Circular economy in practice: case study in a company from the electronics sector

Lorena Gamboa Abadia
(lorenagabadia@gmail.com)
Production Engineering Department, Polytechnic School, University of São Paulo

Diego Honorato Clemente
Production Engineering Department, Polytechnic School, University of São Paulo

Marly Monteiro de Carvalho
Production Engineering Department, Polytechnic School, University of São Paulo

Abstract

The Circular Economy (CE) is an economic model that emerges to face the challenge of resource scarcity and waste disposal in a win-win approach. The purpose of this research was to investigate the motivations and main aspects of a CE process in the electronics sector, to identify which factors can simplify the future creation or transformation of CE oriented business models. The single case study was conducted in a company that performs CE activities in Brazil since 2012. The model studied was raised as a partnership, in the context of the establishment of the National Solid Waste Policy.

Keywords: circular economy, business models, sustainability.

Introduction

In adapting activities to more sustainable habits, society has absorbed lessons learned from the natural ecosystem (Yang and Zou, 2014). As an example, we have the Circular Economy (CE), an economic model that follows the energy circulation model from ecology (Chen, 2009), in order to face the challenge of resource scarcity and waste disposal in a win-win approach with economic and value perspective (Homrich *et al.*, 2018).

It arises as an opposition to the traditional linear approach. In a linear economy, from raw material extraction to final waste disposal, the various environmental impacts that accompany the process are ignored, and the energy potential returns to Earth and is lost through pollution (Sauvé, Bernard and Sloan, 2016). Excessive waste generation represents a loss of valuable material, with potential of being reused or reintroduced into production systems (Mirabella, Castellani and Sala, 2014).

That way, CE can be seen as a cycle of continuous positive development that preserves and enhances natural capital, optimizes resource incomes, and minimizes system risks through management of finite reserves and renewable flows (Ellen MacArthur Foundation, 2015). In addition to reducing pollution and waste at each step, as far as possible and desirable (Sauvé, Bernard and Sloan, 2016).

In the academic world, among politicians, and practitioners of industrial operations, the term circular economy is being more frequently mentioned (Homrich *et al.*, 2018). Private initiatives that carry out research or activities related to the Circular Economy, linked or not to universities, are found in several countries. Some examples can be mentioned as the Ellen MacArthur Foundation, in the UK (Ellen MacArthur Foundation, 2009), Circul'R in France (Coignard and Masvigner, 2014), Institute EDDEC at the University of Montreal, in Canada (Université de Montréal, 2014) and Ideia Circular or Exchange 4 Change, in Brazil (Gejer and Tennenbaum, 2015; Luz, 2015).

It is possible to say that the concept is gaining momentum by offering a clear angle of attack to help solve environmental problems (Sauvé, Bernard and Sloan, 2016). It already brings many opportunities for the Brazilian economy and industry, by aggregating and recovering value in a more resilient and sustainable way (Confederação Nacional da Indústria, 2018).

As a way to help promote this change, the emergence of new Business Models (BMs) represents one of the pillars of building a CE (Ellen MacArthur Foundation, 2015). As it comes, the new paradigm of the CE requires novel concepts and tools to describe and support it (Bocken *et al.*, 2016).

Together with CE, BM are also a topic of growing interest today (Lewandowski, 2016), both for the academy and practice. But, for still being an emerging area of research, there is a lack of theoretical grounding in economics or business studies when related to sustainability issues (Murray, Skene and Haynes, 2017), which also reflects in the scarce number of case studies and empirical analyses in the field (Evans *et al.*, 2017).

By this means, the purpose of the research was to investigate the motivations for the development of a CE process and the main aspects that make feasible the accomplishment of these activities. In order to identify which factors can promote and facilitate the future creation and transformation of business models oriented to CE. This study is part of a greater research project, that aims to investigate business models aligned with the concepts of circular economy.

Context

Circular Economy

The terminology around CE is quite diverse, there is a lack of consensus and several definitions coexist (Homrich *et al.*, 2018). Perhaps because it is still a recent theme, or more likely due to the fact of its origin be given based on several schools and lines of thought that have built the basis for the debate on sustainable development (Confederação Nacional da Indústria, 2018). Considering that, some of the main concepts of the literature that relate to CE in the context of this research are: industrial ecology (Graedel and Allenby, 1995), cradle-to-cradle (McDonough and Braungart, 2002) and, specially, reverse logistics (Fleischmann *et al.*, 1997; Rogers and Tibben-Lembke, 1998), as it is the term used by the Brazilian policy.

Cradle-to-cradle and CE are concepts within industrial ecology that can be considered leading principles for eco-innovation, in which wastes are used as raw materials for new products and applications (Mirabella, Castellani and Sala, 2014). CE creates alternative closed loops through which resources move in circular movements within a system of production and consumption, where, in these cycles, integrated combinations of industrial activities act synergistically to feed and nourish each other (Sauvé, Bernard and Sloan, 2016). Thus, CE can be understood as an industrial economy, restorative and regenerative by design and intention (Ellen MacArthur Foundation, 2015).

Through an approach that encourages the organization of economic activities in feedback processes that mimic natural ecosystems (Geng and Doberstein, 2008), the idea

of CE is based on the recognition of the limits of resources and energies of the planet, and on the importance of understanding the world as a system where pollution and waste represent failures (Bocken *et al.*, 2016). As a restorative and regenerative model, CE seeks to keep products, components and materials at their highest level of usefulness and value at all times (Ellen MacArthur Foundation, 2015). For that, the production and consumption of goods through flows of materials in closed circuits internalize environmental externalities allied to the extraction of virgin resources and the generation of waste (Sauvé, Bernard and Sloan, 2016).

Researches show that the CE is a great opportunity for value creation. The potential results mainly from extension of the cycle of use, increased asset utilization or, as in the case studied, reducing the use of virgin materials in production and the waste generation (Ellen MacArthur Foundation, 2016). Therefore, the transition to a more circular economy requires changes along the value chains, from product design to new business models, from new ways of transforming waste into resources to new consumer behavior modes (Smol *et al.*, 2015; Homrich *et al.*, 2018).

The way companies think and operate must change considerably to address the systemic challenges towards a more sustainable society (Bocken, Rana and Short, 2015). In general, BMs need to adapt to a more sustainable way of life, production and consumption (Murray, Skene and Haynes, 2017). As pointed out by Morioka *et al* (2016), many authors consider business model innovation a key tool to bring changes into organisations. Recent research and practice also show that business model innovation is a promising approach to improving sustainability in manufacturing companies (Yang *et al.*, 2017).

By definition, a business model is a conceptual tool that contains a set of objects, concepts and their relationships, with the purpose of expressing the business logic of a specific company (Osterwalder, Pigneur and Tucci, 2005). In that way, circular business models is a term used to describe business models that are suited for the Circular Economy (Bocken, Rana and Short, 2015; Morioka *et al.*, 2016). With different formats and possibilities, circular business models can allow economically viable ways to reuse products and materials continuously, using renewable resources whenever possible (Bocken *et al.*, 2016).

The concept of BM is closely linked to the concept of value in most business model literature (Yang *et al.*, 2017). In the logic of a business, it should be considered which concepts and relationships allow the simplified description and representation of what value is provided to customers, how this is done and with what financial consequences (Osterwalder, Pigneur and Tucci, 2005).

A study from the Brazilian National Confederation of Industry (CNI) indicates opportunities identified for the Brazilian industrial sector through new business models and material recovery. It also highlights the potential of the electronics industry, with the recovery of materials and new services; and plastics, with great reduction and recovery opportunities, along with civil construction and the textile sector (Confederação Nacional da Indústria, 2018).

Brazilian scenario

Established by the Law No. 12,305 of August 2, 2010, the National Solid Waste Policy (Política Nacional de Resíduos Sólidos – PNRS) provides definitions, objectives and principles related to solid waste management gathered in a single legal document created to guide and support integrated solid waste management.

The PNRS proposes measures to encourage the establishment of partnerships, targets for reducing the final disposal of waste, and when there are no more economically feasible

options, the final disposal environmentally appropriate waste in landfills (Brasil, 2010). It also inserts, finally, the principle of shared responsibility for the product life cycle as one of the matrix conceptions, as well as reverse logistics as a management tool.

The producer responsibility drives companies to put plans in place for product return, recycling and for redesigning their products and packaging to meet these requirements in order to participate in the marketplace (Kumar and Putnam, 2008). That way, the policy requires industry in Brazil to incorporate post-consumption reverse logistics (Silva *et al.*, 2013).

Regulatory drivers exist also in Europe, the US and Japan, dictating the prevention of waste and promoting the recovery of waste for reuse, remanufacture or recycle of materials including electronic equipment and batteries, chemical products, glass, paper, plastics, and heavy metals (Kumar and Putnam, 2008). It is known that the reuse of electronic products is a more complex situation than other types of products due to data and information security and, mainly, cultural aspects. On the other hand, these devices comprise heavy metals, such as mercury, cadmium and lead, which do not pose a hazard as a product, but may be a problem if handled in the wrong way after discarding or during disassembly (Sinctronics, 2017).

Research method

The methodology utilized to support this research includes a literature review and a case study. As theoretical foundation, a literature review was carried out covering the main themes of the research. CE and BM were identified as recent topics, also the connection between both themes is not well established and lacks theoretical grounding. In that aspect, the construction of theory appears to be necessary (Eisenhardt and Graebner, 2007).

In agreement with the relative scarcity of scientific publications on the subject, the research was conducted in an exploratory way. The appropriate methodology for this type of research is the in-depth case study (Handfield and Melnyk, 1998; Voss, Tsikriktsis and Frohlich, 2002) with the purpose of discovering fields for research and development of theories. In addition, case studies emphasize the rich context of the reality in which these phenomena occur (Eisenhardt and Graebner, 2007).

The single case study was conducted in a company that performs CE activities with electronic products in Brazil since 2012. The case study encompassed data collection through semi-structured interviews as well as document analysis as secondary data collection. A visit to the plant was carried out, in which were visited the establishments where the processes of disassembly and recycling are made. During the visit, the responsible engineer of the project accompanied and answered some questions. Later, a semi structured interview was conducted with an employee from the marketing department.

Results

The creation of the circular model of the case studied occurs in the context of the emergence of the National Solid Waste Policy in Brazil, in 2010, as it implemented shared responsibility for electronics manufacturers over their products, generating the necessity to develop a solution to treat the products at the end of life. Then, the company was created from a partnership between a brand of electronics and the contract manufacturer.

The model emerged in Brazil as the first integrated ecosystem of sustainable solutions for the electronics market, with reverse logistics processes, processing of materials as well as Research and Development activities. This solution was developed considering that, since the contract manufacturer was already operating in the market with

manufacturing and assembly of electronic products, it already had the facility of mastering technical knowledge over the products. So, with investments in research and technology, the company reached a model that allows the return of materials to the productive cycle, with actions of processing and disassembly, to transform products at the end-of-life into raw materials again.

The collection of products for the reverse logistics is done through exclusive vehicles and partnerships with shipping companies, which enables the collection in all regions of the country. The company currently receives materials from large companies, with larger volumes that can be delivered in one go, after a delivery notice, and these materials arrive at the collection center through trucks. Regarding the return of products by individuals, some customer companies provide channels for the end consumer. Requests for collection can also be made on the website or by phone, considering that the possibility of this service and the appropriate contacts are informed on the products packaging from the brands in the partnership.

The plant is prepared to separate all types of materials, such as plastics and metals, but reprocessing only addresses plastic materials. Metallic materials such as iron, steel, copper and other parts of greater risk and toxicity, such as batteries, are destined to companies specialized in the recycling or proper disposal of these elements. The various plastics are completely recovered and transformed into new parts, respecting all parameters established by the manufacturer regarding strength, flexibility and color. An analysis laboratory at the company's plant carries out the necessary tests to qualify the recovered material.

The process today involves the use of several technologies that enable acceleration and simplification, such as the use of RFID technology for identification and selection of materials. Other products like ink cartridges are dismantled and recovered for the recycling of plastics as well. However, some alternative activities that could add value to the product prior to its recycling, such as ink repacking for reuse of the cartridges, are not performed.

Regarding the financial aspects of the model, the main source of revenue comes from the reverse logistics process, which is financed by the costumer companies. An additional revenue comes from the sale of recycled plastic resin with certificate and report of origin, originated from the recycling of the products collected and from scrap of the electronics company's production. However, it´s important to highlight that the reverse logistic performed is currently a not financially self-sustaining process.

The value proposition of this business model is a more sustainable solution for solid waste, which instead of being discarded, is recycled and reinserted into the chain as raw material. In addition, it generates job opportunities and attitudes toward a better environment. Ethics, respect and transparency are indispensable values in the company model according to the employees interviewed. Some of these values could be perceived also during the visit to the plant, such as transparency in relation to the production process, with most of the walls being of glass materials or large windows, and educational activities through guided scheduled tours.

When questioned about the relationship with the different stakeholders, the company reported only that it has many partners, some of which can be consulted on its website, and others remain confidential.

Discussion

In the presented case study, a consumer electronics brand joins a producer of electronics to develop solutions for disassembly, recycling and proper disposal of post consumption waste originated from its products. This type of reverse chain represents an important

topic of study, as it arises as a tendency for complex or difficult to reuse and recycle materials. Though, the case studied was designed in a way to attend public policies and market regulations, and so far, does not to provide profit, as others found in the literature (Cottrill, 2003). These conditions limit the interests from other companies in replicating the model, being only interesting as a solution in cases of regulatory necessity.

In Brazil, it is possible to find other examples of companies that carry out reverse logistics activities through the partnership with other companies. To mention the example of TerraCycle, a North American company created in 2001, in search of reducing the generation of waste through innovative ways of reuse and recycling, and that now is present in 21 countries (TerraCycle, 2018). The company has been operating in Brazil since 2009, through waste collection programs for products that are difficult to recycle, which are normally dispensed by recycling cooperatives. Each of these programs is sponsored by a company that engages TerraCycle to plan and manage the entire reverse supply chain, ensuring the recycling of waste from a particular category. This model has been used in Brazil by organizations such as 3M, Avon, Colgate, Tang.

It seems like the corporate world has decided to address the hierarchy of the 3 R's "reduce, reuse, recycle" in the reverse direction (Mulrow, 2017). Perhaps it comes that way because of lack of guidance, the general complexity of the problems presented or the fact that alternative business models do not offer sufficient confidence in their application (Murray, Skene and Haynes, 2017). The lack of case studies and models may also make it challenging for firms to understand how to innovate their business models, especially when considering innovations for sustainability, which leads to a higher complexity related to how to evaluate the impact of the sustainability innovations and how to understand their effects on the whole business network (Evans *et al.*, 2017).

In general, it is noted that the main obstacles to innovative models of sustainable practices, not only circular economy, are related to economic issues. Sustainability, in its classic definition, represents the union of the three pillars: economic development, social equity and protection of the environment (Elkington, 1998). Thus, it is understood that the initiatives toward more sustainable actions and attitudes by organizations should not have a significant negative impact on financial aspects.

In this way, technological advances are needed, but also an advance towards government support and incentives to initiatives for sustainability and reduction of impacts to the environment. It is noteworthy that the issue can not be summed up to the transfer of responsibility to the manufacturers, governments should provide conditions for compliance. Also, the Brazilian scenario suggests that the discussion is still limited to the transfer of responsibility, without considering complementary policies that could promote technological innovation and preventive solutions. For example, there is no encouragement for actions such as life cycle assessment, product redesign or other preventive measures.

In view of these aspects and the analysis of current Brazilian policies, it can be said that the country's situation with regard to integrated solid waste management has advanced a lot in recent years, but there is still much to be improved. In order for the CE to scale up and realize its full potential, it is necessary to create enabling conditions for this transition, such as better quality education, specific public policies, circularity infrastructure and innovative technologies (Confederação Nacional da Indústria, 2018).

Conclusion

In the case studied, more than five years of operation can prove the viability of the solution, which gives space for a yearning for opportunities of more efficient and economically viable processes, aiming to scale up activities. Similar cases to the model

studied have been emerging now in other countries, still it emerged in Brazil as the first integrated ecosystem of sustainable solutions for the electronics market. The study of this type of reverse chain is an important topic since it may come as a trend for other resources that are also difficult to reuse and recycle. The specific characteristics of the case studied may come as a suggestion for the creation of new models, or transformation of existing ones.

The economic aspect is generally the one that makes most projects with socio-environmental principles harder to enable. According to the case studied, the viability of the circular business model depends on the implementation of partnerships. This condition is consistent with what is found in the recent literature. In the context of new production and consumption models, such as circular economy, industrial symbiosis, and product-service systems, in order to overcome obstacles, new production strategies and new business models are required, and those appear to be more feasible when supported by systems thinking, partnerships, collaborations and alliances.

As mentioned above, this study is part of a research project still in process. Greater results should come with the continuation of the research. The presented article presents limitations as it is related to a single case study.

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