Operations strategies in Brazilian e-waste recycling plants

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Abstract

The aim of this paper is to identify and analyze the operations strategies of two Brazilian companies that recycle waste electrical and electronic equipment. We also investigate whether environmental concerns are considered as competitive priorities for operations and as practices implemented in the companies' structural and infrastructural decision areas. The results revealed that "environment" is a key competitive priority. The two companies studied have been implementing environmental programs and investing in cleaner production practices and life cycle assessment.

Keywords: Operations strategy, E-waste, Recycling plants

Introduction

Operations Management can play a decisive role in the development of competitive positions for companies (SKINNER, 1969; HAYES & WHEELWRIGHT, 1984; SCHOENHERR & NARASIMHAN, 2012), and many works refer to Operations Management as the area responsible for reducing companies' environmental impact (JIMÉNEZ & LORENTE, 2001; GONZÁLEZ, PERERA & CORREA, 2003; JOHANSSON & WINROTH, 2010; AVELLA, VAZQUEZ-BUSTELO & FERNANDEZ, 2011).

Environmental practices adopted in manufacturing are numerous and varied, including materials re-use, increasing energy efficiency, reducing waste generation, and waste disposal. Angell and Klassen (1999) described the implementation of environmentally correct practices as a necessary goal, but some studies highlight the difficulty of developing and implementing environmental practices that can contribute to operations' competitive priorities (CHRISTMANN, 2000; AMOAKO-GYAMPAH & BOYE, 2001; GALEAZZO & KLASSEN, 2015; SCUR & HEINZ, 2016).

Companies that overcome the difficulties of addressing sustainability can then develop competencies that rivals will struggle to match, gaining long-term competitive advantages (JOHANSSON & WINROTH, 2010; PALMA et al., 2014; LONGONI & CAGLIANO, 2015).

In Brazil, the National Solid Waste Policy (NSWP), instituted by Law 12305 of August 2, 2010 (BRAZIL, 2010a) and regulated by Decree No. 7404 of December 23, 2010 (BRAZIL, 2010b), imposes on companies the responsibility for the life cycles of their

products. According to this law, manufacturers, importers, distributors, and traders of electronic products and their components are required to structure and implement reverse logistics systems (art.33, VI) by returning products after consumers' use (BRAZIL, 2010a).

Since environmentally correct practices are more easily implemented if integrated into operations strategies, in this article we aim to identify and analyze the operations strategies of two companies that recycle waste electrical and electronic equipment (WEEE). We also investigate whether environmental concerns are competitive priorities for the operations or practices implemented in the companies' structural and infrastructural decision areas.

Operations strategy

Several authors have focused on operations strategy, and although it is not possible to state that a single consolidated concept has been widely accepted, the fundamental constructs are well established.

In Skinner's pioneering study (1969), the production function (or the operations function) is described as strategic for companies. For the author, the term "strategy" is defined as "a set of plans and policies by which a company aims to gain advantages over its competitors" (SKINNER, 1969, p.2).

Slack and Lewis (2008, p.29) define operations strategy as the "total pattern of decisions which shape the long-term capabilities of any kind of operation and their contribution to overall strategy, through the ongoing reconciliation of market requirements and operations resources".

Operations strategy can be divided into two components (ADAM & SWAMIDASS, 1989; SWINK & WAY, 1995). The first is related to the content, i.e., the decisions taken by the organization to achieve the effectiveness of the strategy, which is determined by the consistency between the emphasized competitive priorities of the operations and the corresponding decision areas (LEONG, SNYDER & WARD, 1990). The second is related to the process of conceiving and implementing the operations (in phases of strategy formulation and implementation) (LEONG; SNYDER; WARD, 1990; ANDREWS, 1996). In this process, "policies, plans and improvement projects" are designed or formulated to define the direction of operations development and to provide competitive advantage (SLACK, 1993, p.175).

This paper focuses on the content of the operations strategy, aiming to identify and analyze the competitive priorities of operations and decision areas of two Brazilian companies that recycle WEEE.

According to Lin and Tseng (2016), the establishment of competitive priorities drives companies' efforts to recognize and strategically respond to the needs of business and society.

Companies' decision areas have been classified as structural and infrastructural (HAYES & WHEELWRIGHT, 1984). The structural decisions are characterized by their long-term impacts, by the difficulty of reversing the choice made, and by the need for large capital investments, while the infrastructural decisions are related to tactical processes such as those linked to business operating factors (HAYES & WHEELWRIGHT, 1984).

Figure 1 summarizes the content of operations strategy, considering the competitive priorities and decision areas that were used to conduct the case studies in the present work.

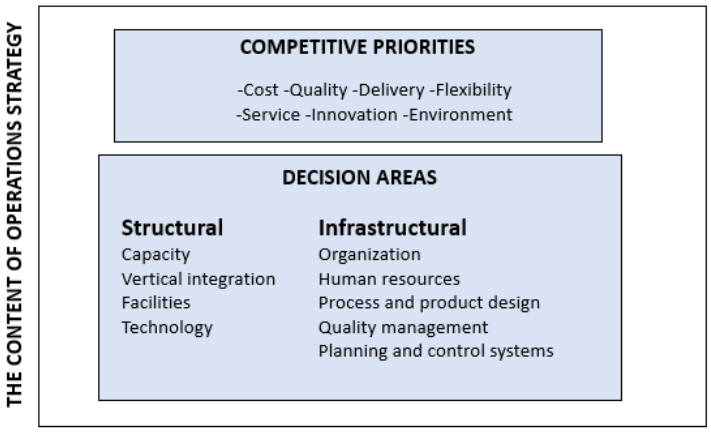

Figure 1- The content of operations strategy
Source: Elaborated by the authors

Operations strategy and environmental dimension

The environmental dimension has not yet reached its full potential and importance in operations strategy (ANGELL & KLASSEN, 1999; SANSONE, HILLETOFTH & ERIKSSON, 2017). However, over the last 20 years companies have been increasingly involved with environmental performance issues.

The movement in favor of the Triple Bottom Line (ELKINGTON, 2001) has grown, demonstrating concern with economic prosperity, environmental quality, and social justice. If an organization's overall strategy includes sustainability, the operations strategy should also reflect it.

Some studies (AZZONE, BERTELÈ & NOCI, 1997; ANGELL & KLASSEN, 1999; JIMÉNEZ & LORENTE, 2001; WILKINSON, HILL & GOLLAN, 2001; SILVA et al., 2008; AVELLA & VAZQUEZBUSTELO, 2010; DÍAZ-GARRIDO, MARTÍN-PEÑA & SÁNCHEZ-LÓPEZ, 2011; LONGONI & CAGLIANO, 2015) indicate the environmental dimension as an important competitive priority, due to the growing responsibility of companies to achieve adequate environmental management, and consequently reduce the environmental impacts (CHRYSSOLOURIS; PAPAKOSTAS; MAVRIKIOS, 2008) that arise from their production processes.

Although not all environmental initiatives have the same effect, they can often serve as a VRIO (valuable, rare, inimitable, and organized) resource, capable of increasing a company's competitive advantage (ANGELL & KLASSEN, 1999; KLASSEN & WHYBARK, 1999; GALDEANO-GÓMEZ, CÉSPEDES-LORENTE & MARTÍNEZ-DEL-RÍO, 2008; SCHOENHERR, 2012; PALMA et al., 2014; BROCKHAUS et al., 2017); reformulating operations strategies to minimize waste during the production process (THEIBEN, SPINLER & WHU, 2014; CHOY et al., 2016); and thereby generating possible future dividends. In other words, "it pays to be green" (VAZQUEZ-BRUST et al., 2010).

According to Jiménez and Lorente (2001), environmental performance can be considered a competitive priority for operations when satisfying two conditions: (1) being obtained within production function; and (2) providing a competitive advantage for the company. Such advantages can be further extended to the company's image.

In a circumstance where the environment is not considered a competitive priority, there is little or no necessity to consider environmental issues in the operations strategy (JOHANSSON & WINROTH, 2010). However, if it is critical to competitiveness, a modified or new operations strategy will be required.

Method

We adopted a qualitative research approach, which "tends to be less structured to capture the perspectives and interpretations of the people researched," besides using the "natural environment" as a research environment (MIGUEL, 2010, p.50-51).

We conducted case studies in two Brazilian companies that recycle WEEE, aiming to analyze their operations strategies.

A case study is an "empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (YIN, 2009, p.18). The main trend in all types of case studies is that "it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result" (YIN, 2009, p.17).

Data analysis was based on data triangulation (EISENHARDT, 1989; YIN, 2009), using multiple sources of evidence (interviews, document analysis, and direct observation).

Case studies

Context

WEEE have increased faster than any other type of waste, driven by the growth of the electronics market and by the high obsolescence rates of these products. According to the Getúlio Vargas Foundation (FGV), Brazil has 280 million mobile devices (notebooks, tablets, and smartphones) connected to the internet (FGV, 2017). In addition, the country is the largest producer of WEEE in Latin America, with an estimated generation of 7.4 kilograms per inhabitant (kg/inh.) in 2016 (BALDÉ, 2017).

Several studies identify WEEE as a critical environmental issue, but also an economic opportunity (SCHLUEP et al., 2009; FRANCO & LANGE, 2011; ABDI, 2012; ARAÚJO et al., 2012; INFODEV, 2012; TANSKANEN, 2013).

The inadequate management of WEEE can result in serious consequences for the environment and public health. Recent regulations are driving new markets for the commercialization of materials contained in WEEE.

Souza et al. (2016) carried out a sustainability analysis of available alternatives for the management of WEEE and suggested that the most appropriate collection system for the city of Rio de Janeiro would be based on a hybrid system. This includes WEEE collection points in electronics stores, subway stations, and neighborhoods, and the integration of social enterprises and cooperatives in the pre-treatment processes.

However, the authors emphasize that achieving this scenario may require progressive implementation. A starting point could be the organization of collection and pre-treatment phases, avoiding informal collection and the disposal of WEEE in landfills, but temporarily exporting the printed circuit boards to developed countries with appropriate recycling technology.

In the following sections we present the case studies carried out in 2017.

Case study of Sinctronics

Sinctronics is a business unit of Flextronics, located in the state of São Paulo. The company started its operations in November 2012, with the objective of transforming WEEE into raw material to produce new products. The company works under the premise of "zero waste to landfill," using the circular economy concept.

Among the activities carried out by Sinctronics are reverse logistics services; production processing including sorting; manual separation of the parts of the equipment; crushing; extrusion and injection of plastics; forwarding of various materials; purchase

and sale of WEEE; research and generation of environmentally correct disposal reports; and technical analysis of materials.

The vast majority of WEEE received by the company comes from the information technology (IT) area, and includes printers, toner cartridges, cell phones, computers, monitors, and ATMs.

The company's focus is on plastic recycling. Its processes guarantee WEEE traceability and mass balance. Furthermore, the company has partners for environmentally correct forwarding of the material coming from WEEE.

Operations strategy at Sinctronics

The research and development manager indicated order of importance of the operations competitive priorities, as follows: 1) quality; 2) environment; 3) cost; 4) flexibility; 5) delivery; 6) service; and 7) innovation.

According to the interviewee, the main objective of a company is to maintain clients, because they are the means of generating resources.

The company invests heavily in quality and the environment in order to provide better results to their clients. We analyzed its structural and infrastructural decision areas, which are presented in Table 1.

Table 1- Decision areas analyzed at Sinctronics

Structural decision areas	
Facilities	The choice of location was due to proximity to the company's matrix, which contributes to greater responsiveness.
Capacity	The company has installed capacity to process 240 tons of WEEE per month. However, the manager points out that this capacity increases to 400t/month when including ATM recycling.
Vertical integration	The company has a high degree of vertical integration, and develops projects in partnership with its clients.
Technology	The company seeks to automate all stages of the production process. Sorting is the only step performed manually. The company has a process engineering area.
Infrastructural decision areas	
Organization	The company has 101 employees, 69 of which are directly involved in the production process.
Human resources	The company invests in several training programs. The company has a career plan, and operators need to study to progress in their careers. Sinctronics also has indicators to measure staff turnover, and employs performance assessments.
Product design	Customers and suppliers are partners in the application of recycled material for the preparation of new products. Additionally, the company has partnerships with Brazilian universities.
Process design	The company invests in new process development.
Quality management	The company is highly focused on quality. It must meet customers' requirements to reintroduce the raw material from WEEE. The company has ISO 14001 (environmental management system); OHSAS 18001 (occupational health and safety management system); and R2 (responsible recycling processes) certifications.
Planning and control systems	Jira Software has been adapted to the needs of the company, and is used in the reverse logistics process.

Adoption of environmental practices

Sinctronics meets the objectives of the NSWP, associated with the adoption of environmental practices such as reduction, reuse, and recycling; sustainable production standards; reduction of the volume of hazardous waste; and technical and financial cooperation for integrated waste management.

The business model adopted favors the implementation of such practices.

The company invests in research and development of environmentally sound technologies, and uses life cycle assessment (LCA) as a tool to improve its goals of reducing water consumption, greenhouse gas emissions, and energy use.

Case study of Coopermiti

Coopermiti is a cooperative of production, recovery, reuse, recycling, and commercialization of WEEE, located in the city of São Paulo.

The cooperative was founded in October 2009, and began operating in March 2010 through an agreement with the municipality.

In 2013, the cooperative received quality management system and environmental management system certifications.

The implementation of a certified process was considered strategic for an image change. During the development of the business plan, the executive director identified that most cooperatives face a lack of infrastructure.

The cooperative receives all types of WEEE. For individuals, it is possible to schedule collection through the website, or drop off at voluntary delivery points or the headquarters of the cooperative.

Coopermiti also receives WEEE from companies. The cooperative offers secure data destruction services and issues reverse logistics reports.

It is sometimes necessary to pay to correctly dispose of items (e.g. cathode ray tubes). The executive director affirms that this process is not sustainable through the sale of material obtained by disassembly of WEEE.

Operations strategy in Coopermiti

The executive director placed the competitive priorities of operations in the following order of importance: 1) waste collection; 2) quality and delivery; 3) environment; 4) service; 5) flexibility; 6) cost; and 7) innovation.

Although waste collection is not indicated in the literature as one of the competitive priorities, it is an input for the production process, besides being a service offered by the company.

We analyzed the structural and infrastructural decision areas, which are presented in Table 2.

Table 2- Decision areas analyzed in Coopermiti

Structural decision areas	
Facilities	The cooperative is in a building of approximately 1,400m².
Capacity	The cooperative has the capacity to process 100 tons of WEEE per month, but at the time of the case study they were only processing approximately 20t/month.
Vertical integration	The company has a low degree of vertical integration. According to the executive director, Coopermiti tried to act as a third party, performing

	the manual disassembly phase, but private companies viewed them as competitors, not partners.
Technology	The focus of the company is not related to the development of technologies.
Infrastructural decision areas	
Organization	The company has 27 cooperative members: 19 at the operational level, and 8 responsible for WEEE dismantling.
Human Resources	The company has an internal training program that establishes rotating functions and helps to identify the profile of each cooperative member. Through this program training needs are also identified.
Process design	Although the company's focus is not on design, Coopermiti maps and identifies process improvements.
Quality management	Quality was considered the second most important competitive priority after delivery. Regarding the quality process, the company has since its inception been concerned with mass balance, data mischaracterization, and brand protection.
Planning and control systems	The company controls the entry and exit of materials. The planning and control system allows reporting on how much was collected from a manufacturer, which type of equipment, and which material results from the disassembly process.

Adoption of environmental practices

The executive director considered the environment as the third most important competitive priority for the company. The company has an environmental management system and implements environmental prevention programs. The company also meets the requirements of a Brazilian standard related to requirements for the activity of reverse manufacturing (named as ABNT NBR 16156).

The preservation of the environment and the concern with pollution prevention are described in the company's objectives, fostering the adoption of environmental practices.

The company adopts the following environmental practices: pollution prevention, reduction of waste generation, reuse, environmental management system, remediation and training projects, and sharing information.

Final considerations

Regarding the operations competitive priorities adopted by the two recyclers analyzed, Sinctronics' priorities are: 1) quality; 2) environment; 3) cost; 4) flexibility; 5) delivery; 6) service; and 7) innovation. Coopermiti views its competitive priorities in the following order of importance: 1) waste collection; 2) quality and delivery; 3) environment; 4) service; 5) flexibility; 6) cost; and 7) innovation.

Although the two companies have different business models, the results indicate that "environment" is becoming a key competitive priority. Quality also stands out among the competitive priorities, being the top concern for Sinctronics. This company has shown great concern in meeting customer specifications regarding the material that will be reintroduced into partner companies' product life cycles.

For Coopermiti, the main competitive priority is waste collection, as the company is focused on increasing this percentage. Quality and delivery were prioritized second, since among the company's main indicators is the degree of customer satisfaction, which depends on process quality and delivery reliability.

The importance given to the environmental factor may be related to the sector studied, which was driven by the publication of the Brazilian National Solid Waste Policy and the consequent obligation to structure and implement reverse logistics systems.

As mentioned by Scur & Heinz (2016), including environment as a competitive priority can be the first step towards the development of a sustainable strategic management.

The adoption of environment as an operations competitive priority also impacted the structural and infrastructure decision areas.

Most of the environmental practices are related to infrastructural decision areas, such as the adoption of certifications associated to quality management; identification of training sessions in environmental fields linked to human resources; and investment in cleaner production practices to improve or develop new processes.

Sinctronics uses LCA associated with Technology, which falls under the structural decision area. The company seeks to automate all stages of the production process, and is concerned with the reduction of water consumption, energy and greenhouse gas emissions.

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