LOGISTICAL ORGANISATION AND PERFORMANCE: EMPIRICAL EVIDENCES FROM THE AUTOMOTIVE INDUSTRY

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ABSTRACT

This paper aims to examine the alignment of operational and strategic decisions related to the logistical activities of purchasing, stocking, transport, warehousing, and order processing, as well as their interfaces with logistical organisational function. The research findings indicate that first tier suppliers make a considerable effort in carrying out logistic planning and manage performance indicators by applying different measurement methods in order to control logistical performance in the short and medium term. The results derived from the research indicate that, taking into account the levels of efficiency of functional integration, the performance of the first tier suppliers' logistical functions seems to be linked to the development of their logistical structure and the complexity of these suppliers' operations.

Keywords: Supply Chain Management; Performance Management; Automotive Industry.

INTRODUCTION

This article presents a discussion about the importance of performance measurement systems on the basis of a research carried out in 2004 with first tier suppliers (FTS) in Fiat Auto's supply chain in Brazil. The aim of this research was to statistically describe the performance and organisation of the logistic function in all the direct suppliers of materials to the assembly company. The study involved mapping the FTS as regards their purchasing, stocking, transport, warehousing and order processing activities, along with obtaining structured data concerning critical variables for the organisation of the logistic function, such as the level of formalisation of the function, the strategies and techniques for performance monitoring, the use made of Information Technology and the real flexibility of the logistic processes in the companies investigated. The paper is organised in five sections, in addition to the one forming this introduction. The first section, containing the theoretical references, brings together a number of theoretical contributions from the literature related to performance measurement systems, specifically, those related to the use of measurement systems in the management of logistical processes. Following this, brief reference is made to the concepts of integrated logistics and supply chain management, and, using this as a basis, the most relevant tendencies in the management of logistic functions relating to FTS operations in the international automobile industry are singled out. After this the consolidated results for each of the constructs used in the research are presented and the results of associations between some of these variables are explored. Next, the section where the data are analysed contextualises the findings of the research and, lastly, the conclusions are given.

THEORETICAL FRAMEWORK

Just as in any other business process, logistic processes require management models directed at measurement of results as well as permanent actions that bring about improvements over time (Lockamy and McCormack, 2004; Poirier and Quinn, 2004; Coyle *et al,* 2003). In this way, it is understood to be impossible for organisations to develop efficient procedures for the management of logistic processes without such systems being explicitly defined and having their performance measured and controlled in a regular basis.

In the academic and business community, performance measurement is a topic which is frequently valued and discussed but one whose essence is rarely defined (Neely *et al.,* 1995; De Toni and Tonchia, 2001). In a relevant effort in order to better define this concept, Neely *et al.* (1995) define performance measurement as a process whereby the efficiency and effectiveness of an action are quantified. They also point out the fundamental differences between the concepts of measurements and performance measurement systems, where the former refers to the metrics used to quantify the efficiency or effectiveness of an action and the latter to the totality of metrics used to quantify both the effectiveness and the efficiency of the actions regarding business processes.

An organisation's attempts to measure performance involve two groups of measurement units. The first of these have to do with costs, including those for production and productivity, and are recognised to have a direct connection with the company's final results, expressed in terms of net profit and profitability. The second group have no relation to costs and involve lead-time, flexibility and quality, among other performance factors. This latter group are usually measured by means of units which may not be necessarily defined in monetary terms (even if they influence financial performance, such a relationship cannot be calculated).

According to De Toni and Tonchia (2001), performance measurement systems (PMS) are changing from ones that are based on cost control and measurement to ones that are based on the measurement and creation of value, and which make use of non-cost performance indicators, that is, ones that are not explicitly economic or financial. In this way, based on performance attributes, such as greater flexibility in response to demand, regularity of delivery dates and reduction of lead times in relation to orders, companies develop capacities and complex packages of skills and knowledge that can be put to use in their organisational processes and, specifically, on their logistical processes (Lockamy and McCormack, 2004; Mentzer *et al.,* 2001). However, it is agreed that achieving a distinctly higher level of efficiency in logistic processes is a possible target as long as certain conditions are present, such as, for example, directives and actions for increasing control over results, predictability regarding cost and performance targets and greater management skills in proposing new and improved performance targets in a continuous and coherent manner over time (Poirier and Quinn, 2004; Lockamy and McCormack, 2004).

Integrated logistics and supply chain management

Integrated logistics involves changes in different organisational functions and processes and, as is well-known, is intended to ensure that the most important of the company's aims are achieved: to offer the product with the features demanded by the market and with the quality expected, at the right time, in the correct quantity, at a competitive price and with constant improvements in after sales service. In fact the essence of logistics, especially in supply chain management (SCM) practices, lies in establishing (setting up) integrated management of the total flow of resources and information along the distribution channels, from the source of raw materials to the final customer/consumer, adding services and reducing costs at all stages of the network. There is also a reduction in the time required to process orders, transport and stock costs are lowered and, in spite of all this, the company's ability to supply the market is not diminished (Chopra and Meindl, 2003; Cooper *et al.,* 1997; Moberg *et al.,* 2003; Coyle *et al,* 2003).

The concept of integrated logistics reflects the concern of organisations to manage the trade-offs involved in the activities that make up the logistics system in a pro-active manner (Lambert and Stock, 1993). The concern shown by companies about integrated logistics implies their acknowledgement of the fact that logistic resources are finite and that it is necessary to balance out costs against the services offered to customers. The challenge then is to guarantee companies the ability to provide the levels of service their customers demand – as set out in each organisation's marketing strategy –, seeking the best possible results in terms of cost and profitability (Christopher, 1992)

Good results in the management of trade-offs between the activities of the logistic complex depend on the company's level of progress in the organisation of the logistic function. The formalisation level of logistic activities, the performance measurement and constant investment in technology, all have the potential to create higher efficiency as regards the flexibility of logistic systems, as has been shown by Bowersox *et al.* (1992). In turn, such flexibility constitutes a competitive differential in relation to the logistic organisation of competing companies for at least two good reasons. First of all, flexibility is often the necessary condition for a company to obtain other competitive priorities such as speed or cost. Also, flexibility is the necessary condition for a company to be able to respond satisfactorily to exceptional situations, something which will have an effect on the levels of service offered to customers.

A brief reference to the present-day tendencies in the organisation of logistic function of FTS in the international automotive industry

The process of outsourcing of service operations, of production activities and, more recently, of innovative activities in the automobile industry world-wide has shown itself to be a fundamental forerunner, due to its size and influence, of important innovation in production chains in other industrial and service sectors in global economies. In the case of the automobile industry, new relationship structures are altering old forms of governance and supplier segmentation regimes in this industry, putting pressure on First Tier Suppliers (FTS) to adopt new responsibilities in regard to manufacture, logistics and the activities of product development (Calabrese and Erbetta, 2004; Liker and Choi, 2004; Lynch, 1999; Dyer *et al*, 1998; Lamming, 1993).

In the last 30 years, this process of deverticalisation has been gradually maturing at the same time as the successful application of other philosophies and principles such as business process reengineering, total quality management and lean production. More recently, the persistence of deverticalisation has been accelerating innovation according to the rules of integrated logistics and supply chain management practices. This innovation has favoured the development of important competitive features in this sector, such as time to market, cost reductions, quality, flexibility and timely attention to demand. Another important tendency seems to be the intensification of the forms of "quasi-market" – in contrast to the typical "arm's length" regime – as a segmented structure for management of a more stable basis of non-strategic suppliers, generally those providing inputs with less aggregated value or which are not considered to be critical for maintaining central competencies of the contracting company (Dyer *et al,* 1998). Finally, without in any way exhausting the issue, it is possible to observe an important tendency towards integration of the inter-organisational processes of assembly plants and first-level suppliers, where the spread of a logistic culture following the principles of lean production and supply can be noted.

RESEARCH METHODOLOGY

As regards its objective, the research can be described as an exploratory-descriptive study, and in relation to its design and the methods used to obtain data, it is a survey. The target population of the research included all the direct suppliers of part/components and modules/systems to Fiat Automobiles of Brazil. The suppliers of machines/equipment/tools and of logistic services were excluded from this population. The Fiat plant in Brazil is located in Betim (state of Minas Gerais) and is considered the Fiat Group's largest industrial complex for automotive production in operation in the world. Furthermore, from a local and regional perspective, it is responsible for the management of a complex supply chain of materials involving mainly suppliers of automotive integrated systems and suppliers of component parts. The data was collected during dozens of technical visits to the assembling plant during 2004, and a survey that was carried out between October and December 2004 among 73 FTS of Fiat Auto. This amount accounts for 30.4% of the total 240 FTS for Fiat operations in the country. The companies operate in the chemical, metal and electrical sectors, and are located in the states of Minas Gerais, São Paulo, Rio Grande do Sul, Paraná and Rio de Janeiro. The subjects were the executives in charge of logistics management or those connected to the sales and order departments dealing with Fiat Auto. During the data treatment stage, various descriptive statistical techniques were used, and the chi-square test (p-value = 0.05) and spearman correlation coefficient were used in order to analyse the associations between variables and check their nature and strength.

RESULTS

Features of the sample

The majority of the companies in the sample (65.8%) are located in the State of São Paulo (48 cases); 26.0% in the State of Minas Gerais (19 cases) and 8.2% operate in the States of Rio Grande do Sul, Paraná and Rio de Janeiro (6 cases). The sample was made up of foreign companies (58.9%), domestic companies (34.3%) and mixed capital companies (6.8%). 61.1% of the respondents were from subsidiaries or branches of foreign companies, 34.7% from companies with headquarters in Brazil and 4.2% from subsidiaries or branches of Brazilian companies. The research included both medium and large-sized companies and in this second category there were 12 companies, 16.45 of the total, which had more than one thousand employees. If organised according to the categories of goods supplied, the sample can be divided into companies that operate in the chemical (36.6%), metal (49.3%), and electrical (14.1%) sectors.

The performance of activities in the logistics complex

Procurement

The research sought to examine the procedures and performance of the FTS regarding their procurement function. The majority of the suppliers recognise that there is a tendency towards the signing of long-term contracts with a limited number of suppliers, preferably on a local basis. There was also a high concentration of business among a small number of firms, as 44 of the companies in the sample stated that 80% of their purchases were from up to 10 direct suppliers. Regarding the division of responsibilities and the segmentation of buyers by category of material procured as the criterion for calculating the degree of specialisation of the procurement function, 39 of the companies in the sample estimated that there was an intermediate level of specialisation; in 21 it was estimated to be high. The principal method of ordering goods from suppliers identified by companies were, allowing for multiple responses, e-mail (64 cases), fax (37), Electronic Data Interchange (27 cases) and telephone (22 cases). The average delivery time (25 days) satisfied the requirements of the production plans of 81% of the companies in the sample. In 37 cases, the companies reported that the average percentage of delays varied from only 0 to 5%. Lastly, the majority of the suppliers examined stated that they were concerned about the monitoring of their procurement policies, as 68 companies said that they recognised the importance of monitoring suppliers and had already set up formal procedures to carry out these checks.

Stocks

The data indicate that there is accuracy over 90% in the control of stocks of raw materials and materials (59 cases) and of finished goods (66 cases). There are many possible explanations for these high levels of efficiency. One of them, corroborated in this research, is precisely related to the element which is basic to control - registration and documentation –, that is considered an important issue in a majority of the sample cases. When an evaluation was made of the relative importance of the different functional areas on the size of stocks of materials and finished products maintained, in both cases, the PPC (Production Planning and Control) function and logistics were considered to be the most significant, with the PPC function receiving a slightly higher average indication. The replies given by the FTS showed that their production policy was, at bottom, guided by make to order politics, and not by anticipation of demand. Surprisingly, from the point of view of the procurement function, the data show that 32 of the companies in the sample stated that they used the economic order quantity (EOQ) method to decide on the quantities in orders in the majority of their procurement operations, while 46 companies confirmed that they used JIT systems with their suppliers. However, out of the total number of companies using JIT, only 13 reported using this method with the majority of their suppliers and 33 stated that they only used it with some of their main suppliers. Finally, considering the relationship of stocking policies to level of profitability of operations with groups of customers, 50 companies in the sample reported that there was no clearly defined policy about stock variation in their organisation.

Warehousing

In relation to warehousing and materials handling, 67 companies were considered to have adequate locations for stocks of materials which were at a suitable distance from the production centres and production lines. There were 43 companies whose installations were held to be clean and well-organised, although the suppliers recognised that there was room for efficiency improvements in this area. More than half (53) of the companies were judged to have stocking systems that allowed efficient identification and shipping of orders, while the rest of the sample agreed that improvements were possible in this area. Regarding the costs of warehousing functions, the results indicate that there is relative equality between the costs of the different factors: direct workforce (58 cases), handling equipment (55 cases), fixed costs for water, lighting and cleaning services (52 cases), depreciation of fixed assets (51 cases) and maintenance of fixed assets (45 cases). The exceptions concern the costs of salaries for administration and data processing for warehousing. These two aspects were the least mentioned in relation to the costs of warehousing – 35 and 29 companies respectively. The companies showed significant interest in monitoring their warehousing and shipping activities and emphasised the control and recording of cases of damage to products stored in the warehouses. 58 companies stated that monitoring warehousing and shipping activities was important and in 91.5% of the cases investigated, there was seen to be great interest on the part of the companies in quantifying the extent of damage to goods in warehouse installations.

Transport

In a large majority of cases, the FTS are the ones responsible for deciding on the modes of transportation, the routes and the companies to be used for shipping to customers. The data indicate that the FTS researched mainly use the road transportation mode, for both supply (71 cases) and distribution operations (71 cases). But the findings also confirmed the importance of air transport in the composition of enterprise strategies in both supply and distribution operations. Air transport is used by 31 companies for supply operations and by 16 companies for distribution. Furthermore, 54 of the companies in the sample stated that they used consolidated loads with a reduced percentage of suppliers indicating use of mainly partial loads. 50 FTS stated that their decision-making processes for transport, warehousing and stocking were highly integrated and 57 companies stated that they contracted out their transport activities to third parties. The above distribution suggests a high level of integration of FTS operations with those of their suppliers of transport and logistic services.

Order Processing

The companies in the research were evaluated primarily as regards their perception of the service that was most highly valued by their customers, and the principal results were: meeting delivery dates (69 cases); availability of stocks to ensure continuity of supply (58 cases); ability to deal with orders in exceptional circumstances (55 cases); accurate information in invoices (51 cases); the quality of the packaging used in transport (51 cases). Regarding the structure for organising customer service, 54 suppliers stated that there was an area of the company or a person or group with exclusive responsibility for such a function. It was also found that in 54 of the FTS there were high levels of integration between the commercial area and the production planning function. In order to manage demand efficiently, the research confirmed that the processes and activities that are typical of the interface between supplier's commercial area and the purchasing area of the car company have to be properly computerised. At the time of the research, the companies stated that they had computerised the following areas: all price data (68 cases); production programmes (68 cases); availability of stocks (68 cases); loading and shipping schedules (65 cases) and customer information (64 cases).

Stage of development of logistic operations

Formalisation of the logistic function

The findings showed that for 53 FTS there was a specific area of the company dedicated to logistic operations, while only few companies reported that there was no area responsible for this function or the responsibility for such operations was dispersed throughout company's organisational and functional structure. In 31 FTS, the logistic function was not subordinated to any other functional area and in 42 companies those in charge of logistics held a high management-level post. However, irrespective of the position held, the data indicate that these managers had a strong influence over the wider strategic decisions in the companies investigated: in 49 companies this influence was considered to be significant and the rest of the sample felt that it would increase in the future.

Monitoring logistic performance

FTS reported that control graphs (59 cases), flow diagrams (54 cases) and Ishikawa diagrams (59 cases) were the tools most used to monitor and control production processes. In the case of logistic processes, the tools that received most mention were control graphs (50 cases), checklists (42 cases), and flow diagrams (39 cases). There is also evidence of the fact that the FTS make simultaneous use of many indicators to manage their assets. The majority of the companies mentioned using indicators such as daily or monthly stock levels (61 cases) and levels of stock turnover (57 cases). However, there was a greater diversity of responses if productivity indicators are considered. The two most used indicators were reported to be labour costs per unit of production (51 cases) and capacity (45 cases). The two indicators that were also mentioned to a lesser extent were analysis of volume of shipments in relation to historical levels (34 cases) and programs of targets for the reduction of logistic costs (31 cases). If we consider only the indicators used for monitoring the quality of the warehousing and distribution operations, the most used was the number of product returns (48 cases). The indicators that companies reported using most for monitoring the levels of customer service were: customer feedback (50 cases), regularity of delivery times (42 cases), percentage of quantities correctly delivered for each order (42 cases) and undelivered orders (35 cases).

Technology applied to logistics

Companies made significant investment in the application of technology to their logistics processes, especially in Electronic Data Interchange (EDI), software for Production Planning and Control activities, barcode systems and manual data collection. It is important to highlight that EDI was mainly used for the FTS' customer relationships. Also, it was only used with some second level suppliers (24 cases) and with financial institutions (14 cases). Despite the fact that the data indicate that the greater part of the sample is made up of technology intensive companies, the majority of the FTS investigated consider that it is necessary to increase the quality of logistic information that is presently available in their information systems. Thus, while 24 companies in the sample described their logistic information as being accurate and easily accessible, 35 other companies recognised that the quality of their information is only relatively accurate and reliable.

Flexibility in exceptional situations

The majority of the companies in the sample held that it is possible to achieve total flexibility in exceptional situations on order to deal with unexpected events where there are sudden changes in demand or the need to adapt levels of service to new requirements made by customers or groups of customers. However, a statistically significant number of suppliers signed a low level of flexibility for changing orders that were in their distribution channels and for withdrawing products from the market.

Logistic complexity

The second tier suppliers are mainly located in the same state as the one where the FTS have their production facilities, but a significant percentage of their purchases are made from companies in other Brazilian states or abroad. There is an average number of 74 second level suppliers who supply the FTS. Regarding the destination of products, most of the production goes to the states in which the companies in the sample hold its production facilities and, in a limited number of cases, the production goes mainly to foreign customers. The majority of the companies in the sample reported that they used from one to three installations both for storage of materials and finished products and distribution facilities. There was an average number of 554 places for pallets in warehouses for finished products and an average of 1764 square metres in warehouses for storage of materials and finished products.

CORRELATIONS

On the basis of this descriptive analysis, certain variables were selected with the aim of examining possible associations between the constructs used in the research. For this purpose, the following hypothesis was formulated for each of the associations subjected to analysis.

H_0: The variables are independent or there is no evidence of association between them.

The analysis of this hypothesis used the Chi-Square test (X^2). On the basis of the null hypothesis H_0, the accuracy of fit of the Chi-Square test determined whether the difference between the observed and expected values could be considered significant or not. The significance of the test is given by its *p-value*. In order to determine the direction and strength of the associations the Spearman Correlation Coefficient was used (Agresti, 1990; Bhattacharyya e Johnson, 1977). The results associated to the use of those tests are shown in Table 2:

TABLE 1 – Results of the chi-square test and Spearman correlation coefficient

Association	X^2	Spearman
"Rank of the person in charge of logistics" and "Influence of the person in charge of logistics on the company's strategic decision-making"	0.065	0.295
"Influence of the person in charge of logistics on the company's strategic decision-making" and "Degree of specialisation of the purchasing function"	0.099	0.248
"Rank of the person in charge of logistics" and "Degree of specialisation of the purchasing function"	0.005	0.266
"Accuracy of stock control of material and finished products higher than 90%" and "Cleanliness and organisation of the warehouse"	0.046	0.266

"Number of different products and services sold" and "Transport decisions integrated with stock decisions"	0.062	-0.237
"Existence of a specific functional area responsible of logistic activities" and "Importance of monitoring of performance of logistic activities"	< 0.001	0.239
"Existence of formal, written planning of logistic activities" and "Importance of monitoring of performance of logistic activities"	0.047	0.26
"Quality of logistic information available at present in your company" and "Company's level of flexibility necessary to match levels of service to customer requirements"	0.07	0.311
"Quality of logistic information available at present in your company" and "Accuracy of stock control of material and finished products higher than 90%"	< 0.001	0.295
"Company's level of flexibility in adapting to sudden changes in demand" and "Company's level of flexibility necessary to match levels of service to customer requirements"	0.002	0.508
"Duration of contracts with suppliers" and "Level of suppliers' concentration into the company's supply strategy"	0.068	-0.284

All the associations presented in Table 2 are significant at *p-value* of 10%. Thus, the null hypothesis could be rejected. However, in order to take into account only the more significant associations and increase the rigour of the test, a *p-value* of 5% was used. In this case, only 6 (six) of the associations presented showed a level of significance higher than 5%, which led to rejection of the null hypothesis.

As regards hierarchical levels, it was found that the influence of the person responsible for logistics on the company's strategic decisions is not related to the rank the person holds in the company. However, as regards the relationship to the degree of specialisation in the purchasing function, this is related to rank of the person who is mainly in charge of the company's logistic activities. Such a relationship is demonstrated by the low level of significance found in the Chi-Square test (0.005) and a positive relationship for the Spearman Correlation (0.266).

The higher than 90% level of accuracy in material and finished goods stock control was found to be related to both cleanliness and organisation of the warehouse (significance = 0.046) and to the quality of logistic information presently available in the company (significance < 0.001). This finding corroborates previous work that discusses the effect of lack of precision in stock control on the whole company, especially on the company's logistic activities (Iglehart and Morey, 1972; Brown *et al.,* 2001).

When the variable related to the importance given by companies in monitoring their logistic performance was evaluated, a positive relationship was found between this variable and formal and written planning of logistic activities (significance < 0.001). Such relationships demonstrate that companies that give importance to monitoring their logistic importance make efforts both to formalize their logistic planning and to define their functional structure in a better way.

When investigated the relationship between the organisation's level of flexibility in adapting to sudden changes in demand and the level of flexibility necessary to match levels of service to customer requirements, it was found that there was evidence of a fairly relevant association (significance = 0.002), and there was also found to be a high positive value for the Spearman co-efficient (0.508).

DATA ANALYSIS

Just as with any other organisational process, the activities and processes within the cycles of logistical supply, production and distribution require consistent planning and the proposition of management models that are directed at controlling results and bringing about permanent improvements. It is expected that these efforts, over time, will bring about sustained improvement of the efficiency of logistic processes (Ritzman and Krajewski, 2003; Chan and Qi, 2003). Taken together, the results of this research corroborate the premises that FTS make a considerable effort to carry out logistic planning and to manage performance indicators by the use of various measurement methods that are able to control and measure logistic performance in the short and medium term. The efforts made by companies to quantify the levels of efficiency and efficacy of their logistic operations are a first step in the direction of aligning their performance measures and their competitive strategies with consequent encouragement of decision-making processes and management activities that are more connected with the wider strategic planning guidelines of these organisations. The results of this research indicate that, taking into account the levels

of efficiency of functional integration, the performance and results of the FTS' logistic functions seems to be linked to the level of development of their logistic structure and the complexity of these suppliers' operations. This fact echoes the findings of other empirical studies, such as those recently carried out by Liker and Choi (2004) as well as by Belzowski (2004).

In the case of the present research, there are evidences that a good part of the "logistic culture" that Fiat Automobiles has developed during the last 20 years is deeply rooted in principles of lean production with its FTS. These principles are: (i) development of local arrangements to take care of the majority of supply needs; (ii) giving importance to long-term relationships with a limited number of second tier suppliers; (iii) precise control of stocks of materials and finished products with intensive use of information technology in deposits of materials and warehouses for finished products, with special attention given to the use of stocking systems that facilitate the identification of orders and shipping activities that cause a great impact on the lead time for supply operations; (iv) a production policy aimed principally at the placement of firm orders from the assembly company and not at anticipating demand; (v) integration of operational decisions concerning transport, warehousing and stocking functions; (vi) efficient integration of the PPC functions and commercial activities, especially sales; (vii) significant computerisation of data relating to the activities at the interface between the suppliers` commercial area and Fiat's procurement area, specifically data on costs, production programs and availability of stocks.

The research data also corroborated the viewpoint that, in the same way as already happens with production processes, information technology (IT) and statistical tools are being used in controlling logistics performance. In the specific case of IT, it is important to recognise that new technologies have had positive effects on the processes of collection, analysis and treatment of logistic information and have ensured wide accessibility and up-to-date information for real time decision-making (Lambert and Stock, 1993; Bowersox *et al.,* 1992). The findings of this research corroborate this evidence and the data obtained indicate that the monitoring of performance has been strongly associated with the quality of information available in these structures – the more accessible and accurate the information, the better the results in terms of monitoring the performance. These suppliers also held that flexibility in exceptional situations was dependent on the quality of the information system available.

The number of companies in the sample who reported having this flexibility without having systems that were minimally functional, accessible and able to provide accurate data was not statistically significant. Apart from technology itself, the research data corroborated the point of view held by Bowersox *et al.* (1992) that the effort of monitoring logistic performance is influenced by the levels of formalisation of the companies' logistic function, in particular of the logistic planning and degree of the company's direct control over logistic resources. Excessive fragmentation of activities critical to the logistic function, exactly the opposite situation that was found in this research, generally derives from the absence of logistic planning linked to the companies' wider strategic planning.

A low level of formalisation of logistic planning may directly cause undesirable effects on the performance of companies, such as duplication of effort, conflicts of authority, waste of resources and loss of competitiveness (Harrison and Hoek, 2002; Bowersox *et al.,* 1992). There is good reason to think, therefore, that, in the same way as happens in the supply chains of Fiat's competitors, superior levels of performance in logistic performance and the clear evidence of FTS' efficiency in integrating their internal and inter-organisational processes may be the direct result of the significant effort made by these companies to formalise their logistic structures. Among other effects, it may be supposed that it is precisely the greater influence of logistic functional authority and the importance given by the FTS to logistic planning over strategic planning, along with more integrated management of the activities making up their logistic complex, that provide one of the necessary conditions for greater efficiency in the management and allocation of logistic resources in these companies.

CONCLUSIONS

If we consider the two important issues previously mentioned in this paper – logistics performance and organisation of the logistic function – the results confirm the fact that the FTS face a distinctive complexity in their operations in the supply chain in the context of a competitive scenario which imposes challenging competitive priorities on them: continuous increments in the quality of products and processes; organisational and technological competence to innovate; velocity in dealing with orders; progressive cost reductions; offer of superior levels of service; flexibility in manufacturing and logistic operations; supply chain management practices. Such complexity can be explained basically by the vital position these suppliers hold in the expanded value chain, especially the fact that these companies face the

basic need to integrate their processes and functions both internally and in relation to the procurement and distribution processes of their own suppliers and customers.

Overall, the data suggests that the operational characteristics of each organisation undergo the direct or indirect influence of many factors, such as, among other conditioning and limiting factors: the nature and the complexity of first tier supplier's production process; the level of integration of decision-making regarding transport, stocks and warehousing; the number of second tier suppliers who satisfy the supply needs of the first level supplier; the location of second tier suppliers; the number of customers dealt with; the location of these customers and their respective demands in relation to goods and services; the production policy adopted; the intensity and the focus of investment in technology.

Due to this complexity, statistical generalisations should be employed with caution bases on this survey. The data obtained from the field research should not be extrapolated in the direction of an "ideal" logistic system or to the definition of measuring instruments and performance aims that are common to all companies, whether or not part of the sample of companies used in this research. Although the statistics are sufficiently representative to allow generalising the results of the research to all Fiat's direct suppliers, such generalisation should be carried out with equal caution. The research did not have a sample plan for the three categories of supplier – from chemical, electrical and metal sectors – and, in the end, this resulted in an important difference in terms of the respondent base in each category.

The results should also be interpreted in the light of another basic limitation in that the evaluations of performance and organisation of the logistic functions of the companies in the sample were made by the suppliers themselves. This fact does not have a negative effect on the accuracy of the information obtained but some of the evaluations could have been complemented by an evaluation made by second tier suppliers and customers.

The companies making up the sample of this survey are part of a limited and very select group of global players in the automotive industry. The data suggest that the performance levels of FTS in their production and logistic functions are, in fact, extremely high, given that their performance was found to be high in practically all the attributes that were examined. It is inevitable to suppose that their persistence in giving a strategic dimension to their logistic functions within their corporate planning will mean greater demands on the second tier suppliers, which are probably smaller companies and do not yet, have a formalised structure for managing their logistic activities. In this way, the strategic alignment of business practices of first and second tier suppliers will depend, amongst other factors, on investment directed towards integration of these agents' information systems, with new potentially significant repercussions on the level of costs and services in the Fiat Auto´s supply chain.

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