CONTRIBUTIONS OF OPERATIONS MANAGEMENT TO THE COMPETITIVENESS OF THE BRAZILIAN ELECTRONICS SECTOR

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Abstract. The objective of this paper is to identify and analyze various aspects of the internal and external operations management of Brazil's electronics sector and to consider the opportunities for and the threats to increasing the competitiveness of its participation in the global supply chain. To address this shortage in the literature, a survey of Brazilian Electric and Electronic Industry Association (ABINEE) companies was conducted. The collected data were complemented with secondary data to establish an overall view of the electronics sector in Brazil. The results suggest that electronics product assembly companies have the opportunity to invest more in information technology to expand process integration, plan and develop products, integrate customers, and maintain rather than expand their supply chain practices. The alignment between internal and external operations management becomes important in this context. The originality of this paper lies in its clarification of operations management in an economically important sector and the insight it provides to academics, practitioners and policy makers involved in the domestic and international electronics sector.

Keywords: Operations Management; Electronics sector; Supply Chain Management; Brazil.

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Introduction

Operations management is responsible for ensuring efficiency and efficacy in the transformation process (Prentis 1987) using a set of policies and practices that are defined and implemented by a company and are aimed at satisfying the market (Fleury 1999). At present, operations management must address the growing complexity of production systems, deep changes in industry structure, and the different roles that must be performed by different companies in the supply chain. These roles are influenced by factors such as information technology (IT) and globalization (A. Fleury, M. T. Fleury

2007). According to Prentis (1987), changes occurring in the market and in technology demand the correct positioning of production systems.

According Sohal *et al.* (1999), in recent decades, industries in many countries have been analyzed to examine strategies, and various production processes were adopted. The objective of many of these studies was to identify the "best" strategies and practices that yield superior performance. However, Brazil's electronics sector, which is responsible for 4% of the GDP (Abinee 2010a), has yet to have its operations management analyzed extensively; the available studies (Gonçalves 1997; Nassif 2002; Gutierrez, Alexandre 2003; Cnm, Dieese 2010; Chami Batista 2010) mainly focus on its macroeconomic trajectory.

Based on a search of the most prestigious databases for Brazilian scientific papers that cite only the electronics sector, there is little information on how the sector conducts its internal and external operations (Fensterseifer, Bastos 1989; Belle 1991; Slongo 1996; Martins 2001; Talamo, Carvalho 2004; Mafra, Grisci 2004; Jansen *et al.* 2005; Araujo, Oliveira 2006; Hauser *et al.* 2007; Vianna *et al.* 2007; Balbinot, Marques 2009). However, a search for articles in international databases reveals a more intense and detailed discussion about the electronics sectors in several countries. For example, a study on research and development maturity in emerging countries (Tan, Hwang 2002), a proposal for implementing production management systems (Helo 2004), a proposal for a quality management model (Yeung *et al.* 2005), a study on intermediation in the electronic sector (Shunk *et al.* 2007) and a study on supply chain management (Singh, Al-Hakim 2009) can be found. Thus, there is a need to understand operations management in various cultural/national environments (Alas *et al.* 2010).

Considering the knowledge gap in Brazil regarding the state of the art in the global electronics sector, this paper proposes to answer the following question: "What are the main aspects of Brazil's electronics sector, particularly with regard to internal (operations strategy, ways of meeting customer demands, use of information technology and managerial actions) and external (means of relating to customers and suppliers and the adoption of supply chain management practices) operations that offer opportunities for and threats to increasing the competitiveness of the sector's participation in global supply chain?" The main objective of this study is to identify and analyze the aspects of internal and external operations management of Brazil's electronics sector and to consider the opportunities for and the threats to increasing the competitiveness of its participation in the global supply chain.

The data collection procedure used was a survey of companies affiliated with ABINEE. The research was conducted in the second half of 2009.

1. Literature review

1.1. Brazil's electronics complex

An electronic industrial complex is a set of industrial segments and sectors characterized by a common technical base (microelectronics) (Nassif 2002; Gutierrez, Alexandre 2003; Hauser *et al.* 2007). The electronic complex is divided into four segments: computers, telecommunications, automation and electronic consumer goods (Gonçalves 1997).

To Gutierrez and Alexandre (2003), this complex is very important because electronics are involved in almost every economic activity (the production of capital goods, consumer goods, energy, etc.). A study by Cnm and Dieese (2010) affirms that the quality and power of the electronics sector to offer products to other economic sectors are crucial to national development.

In Brazil, the electronics sector has gone through different phases from its inception to the present day. Nassif (2002) states that between the 1950s and the first half of the 1970s, Brazil did not have a sufficient number of companies to shape an electronic complex. During this period, the Brazilian electronic sector was characterized by the activity of multinationals.

In the beginning of the 1970s, an impressive expansion in consumer electronics occurred, driven by tax and fiscal incentives granted to companies that established business in the Manaus Free Zone (ZFM). The city of Manaus is located in the north of the country near the Amazon Forest. The intention was to make Brazil an exporter of electronic products and to replace imports. The objective of the ZFM was to attract branches of multinational companies, but as a result of this dynamic, several domestic capital companies were excluded from the market (Nassif 2002). The lack of competitiveness of the final goods produced in the ZFM did not permit exports to large markets, dooming the promising domestic production market to failure. The reasons for this lack of competitiveness include the fact that the region did not (and does not) have adequate infrastructure (poor road conservation), skilled labor or the appropriate distribution logistics (it is far from consumer and production centers), which resulted in higher costs, even with the fiscal incentives (Chami Batista 2010).

In the 1980s, the country adopted an extreme industrial policy that had direct effects on the electronic product sector. The restrictiveness of trade policies in the telecommunications and computer sectors are noteworthy, as is the prohibition of a long list of consumer electronic goods imports (Chami Batista 2010).

However, with trade liberalization in 1990, imports grew, and most domestic companies left the market; the few that remained stayed in specialized niches (Nassif 2002). As a consequence, Brazil is currently experiencing a negative trade balance in the electronics sector.

An incentive for the sector, known as the Computer Law, Law Number 8.248, has been in effect since 2001. This law stipulates that companies that invest a percentage of their gross revenues in research and development in the computer field can request tax breaks (Brasil 2010a).

As a result of the electronics sector's trajectory over the past 50 years, the sector has the following characteristics:

– The basic production process is restricted to product assembly using a set of components that are imported; therefore, there is almost no production of electronic components. Thus, there is no complete cycle of integrated circuit production (components that increasingly concentrate the final good's functionalities) (Hauser *et al.* 2007);

– The products manufactured in Brazil are designed abroad, and consequently, the component design and engineering activities have already been completed. Brazil then adapts the multinational products and services, customizing and nationalizing them for the local market (Kronmeyer Filho *et al.* 2004); and

– The dynamism of the electronic complex is tied to the successive product life cycle, whether radical or incremental, and in Brazil, incremental innovations related to product functionality and quality predominate (Gonçalves 1997).

Finally, according to Abinee (2010b), the sector's retail activity is very concentrated and exercises great bargaining power. The majority of suppliers (70%) are local, small- to medium-sized, and rely on the import of foreign components, which constitute approximately 30% of the raw materials. There are many destinations for the final products; 7% are exported (Abinee 2010b). The structure of the electronic supply chain is summarized in Figure 1.
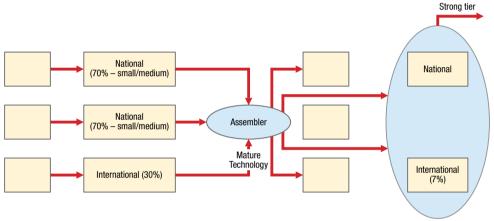

Fig. 1. Brazilian electronics SC structure

Therefore, in Brazil, the electronics sector experiences opportunities for and threats to increasing the competitiveness of its participation in global supply chain. These opportunities and threats require better knowledge of operations management and competitiveness.

1.2. Aspects of operations management

Considering the complex responsibilities of operations management (Slack *et al.* 1996), this paper also poses questions related to understanding the strategic objectives of production from a production strategy content perspective. These questions have implications for the internal management (production planning) and the external management (supply chain management) of operations as the Brazilian electronics sector seeks to increase its participation in global supply chains.

In this research, operations management is defined as the planning, direction and control of processes that transform inputs into services and products for internal and external customers (Krajewski *et al.* 2009).

Operations management performs based on a competitive strategy. One of the main activities of this strategic process is defining the competitive priority of operations. Competitive priorities (CPs) are defined as the translation of customers' needs, that is, the performance objectives for production. In general, these needs include quality, costs, flexibility and delivery (Hayes,Wheelwright 1984).

CPs inform some decisions that solidify operations management, whether they are internal or external. One of the main issues concerning internal operations is production planning and control (PPC). PPC concerns how the company organizes, allocates and distributes its production resources (people, machines, time) to serve its customers (volume, mix, deadline, etc.). PPC can fill customers' orders in several ways: make to stock (MTS), assembly to order (ATO), make to order (MTO) and engineer to order (ETO).

A set of information technology (IT) and managerial actions have been adopted to computerize PPC, such as Enterprise Resource Planning (ERP), electronic kanban (controlling stock via the Internet), Collaborative Planning, Forecasting and Replenishment (CPFR), Vendor Managed Inventory (VMI) and in-plant representatives.

In external operations, an important issue is the degree of vertical disintegration, that is, how the organization manages its supply chain (SC). This management implies establishing and maintaining relationships with customers and suppliers and implementing supply chain management (SCM) practices.

Supply chain management is an integrative approach that starts with materials planning and control, logistics, services and information flows from suppliers to producers and final users (Fantazy *et al.* 2010). SCM practices are defined as a set of activities performed by an organization to promote effective management of its SC (Li *et al.* 2005; Li *et al.* 2006; Koh *et al.* 2007). Jabbour *et al.* (2011) consider SCM practices to consist of the following: (a) the integration of SC for support in PPC, (b) the sharing of information about products and strategic guidelines, (c) strategic relations with customers and suppliers, and (d) support for customer orders. Each category has a set of variables. We conducted empirical research to discuss these concepts in the Brazilian electronics sector.

2. Methodology

2.1. Study subjects

The companies studied in this paper are members of the Brazilian Association of Electric and Electronic Industries (ABINEE), which represents Brazil's electronic sectors. Founded in 1963, the ABINEE has 552 national and multinational member companies.

2.2. Data collection

This is a quantitative study that used an e-mail survey to obtain data.

The data collection instrument was a questionnaire with closed and multiple-choice questions. It was divided into four sections: the first characterized the companies' profiles, the second measured the degree of importance placed on competitive priorities

with regard to production, the third verified the degree of SCM practice implementation and identified the type of relationship adopted with the other tiers, and the fourth listed some IT and managerial actions adopted at the companies that responded.

Section 1 of the questionnaire uses a nominal scale and deals with issues such as company size. According to Sebrae (2009), in Brazil, one way of classifying company size is based on the number of employees. This questionnaire used four categories: micro-company (1 to 19 employees), small company (20 to 99 employees), medium company (100 to 499 employees), and large company (500 or more employees). This section also identified the responding companies' positions in their main SCs, their bargaining power in the chain; and how they filled customers' orders.

Section 2 of the questionnaire, based on a literature review of CP, included 13 questions and used a 5-point Likert scale (1 – extremely irrelevant to 5 – extremely relevant).

Section 3 adopted the questions validated by Jabbour *et al.* (2011) to measure the degree of implementation of SCM practices using 22 statements regarding SCM practices that were scored on a Likert scale (1 – not implemented to 5 – completely implemented). Spekman *et al.* (1998)'s concepts were adopted for understanding the company's relationship with the other tiers in the chain. Finally, there were questions about the set of IT and managerial processes adopted at the companies (Barbosa, Musetti 2010).

This survey adopted a self-managed questionnaire as the data-collection instrument. The self-managed questionnaire was pretested before being sent to the analysis units. Synodinos (2003) affirms that the questionnaire test is essential to identifying questions that need to be rewritten. The pretest for this survey was conducted in two steps. The first was with operations management professors and the second was with company managers.

The questionnaire was deemed appropriate (as a result of respondent feedback and Cronbach's alpha). Data were collected in 4 steps. The first step was to contact the ABINEE public relations department to obtain an updated database of its members. The second step began with the name and e-mail of each company's operations manager. This step consisted of formatting the questionnaire so that it would be easy to access and to answer. Internet services were used to formulate a home page with the questionnaire content. The third step was to send personalized e-mails using the direct mail mechanism for all ABINEE spreadsheet contacts. E-mails were sent to the 552 registered companies. However, 20 were returned for a variety of reasons. The fourth step was to manage the return of questionnaires and to take steps to increase the return rate.

After 44 days had elapsed (from July to mid-September 2009) and three waves of e-mails had been sent, there was a return rate of 20% (107 respondents). This return rate was considered adequate (Malhotra, Grover 1998).
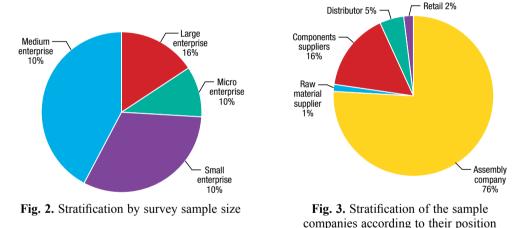
2.3. Data analysis

Descriptive statistical techniques were adopted. The purpose of descriptive analyses is to understand the frequency distribution of each variable according to its core and dispersion tendency. These analyses are appropriate because they permit an understand-

ing of the competition foci in the sector (competitive priority), the main SCM practices and the use of IT and managerial actions. The data analyses were performed using the Statistical Package for Social Science (SPSS). Secondary data were also used to complement the analyses (Abinee 2010b),

3 Results

3.1. Characterization of the sample

In the sample, small (32%) and medium-sized (42%) companies predominate; micro-companies represent 10% of the sample, and large companies represent 16% (Fig. 2). When classified by their position in the SC, 76% of the companies are assemblers, 16% are component suppliers, 5% are distributors, 2% are retailers, and 1% are basic raw material suppliers (Fig. 3).

When classified by bargaining power in the main SC, 81% consider their customers to be organizations that are able to coordinate or even impose themselves in the chain (Fig. 4).

Fig. 2. Stratification by survey sample size

Fig. 3. Stratification of the sample companies according to their position in the main SC

Fig. 4. Distribution of sample according to bargaining power in the main SC

3.2. Management of internal operations

In general, the set of variables related to competitive priorities was deemed relevant to extremely relevant, which can be observed in the variable averages (Table 1). To underscore the most important variables, and thus identify trends in CP selection by companies to compete in their markets, the 25% of the variables with the highest percentage (alluding to a quartile perspective) was used as a parameter. Thus, 4 variables reflect the CP tendency: defects, technical requirements, delivery dates and functionality. These correspond to the "quality" and "delivery" attributes for the most valorized CPs in the analyzed sample.

Table 1. General CP trends in the sampled companies

Variables	Average	Standard Deviation	Coefficient of variation	Maximum	Minimum	Percentage
Prevent Defects	4.86	0.375	0.077	5.00	3.00	0.97
Follow Technical Requirement	4.74	0.572	0.12	5.00	1.00	0.95
Meet Delivery Date	4.70	0.499	0.106	5.00	3.00	0.94
Functionality	4.69	0.503	0.107	5.00	3.00	0.94
Production Cost	4.64	0.573	0.123	5.00	2.00	0.93
Product Durability	4.43	0.601	0.135	5.00	3.00	0.89
New Products	4.40	0.580	0.132	5.00	3.00	0.88
Less Time	4.31	0.605	0.140	5.00	3.00	0.86
Production Volume	4.32	0.667	0.154	5.00	2.00	0.86
Quick Change in Design	4.09	0.734	0.179	5.00	2.00	0.82
Lowest Price	4.00	0.752	0.188	5.00	2.00	0.80
Product Range	3.86	0.745	0.193	5.00	1.00	0.77
Product Variety	3.70	0.792	0.214	5.00	1.00	0.74

The following are characteristics of Brazil's electronics sector: considerable importation of foreign components, approximately 30% of which are raw materials (Abinee 2010b), domestic competition with imported goods and the non-participation of the sector's products in the complete production cycle. As a result of these characteristics, Brazilian companies focus on quality, which translates into fewer defects, product technical requirements and functionality because this sector generates products that must comply with a series of national and international safety standards and norms to be competitive domestically and to permit possible export. Furthermore, Brazilian companies can innovate in this sector by improving product functionality (Gonçalves 1997). They also focus on delivery; companies in this sector import parts from other countries, so one way to differentiate themselves is to have parts in stock to reliably meet orders because import logistics follow a cycle of approximately 90 days on average.

Four modalities for meeting customers' needs are adopted by the companies in the sample. The make to order modality is the most used (33.6%), followed by the assembly to order modality (27.1%) and make to stock (26.2%). The least-used modality is engineer to order (13.1%) (Fig. 5). These results demonstrate that this sector imports a considerable percentage of parts and that companies must store the parts to assemble products and fulfill orders. The companies are not designing and producing genuinely new products, as demonstrated by the fact that the engineer to order modality is the least used in the sector's survey sample, revealing the companies' weakness in the area of developing completely new products.

Various IT and managerial actions are being employed in the electronics sector to guide companies' internal and external activities (Fig. 6). ERP is the most adopted IT tool among surveyed companies (75.7%), followed by the organization of workshops with customers (41.1%), Electronic Data Interchange (EDI) (31.8%), workshops with suppliers, and the use of electronic kanban (29%).
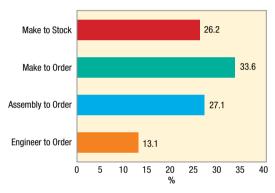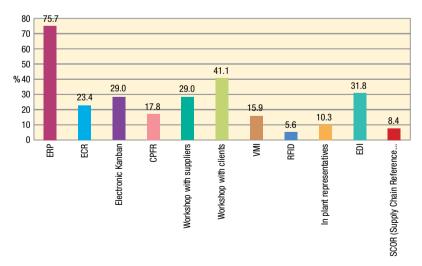

Fig. 5. How customer' orders are fulfilled

Fig. 6. Actions adopted to facilitate management with customers and suppliers

With the exception of ERP, the other systems used aim at facilitating the relationship among the company, its customers and its suppliers and the exchange of information. According to Lankford and Johnson (2000), EDI is a form of electronic communication that permits the exchange of information and documents in structured formats that can be processed by a certain type of software. The advantages of EDI include the following (Ferreira, Assumpção 2005): (a) greater visibility for inventory planning and control (which supports the electronic kanban practice), (b) better product delivery planning and (c) agility in transmitting, receiving, and processing orders and reducing errors. In addition to EDI, formal meetings (workshops) that include the company, customers and suppliers help evaluate performance and guide current and future needs regarding products and operational processes. ERP contributes to companies internally by integrating the data from business processes and quickly generating reports for operational and strategic decision making, thus making it possible to appropriately plan for better operational efficiency.

3.3. Management of external operations

Of the sample companies, 55.1% adopt long-term relationships and partnerships in product development activities with important and strategic component suppliers (Fig. 7). There was no clear trend in relationships with the other tiers in the chain; the answers were diverse. For example, with basic raw material suppliers, 38% of the companies adopt market relationships, whereas 35% adopt long-term relationships (Fig. 8). Downstream, the trend is not so clear because with intermediate customers (distributors), the relationship was divided; 35% adopted market relationships, and 35% adopted long-term relationships (Fig. 9). With final users (retail), 30% of the respondents consider market relationships to be the most common, 30% consider long-term relationships to be the most common, and 26% consider long-term relationships and partnerships in product development activities to be most common (Fig. 10). Relationships with final users are not broadly developed (Fig. 11).

The most prosperous relationships among the studied companies are those with their important and strategic component suppliers (1st tier) and with retail agents (2nd tier customers).
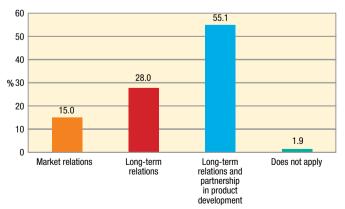

Fig. 7. Company relations with important and strategic component suppliers
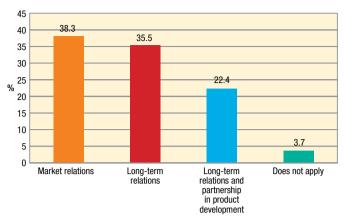
Fig. 8. Company relations with basic raw material suppliers
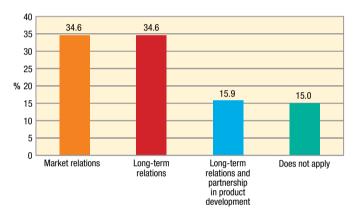

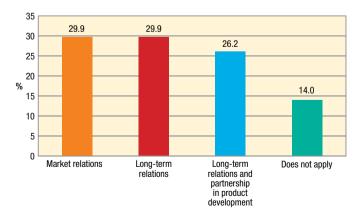**Fig. 9.** Company relations with intermediate customers (distributor/wholesaler)

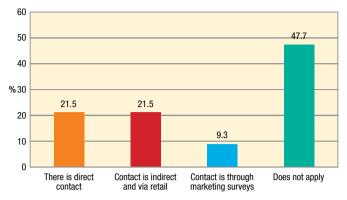**Fig. 10.** Company relations with retail agents

Fig. 11. Company relations with final users (Individuals)

Relationships with component suppliers are predominantly long-term and involve partnerships in product development activities because: (a) the more technologically sophisticated the product, the more strategic the relationship should be, resulting in a reduction in the supplier base (Berry *et al.* 1994); and (b) assemblers of electronic products constantly redesign their products with the objective of reducing costs and increasing functionality, with great emphasis on supporting suppliers in this process (McIvor, Humphreys 2004).

Relationships with retail customers are predominantly long-term with a tendency toward supporting product development activities. This type of relationship can be explained by the fact that the strongest tier for most of the assemblers studied is downstream in the chain. In other words, these are the companies that influence the rest of the chain (Mouritsen *et al.* 2003), and it is important to create harmony in operations and in relationships because the company, which is closer to consumers, receives clearer and more immediate information concerning demand and inventory. That is, maintaining a long-term relationship supports the internal efficiency of assembler operations (Berry *et al.* 1994).

Table 2 depicts the range of SCM practices adopted by companies.

The results indicate that currently, SCM practice adoption is, on average, in the "partially implemented" phase because the average of the medians was 3.05; this value corresponds to "partially implemented" on the Likert scale.
Six variables can be highlighted:
  – "Obtaining feedback from final users concerning product fitness";
  – "Determining future needs of the customers";
  – "Integration of product development activities with suppliers";
  – "Collaboration with suppliers in forecasting demand";
  – "Consulting customers to support new product decisions";
  – "Integration of product development activities with customers".

There are more practices that are directed toward customers. The existence of a wide variety of practices could be evidence for the influence of the chain's strong hierarchy, that is, customers exert power over companies further upstream, which eventually leads

Table 2. Core and dispersion trends in the adoption of SCM practices

Variable	Average	Standard Deviation	Coefficient of Variance	Median	Percentage
Client Feedback	3.77	1.112	0.294	4	0.75
Future Needs of Clients	3.30	1.191	0.361	4	0.66
Supplier Integration	3.32	1.364	0.411	4	0.66
Collaboration Supplier Forecast Demand	3.24	1.338	0.413	4	0.65
Support New Product Client	3.27	1.263	0.386	4	0.65
Client Integration	3.15	1.309	0.415	3	0.63
Collaboration Supplier Planning Production	3.09	1.438	0.465	3	0.62
Collaboration Client Forecast Demand	3.09	1.285	0.416	3	0.62
Collaboration Supplier Planning Inventory	3.07	1.445	0.470	3	0.61
Collaboration Client Planning Inventory	3.03	1.397	0.461	3	0.61
Support Supplier Product Development	3.07	1.406	0.457	4	0.61
Collaboration Client Planning Production	2.97	1.404	0.473	3	0.59
Consult Supplier Programming Production	2.92	1.487	0.510	3	0.58
Consult Client Programming Production	2.87	1.530	0.533	3	0.57
Involvement Supplier Plans	2.79	1.419	0.508	3	0.56
Involvement Client Plans	2.79	1.358	0.486	3	0.56
Communication Strategy Future Supplier	2.64	1.369	0.518	3	0.53
Information Supplier Product Launch	2.61	1.323	0.506	3	0.52
Participation in Client Marketing	2.53	1.383	0.546	3	0.51
Assembly Near Client	2.38	1.527	0.641	2	0.48
Sharing Information Client Cost	2.12	1.385	0.653	1	0.42
Creation of Multifunctional Teams	2.05	1.334	0.650	1	0.41
Average				3.05	

to greater effort being invested in relationships with and support for customers (Mouritsen *et al.* 2003).

Figure 12 summarizes the main survey results in relation to the internal and external operations management of companies in Brazil's electronics sector.
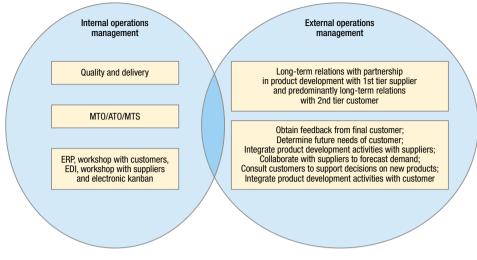
Fig. 12. Summary of the main results regarding operations management
in Brazil's electronics sector

4. Discussions

Some conclusions can be made regarding internal operations management. Brazilian companies do not compete on costs (lower price), but rather in quality and delivery. This focus on quality and delivery can be used as a tool to address the competition posed by cheaper products originating mainly from Asia (which competes on cost) and to address problems stemming from the exchange rate in setting final product prices.

The most adopted actions to fulfill customer orders (assembly to order and make to stock) are aligned with competitive strategies, especially delivery. Whether companies conclude product assembly after receiving the order or meet the customer's order from products in stock, their lead time for meeting the customer's order is shorter, which makes delivery reliable.

There is evidence of alignment between IT, competitive priorities and the forms of customer service in electronics sector companies (internal operations management). Some technologies are used to control inventory (EDI and electronic kanban) and consequently promote delivery reliability, and others (workshops with customer and suppliers) seek to improve product quality via interaction with customers and suppliers regarding future needs and feedback from the customer.

The alignment between adopted practices and strategies seems less intense (internal and external operations management). For example, the strong tier in the electronics chain is the 2nd tier customer, with whom the assemblers maintain predominantly long-term partnerships in product development, implementing a set of SCM practices that are relevant to product quality (customer feedback and the determination of future needs of the customer) and product development. However, assemblers adopt few IT and managerial procedures and distinguish themselves only in terms of EDI and workshops. Thus, SCM

practices seem not to be supported by IT, which may indicate that SCM practices can be ineffective in practice.

Another apparent inconsistency occurs upstream from the assemblers' supply chain. The relationship between the assembler and the 1st tier supplier is long-term, with partnerships in product development and the support of IT and managerial actions (EDI, electronic kanban and workshops). However, there is potential to implement more SCM practices to establish a more effective relationship with suppliers, leveraging competitiveness based on quality (product functionality) and delivery, mainly because most of companies are geographically close (70% of raw materials are domestic).

We can identify some opportunities for and threats to a more efficient electronics sector increasing its competitiveness in the global supply chain. These opportunities and threats relate to the search for greater synergy between the management of internal and external operations. Companies can realize this synergy either by expanding the use of IT to support the implementation of SCM practices with customers, who are influential in the chain, or by boosting the use of SCM practices from the IT and management procedures already used with the suppliers.

Brazilian automakers could make use of IT and management actions such as VMI and CPFR, for example, to improve the effectiveness of SCM practices with customers. This would not be so difficult considering that relationships with customers are maintained in the long term in product development partnerships. On the other hand, automakers are already making use of important IT and management procedures with suppliers (electronic kanban, EDI, workshop, ERP), which would facilitate an increased use of SCM practices. Therefore, the search for greater integration of internal and external operations management would enable greater organizational efficiency and may be a way to make these organizations more attractive as a tier in global supply chain. That is, having efficient management and competitive operations can facilitate the further internationalization of the Brazilian electronics industry.

Conclusions

This paper identified and analyzed aspects of the management of internal and external operations in electronics companies in Brazil. The main results of the research are as follows: (a) companies compete based on product quality and reliable delivery; (b) assemblers maintain long-term relationships and product development partnerships with 1st tier suppliers, whereas they predominantly maintain long-term relationships that tend toward product development partnerships with 2nd tier customers; (c) companies adopt information technologies and managerial actions (ERP, EDI, workshops and electronic kanban) to support internal and external management; (d) the most adopted supply chain management practices, such as obtaining customer feedback, determining customers' future needs, consulting customers to support new product decisions and integrating product development activities with customers, are geared toward customers; (e) there is alignment among the internal operations management aspects that were analyzed; and (f) internal and external operations management are not totally aligned.

According to Alas, Kraus and Niglas (2010), there is a need to understand operations management in various cultural/national situations; therefore, this research analyzed aspects of operations management in the Brazilian electronics sector, allowing us to highlight the importance of the search for alignment between internal and external operations management to increase the competitiveness of this sector's participation in the global supply chain.

The electronics sector passed through different phases throughout its development process in Brazil. There was government intervention that attempted to leverage the sector; however, these policies were not successful. The consequence was a tendency toward low competitiveness in the sector as a result of the absence of a complete production cycle, resulting in dependence on imported components and products and dependence on multinationals that operated within the country. To overcome years of technological gaps and delays, it is necessary to invest in efficient operations management. Assemblers must invest more in IT to expand the integration of processes, production planning and product development between themselves and their customers and to expand the adoption of SCM practices with suppliers. Brazilian companies should focus on operations management efficiency to overcome the sector's negative history.

We also suggest the creation of policies to encourage the domestic production of integrated circuit components to stimulate the Brazilian production chain. Public authorities could use the lesson of the Manaus Free Zone as an example to avoid committing the same errors and to stimulate other regions of the country, such as the Midwest or Northeast, which are still underdeveloped, for installing electronics component production centers. Development of the electronics sector must follow a logistics infrastructure plan for production flow (highways, railways, ports, etc.), and universities must produce skilled human resources. A stronger industrial pole in these regions would attract private investments, generate jobs and income, and reduce the inequities among regions in Brazil.

This paper has limitations, such as its focus on a single industrial sector in Brazil. However, this example can provide lessons for other countries in similar situations and highlight the importance of public authorities in the effective management of internal and external operations. We hope future studies use the information contained herein to compare Brazil's electronics sector with data from other countries.

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