the response time of the supply department to the needs of internal and external customers was observed; this was only possible with the commitment of the suppliers, who adopted and assimilated the culture.

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