REVERTIA

A Circular Economy Business Model Case

ICEDE Group, Universidade de Santiago de Compostela (USC)

Author: Ángeles Pereira

Contributor & supervisor: Xavier Vence

Collaborators: Adolfo Carballo-Penela, Xosé Miguel Alcalde-García, Marisa Chas

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Executive Summary

This report presents the results of the Revertia case study, selected in the framework of the R2PI project, among 17 other cases, because of its focus on an activity linked to priority areas of the Circular Economy, namely Plastics and Critical Raw Materials. The information contained in the report is based on the methodology designed within the framework of the R2PI project to understand the characteristics of the business model, evaluate its outcomes and identify the main barriers and enablers of the CEBM.

Revertia is an authorised Waste Electrical and Electronic Equipment (WEEE) manager that combines e-waste management services with a circular value proposal consisting in the preparation of IT equipment for reuse. The company responsibly manages an e-waste flow and, by applying secure reconditioning processes, is able to extend the service life of IT equipment that has been discarded. Refurbished equipment, with a 1-year warranty, are sold in second-hand markets or donated. The activity of preparation for reuse also involves the utilization, to the extent possible, of used and recycled components. In addition, the business model is based on efficient logistics, avoiding e-waste transportation when reconditioning is not an option.

The value proposition is based on the provision of high added value services to corporate IT equipment users, who need to manage their WEEE responsibly. The value network is thus formed by the origin-customer that generates e-waste and the EEE manufacturers represented through collective schemes. Downstream there are the destination-customers of second-hand and donated products, as well as the WEEE recycling companies to which Revertia's own waste is destined.

Revertia's business model is clearly influenced at the context level by the WEEE Directive 2012/19/EU and the Spanish RD 110/2015, which regulate the industry and set targets for reuse and recycling of WEEE. In addition, the market context given by the rapid technological change in the EEE sector, the collective schemes derived from the implementation of the EPR obligation, the maturity of the WEEE recycling industry, the existence of illegal scrap metal agents, and some socio-cultural aspects such as the lack of awareness of WEEE's environmental costs are factors that strongly affect Revertia's activity.

The report also presents an assessment of the circularity of the business model. The model corresponds to the Re-make pattern among the CEBM defined in the R2PI project. Its circularity lies in extending the useful life of a product, also integrating used and recycled components as far as possible. Current circularity is limited, since it is not based on services added to this second-hand product, nor is the organisation further able to act on the products manufacture or end of life. Therefore, Revertia takes opportunity of a gap left by other players in the sector (EEE manufacturers). Therefore the business model is dependent on the generation of an e-waste flow as well as on sales of refurbished computers.

With regards to the outcomes assessment, the main advantages of the business model are found in the non-financial aspects: reuse of IT equipment for the same use demonstrates clear environmental benefits compared to recycling. In addition, it also allows for greater local employment generation linked to the management and preparation for reuse activity. In the socio-economic area, second-hand products provide access to quality equipment at very affordable prices.

The SWOT analysis shows that the main strengths are the long-lasting and stable relationships with the origin-customers, the know-how and expertise of Revertia. The weaknesses point to its dependence on the linear model, therefore, to being able to capture waste streams, in competition

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with the mature recycling industry. The opportunities lie in the Spanish regulatory framework, which sets targets for the reuse of WEEE, as well as a state of opinion more favourable to responsible and sustainable consumption; however, there are also clear threats to the model, such as the possible entry of more competitors and the lack of sensitivity of EEE manufacturers towards reuse.

Based on the analysis, it is concluded that the Re-make CEBM is replicable and transferable, especially as long as the linear economic paradigm is dominant. However, there are a number of business and policy recommendations that may support greater circularity: first, specific agreements with EEE manufacturers to extend circularity from the conception of EEE products until its final disposal after multiple lifetimes; second, at the policy level, tighter regulation, with inspection and sanction systems, incentives for eco-design and product life extension activities, transparent information and monitoring systems, as well as education and training measures are needed.

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1 Introduction

1.1 Background and context

R2π – Transition from Linear to Circular is a European Union Horizon 2020 project focused on enabling organisations and their value chains to transition towards a more viable, sustainable and competitive economic model in order to support the European Union's strategy on sustainability and competitiveness.

R2π examines the shift from the broad concept of a Circular Economy (CE) to one of Circular Economy Business Models (CEBM) by tackling market opportunities and failures (businesses, consumers) as well as policy opportunities and failures (assumptions, unintended consequences). Its innovation lies in having a strong business-model focus (including designing transition guidelines) as well as in the role of policy development (including designing policy packages).

The ultimate objective of the R2π project is to accelerate widespread implementation of a circular economy based on successful business models and effective policies:

- to ensure sustained economic development,
- to minimize environmental impact and
- to maximize social welfare.

The mission of the project is therefore to identify and develop sustainable business models and guidelines that will facilitate the circular economy, and to propose policy packages that will support the implementation of these sustainable models.

A core part of this project is to work with organisations who are on the journey towards developing circular economy business models, as well as those who have the ambition to do so but haven't yet begun. The project has conducted case studies of 18 selected organisations.

The 18 chosen cases covered all five priority areas highlighted in the EU Action Plan on the Circular Economy: plastics, food waste, biomass/bio-based, important raw materials, and construction & demolition. Additionally, the cases were selected to ensure learning in each of the seven business model patterns defined by the R2Pi project: re-make, re-condition, circular sourcing, co-product recovery, access, performance and resource recovery, and these will be discussed in more detail in this report. To gather wide-ranging lessons from differing company sizes and maturities, the following were selected: 7 large corporations, 8 small, medium enterprises, 1 public entity, 1 entire value chain with both public and private organisations and 1 ongoing social project.

This report presents the case study of Revertia Reusing & Recycling. It was chosen due to its role in the electronics sector as a Spanish pioneer in collecting and preparing computers for reuse.

The next section provides a more detailed overview of the case organisation's business.

1.2 Business overview

Revertia is a small company that started its activity in 2011 focusing on offering Waste Electrical and Electronic Equipment (WEEE or e-waste onwards) management services to corporate customers. Revertia provides each customer with the tools and solutions necessary to guarantee the responsible management of their IT equipment (computers and printers) at the end of life. The service covers handling and removal of waste from customers' premises, their transportation to Revertia facilities, e-waste treatment for re-use and / or recycling and the issuance of environmental management certification. A team of business consultants supports the correct management of all waste produced as well as compliance with current legislation.

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The company is specialised in waste management derived from IT equipment. Revertia eliminates all information and data stored on the customer's equipment in a secure and certified manner. All hard drives are removed from their devices and undergo a high-security data elimination process.

One of the most innovative aspects of the services portfolio is the carbon footprint analysis. Revertia offers the possibility to quantify the customers' CO2 emissions resulting from preparing IT equipment for reuse compared to manufacturing new devices. The results can afterwards be included in the customers' CSR reports.

FIGURE 1. REVERTIA LOGO

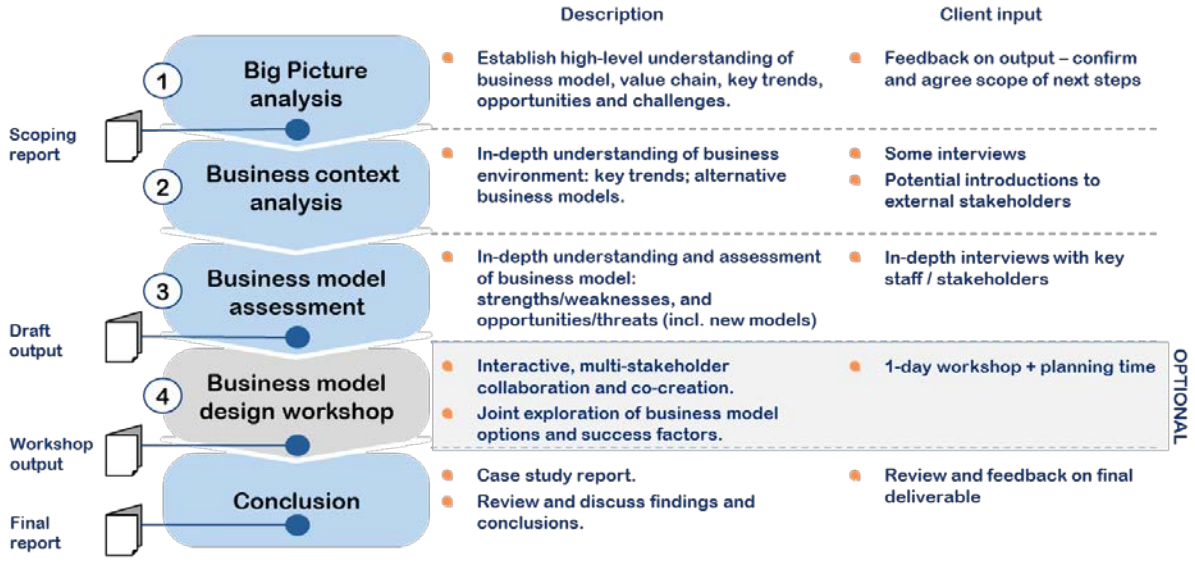
Source: Revertia Reusing & Recycling

The differentiated value provided by Revertia relies on preparing IT equipment and components for reuse under the following principles:

- Implementation of waste hierarchy
- Circular economy: artefacts are considered as a resource at their end of life and recovered for productive loops
- Only one stakeholder for managing dangerous and non-dangerous waste
- Integration of management processes in CSR schemes of the customers
- Quantification of social and environmental benefits

1.3 The case study analysis process

The case study process was structured in three main steps, and concludes with this document as the final report (see diagram below).



The different steps taken along the case study research were addressed by means of face to face interviews, telephone calls and emails exchange. All the interviews and electronic communication were kept with the CEO, and employees from the Environment and Communication department of the company.

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The kick-off meeting took place on the 26/09/2017. Along the different steps of the research process, both informants from Revertia were asked to fill in the developed methodological tools for business context analysis and business model assessment. Afterwards, in-depth interviews were conducted by three members of the USC team, in order to clarify and get in-depth insights. In particular, the context analysis was addressed in a specific interview on the 07/11/2017. The last interview was conducted on the 20/12/2017 and focused on analysing and discussing the business model circularity and SWOT. Desktop research was conducted since the kick-off and during the research process until the final writing of the report. The analysis of the results and the writing of this report was carried out between January and March 2018, with telephone and email correspondence kept with Revertia informants to clarify and get additional data and information.

1.4 Report outline

The first chapter introduction has provided a high level overview of the case and case study process. Chapter 2 presents the big picture surrounding the business, showing the context in which it operates and the key external factors potentially affecting the circular business model. Chapter 3 is an analysis of the business at the building block level of the business model, including the circularity of the business, the financials and the strengths and weaknesses. Chapter 4 draws conclusions about the current state of the business and its future potential.

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2 Revertia's business context analysis

2.1 Scope of the business context analysis

The objective of the context analysis is to identify the main external factors that are to be considered in order to explain the success (or failure) of Circular Economy Business Models (CEBM), as well as their potential role in accelerating the transition towards a Circular Economy.

The business context research was carried out in two stages. In the first stage, the case study team conducted desk research in order to identify the country and sector-specific factors that may potentially affect the business model from an industry perspective. To this aim, the check-list provided in D.3.2. Methodology was used. This overall information was collected from available data and information on websites, sectoral reports at the international level and scientific literature.

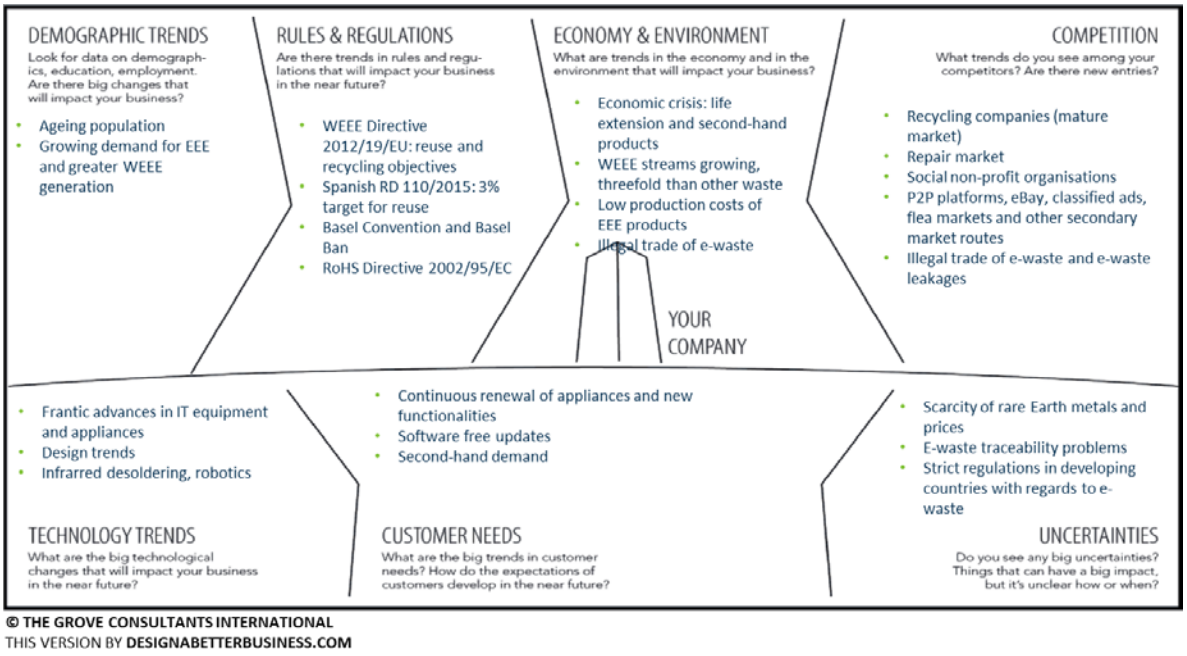
In the second stage, the team conducted interviews with relevant key stakeholders of the case organisation.

2.2 Contextual factor analysis

This sub-section presents the different factors that affect the context of the Electrical & Electronics Equipment Industry, from a Circular Economy perspective. Information presented is based on desktop research and does not include the view of Revertia informants on each matter.

The different factors that appear in the map (Figure 2) will be described below, according to different categories, namely: demographic factors, rules & regulations, economy & environment, competition, technology trends, customer needs and uncertainties.

FIGURE 2. CONTEXT MAP CANVAS FOR WEEE MANAGEMENT AND PREPARATION FOR REUSE



Source: own research

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2.2.1 Demographic trends

Demographic trends are increasingly affecting the consumption patterns. In the last decades, the main demographic shifts are the ageing of population, larger proportion of working women, decline of the middle class and increasing ethnic diversity. All of the factors might have an influence in the consumption patterns of Electrical & Electronics Equipment (EEE) but a deep analysis of those trends is out of the scope of this report.

Notwithstanding it is worth to remark that the world population has doubled during the last 50 years. As a result of increasing population, the demand for consumer products has raised. In recent decades, the consumption of desktop PCs has been declined while the demand for other electronic appliances, such as laptops, tables and cellular phones continues increasing.

Growing demand for EEE also translates into greater e-waste generation. With regards to WEEE generation, there is a disparity between developed and developing countries. For instance, per capita e-waste generated in 2014 ranged from 4.4 kg in China to 23.5 kg in the United Kingdom (Tansel, 2017).

2.2.2 Rules and regulations

This sub-section offers an overview of the main regulatory factors that affect the WEEE industry and as such, set the conditions that any business must observe.

2.2.2.1 WEEE Directive 2012/19/EU

The WEEE industry is regulated at the European level by the Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE), which has set as its main goal to contribute to sustainable production and consumption by prioritising WEEE prevention and treatment strategies such as preparation for reuse.

The general regulatory framework for Waste of Electric and Electronic Equipment (WEEE or e-waste onwards) is based on the Extended Producer Responsibility (EPR), either through individual producer responsibility or collective systems. According to this framework, manufacturers assume legal and financing responsibility for the entire life span of their own products, including collecting and final disposal treatment related costs. The final aim of EPR is to internalise environmental costs by the manufacturer while promoting eco-design and increasing reusing and recycling.

Based on this regulation, Spanish manufacturers take on their responsibility through collective schemes and the costs must be financed with the revenues generated by the sale of products. This way consumers can dispose of their WEEE in the same collecting point, without distinguishing by brand. The model also allows municipalities and distributors disposing of WEEE to other different agents apart from manufacturers.

Overall, the regulation sets that household WEEE may be disposed of in a collective system or in a retailer store if the customer buys a new similar equipment or appliance. WEEE from corporate users needs necessarily being collected by e-waste authorised managers or received by retailers. The process is usually as follows:

Firstly, the used Electrical & Electronic Equipment is deregistered and it becomes WEEE. Secondly, the WEEE is sorted and classified: it can be derived for social projects or it can be disposed of as a dangerous waste. Based on this classification, the traceability system works until the final disposition. That used EEE that can be repaired and prepared for reuse in social projects are delivered to specialized facilities. Waste is delivered to authorized WEEE managers, which carry out the dismantling process. Then, those companies separate, dismantle, shred and prepare WEEE according to composition in order to recover raw materials such as: plastic, ferrous and non-ferrous metals, glass, cupper and precious metals coming from printed or integrated circuits.

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The priority of the Directive 2012/19/CE and the Spanish Royal Decree (RD) 110/2015 is to prevent WEEE generation; other objectives are: promote reuse, recycling and other ways of valorising WEEE; and improving environmental behaviour of every agent involved in EEE lifecycle, including manufacturers, distributors, consumers and collectors and managers of EEE.

The WEEE Directive set targets for recycling and reuse altogether. A collection target of 65% of equipment sold, or 85% of total WEEE generated has been set for 2019. Compliance with this target will ensure that in 2020 around 10 million tonnes of WEEE, or roughly 20kg per capita, will be separately collected in the EU. The Spanish RD 110/2015 (Real Decreto 110/2015, de 20 de febrero, sobre residuos de aparatos eléctricos y electrónicos) also sets specific objectives for reuse, according to the WEEE category. For instance, the current reuse target for IT equipment is 4%.

The Spanish RD considers WEEE as dangerous waste; the Spanish recycling industry states that this decision has a number of consequences that might affect the industry (FER, 2016):

- Many small WEEE managers would disappear since they are not able to get an authorisation for dangerous e-waste. As a consequence, many WEEE managers would not be able to carry out the preparation for reuse activity, that must take place close to the collecting point;
- The guarantee bond for dangerous waste management facilities is much higher than for facilities that manage non-dangerous waste;
- Many regions ask for a guarantee bond to transport dangerous waste;
- Dangerous waste management requires a rise in insurance policies to be taken out by facilities;
- Increasing management costs due to bureaucratic charges;
- Illegal channels for managing WEEE might increase.

Moreover, the Permanent Commission of the Council of State examined and issued in 2015 the Opinion on the RD 110/2015. This official document highlights some critical issues of the Spanish regulatory framework for WEEE management and set clear recommendations for overcoming the pitfalls of the RD:

- Establishment of clearer regulation that increases the jury safety and sets a detailed description of obligations of users, manufacturers, authorized representatives, importers, retailers and managers;
- To integrate a single tool to control WEEE data from Autonomous Communities and the State that allows to check the compliance with objectives and guarantee waste tracking and adequate management;
- To promote reuse and preparation for reuse, fostering the creation of reuse centres and creating employment in the sector;
- To create trust and systemizing information obligations of EEE manufacturers and WEEE managers about preparation for reuse, collection and valorisation of WEEE in the entire territory, guaranteeing homogeneity of management criteria and market unit;
- To economically optimise and to make management of WEEE efficient based on Extended Producer Responsibility.

2.2.2.2 RoHS Directive 2002/95/EC

EU legislation restricting the use of hazardous substances in electrical and electronic equipment, RoHS Directive 2002/95/EC, entered into force in February 2003. The legislation requires heavy metals such as lead, mercury, cadmium, and hexavalent chromium and flame retardants such as polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE) to be substituted by safer alternatives.

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2.2.2.3 Basel Convention

Basel Convention on the Control for the Trans-Boundary Movement of Hazardous Wastes and their Disposal, in force since 1992, is the first and only global environment agreement on waste and now comprises almost 172 national governments. This global agreement regulates trade in hazardous wastes, including WEEE; it seeks to ensure that they are disposed of safely and that the generation of such wastes is minimized. An Amendment to the Convention, commonly known as the Basel Ban, which calls for prohibiting the export of hazardous waste from OECD to non-OECD countries, is still to come into force.

2.2.2.4 China's National Sword policy

China implemented the Nation Sword 2017 to fight against contraband of industrial, electronic, household and plastic wastes. This policy, which implies a sharpening of environmental controls worldwide, will also have effects on the localisation of the recycling industry.

2.2.2.5 Voluntary regulation and standards

Weeelabex is a set of normative standards with respect to the collection, sorting, storage, transportation, preparation for re-use, treatment, processing and disposal of all kinds of WEEE. They have translated into formal Cenelec EN standards, which have been adopted by a number of European countries.

There are significant issues around reliability, joint integrity (role of intermetallics), expected life, degradation and warranties as well as training of operators. Electrical testing and qualification of such components must be done against specifications that may be only available from the original supplier, if the part is not obsolete. To overcome these issues new specifications and standards are required, allowing more confidence with regard to warranties and performance. Another issue that should be addressed is the labelling of electronic assemblies and products with hazardous substance information (ISQ, 2009).

Apart from that, the e-waste management industry can observe voluntary regulation such as the ISO 9001 for operating an effective system, ISO 14001, which sets out criteria for an environmental management system and the EU Eco-Management and Audit Scheme (EMAS), which has been developed by the European Commission for companies and other organisations to evaluate, report, and improve their environmental performance. A total of 346,189 valid ISO 14001 certificates were reported in 2016. As of 2014, 4,049 organisations and 7,556 sites were EMAS registered worldwide.

2.2.3 Economy and environment

This sub-section presents the main factors that are considered relevant to understand the market environment of the WEEE industry.

Based on Eurostat databases, between 2010 and 2013, the amount of EEE put on the market in the European Union (EU-28) dropped probably as a consequence of the financial and economic crisis. In recent years, this volume increased again to 9.8 million tons in 2015, 3.4% more than in 2010. The dominant product category is large household appliances, followed by IT and telecommunication equipment, small household appliances, and consumer equipment.

This trend has also a correspondence with the volume of WEEE generated. According to Eurostat, more than 3.5 million tons of WEEE were reported by EU-28 countries as collected and recycled in 2015, which could represent approximately 65% of the total WEEE generated[i]. The total amount of collected WEEE varied considerably across EU-28 countries (1.6-14.7 kg per inhabitant) being the average around 6 kg/capita. Spain registered a lower value than the EU average (4.61 kg/capita), although higher than the 4 kg per inhabitant target.

Other authors estimate that only 35% of all the WEEE ended up in the officially reported amounts of collection and recycling systems (Huisman et al., 2015). The remaining is either recycled under non-

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compliant conditions in Europe, removed of valuable parts, thrown in waste bins, or exported to developing countries, such as China, India, Ghana and Pakistan, due to low-cost labour and less restrictive environmental regulations. Although the Basel Convention banned in 1992 all forms of hazardous waste exports, illegal trade is still occurring from the EU countries (Huisman et al., 2015).

The WEEE recycling industry is an important sector across all the EU countries. In Spain, more than 600,000 tonnes of new electronic appliances are launched to the market every year. It is estimated that e-waste generated per inhabitant is 17.8 kg[ii].

Globally, e-waste continues to grow at an annual rate of about 5 per cent globally and the problem is that in developing countries e-waste grows exponentially, and volumes could grow by as much 500 per cent over the next decade in some countries (Mccann & Wittmann, 2015). Therefore, the role of WEEE authorized treatment and recycling facilities is key to avoid the loss of important resources and also negative impacts, such as the release of heavy metals and CFC gas emissions in the environment.

The WEEE recycling sector is a mature sector in Spain. There a number of experienced businesses, equipped with last technological advances and well adapted to current regulation. It is worth to mention that Spain is the European country with the highest number of WEEE-LABEX (WEEE Label of Excellence) certified facilities. There is the only centre that manages four different types of appliances, Wirec, and one centre specialized in refrigerators, which are the most difficult ones to treat, Lyrsa.

The WEEE Directive sets that electronic equipment manufacturers have the obligation to adopt the necessary measures for selective collection and management of waste derived from its products at their end of life. Thus, companies may choose to comply with the law individually or by means of collective schemes. Collective schemes allow for saving costs, simplifying permits, sharing knowledge and experiences and actively collaborating in promotion and diffusion of a recycling culture. Collective schemes represent the model followed in Spain for the compliance with the WEEE Directive. There are currently eleven collective schemes for Extended Producer Responsibility dealing with WEEE. Each platform is authorised to manage from just one to ten WEEE categories. Those schemes are related to a network of authorised e-waste managers and to a number of municipal collecting points across the territory. Thus, the collective schemes, which represent the EEE manufacturers are an important stakeholder in the WEEE market.

Apart from authorised e-waste managers, it is true that there is still an important network of informal scrap dealers. They also operate in the market, negatively affecting the correct WEEE management. In this sense, those agents usually cannibalize the WEEE, just taking those elements that have an important economic value in the market. In this sense, it is worth noting that numerous innovative processes for recovery of metals and other materials from electronic assemblies have been developed and WEEE recycling is now a commercial alternative. However, there is still a perception that the business case has not been truly made for recovery or reuse of e-waste.

On another level, there are number of factors that support the linear economy in the electronics industry. For instance, in Spain it is commonly found that regional governments usually support the acquisition of IT equipment providing subsidies to businesses and households. This financial support is aimed at promoting the digitisation of society but in some way it also supports the renewal of IT equipment that could extend its life otherwise.

One factor that especially affects the reuse market is the nature of EEE products. They are nowadays less durable and repairable than in the past. In addition, they bring increasing difficulties for repair (RREUSE, 2015):

- Lack of access to and high costs of spare parts: costs of repair are higher than purchasing a new appliance;
- Lack of appropriate repair information: no free access to service manuals, software and hardware of product and components, for independent repair operators;

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- Product design and components without re-use potential: new designs make it increasingly difficult to repair a product or components without breaking them forcefully.

These factors significantly contribute to the costs associated with repair, making direct replacement of a product, often the cheapest option for the consumer. As a consequence of increasing obstacles and costs to reuse and repair, the decline of jobs in the sector has been noticeable for at least the past 30 years.

Moreover, the production of EEE has become increasingly centralised, notably in Asian countries, which has contributed to lowering the production costs and therefore product prices. For example, the price of a computer has dropped to one tenth of its price 15 years ago (Mccann & Wittmann, 2015).

2.2.4 Competition

Information contained in this sub-section is, to a certain extent, closely related to the market framework depicted in the previous sub-section. In this case, deeper insights are presented with regards to reuse and repair businesses.

Official statistics from Eurostat[iii] show that only a 2% of the collected WEEE is prepared for reuse, whereas a 68% is recycled. The existing system is a 'material collection system' and not 'manufacturing-centred take-back system' (Parajuly & Wenzel, 2017). Notwithstanding, in recent decades, the EEE reuse sector has grown substantially with many organisations having successfully developed in both the profit and non-profit sectors and despite facing several different challenges (Milovantseva & Fitzpatrick, 2016). In this sense, there are a number of reuse practices to extend the useful life of certain EEE and components, from collection, preparation for reuse, refurbishment, remarketing and redistribution of used equipment. The main models for reuse have been identified by the StEP initiative (Milovantseva & Fitzpatrick, 2016, p. 7):

Networking Equipment Recovery. This is a for-profit model that processes both used and excess new durable IT networking equipment, such as rack servers, routers and switches. Organisations that use this model receive equipment from third-party service providers to customers of IT equipment and also collect directly from corporate users. The majority of reuse is distributed in components from the received products. The reuse rate ranges between 10 and 50 per cent.

IT Asset Management. This is also a for-profit model that specializes in the refurbishment and remarketing of desktop and notebook computers for resale to distributors and retailers. This model offers asset recovery services and receives much of its input from commercial corporate users or leasing companies who offer take-back service to their customers. Due to the corporate users' more frequent equipment replacement, the reuse rate for this model is greater and ranges between 25 and 95 per cent.

Bridge the Digital Divide. This is a non-profit model that provides used desktop and laptop computers to beneficiaries in developing countries, such as educational and medical institutions or local non-profit organisations. The majority of equipment is received via donations from corporate and public users. In exchange, this model's practitioners offer equipment collection, data sanitation and appropriate compliance certification.

Social Enterprise. This is another non-profit model in which organisations acquire and prepare equipment, including computers, peripherals and large household appliances, for reuse and resale to individual users with the objective of creating social benefits (i.e., employment or training for disadvantaged individuals). Normally, social enterprises focus either on computers received through donation or large household appliances from various providers. Refurbished equipment is sold to eligible recipients.

The market of reuse also needs to take into account repair businesses. While preparation for reuse is based on WEEE, repairing is focused on extending the lifetime of products that are still not disposed

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of, and hence, not considered e-waste. According to Eurostat [iv] there were 209.7 thousand enterprises operating with the repair of computers and personal and household goods as their main activity in the EU-28 in 2014. Together they employed 414.7 thousand persons, equivalent to 0.3 % of the non-financial business economy workforce, while they generated EUR 10.9 billion of value added which was 0.2 % of the non-financial business economy total.

Reparation of computers and personal and household goods sector is characterised as a labour-intensive activity. Just under three quarters (74.3 %) of the enterprises within the EU-28's repair of computers and personal and household goods sector were classified to the repair of personal and household goods in 2014, with the remainder repairing computers and communication equipment. In employment terms, the share of the repair of computers and personal and household goods sector in the non-financial business economy workforce peaked at 0.5 % in France, Greece and Spain. The repair sector is dominated by micro enterprises. Together these micro enterprises employed 278.0 thousand persons.

Business clients with more complex requirements for information technology (IT) services may receive repair and maintenance services for computers and communications equipment bundled into broader IT services provided by information technology services providers. Repair and maintenance services may also be provided as a secondary activity by companies that are mainly manufacturers or distributors of computers and communications equipment.

Many repair activities, often face increased demand during downturns in the overall economic cycle as households and businesses postpone purchases of new capital goods or consumer durables and semi-durables and repair existing items instead; equally demand for repair services may decrease during an upturn in the cycle.

The repair market includes activities that are quite similar in nature to preparation for reuse; however, since preparation for reuse starts with e-waste, companies are affected by stricter regulation and bureaucratic charges. The Spanish association FER has calculated that on average, an authorized e-waste manager faces a cost of 20,000 euros per year due to bureaucratic costs.

Besides that, there are a number of P2P platforms operating in the market that allow for exchanging and selling second-hand products among consumers themselves.

Finally, due to valuable materials embodied in WEEE, the system is affected by illegal scrappers that cannibalise the products, making them unable to be reused.

2.2.5 Technology trends

The development and adoption of new consumer technologies are occurring at faster rates along the last decades. Technological efforts of the leading companies are aimed at developing efficient and useful consumer products for a wide range of applications. However, new technologies usually offer limited use times due to rapidly changing software, needs, lifestyles and applications. Therefore, the quantities of discarded consumer products have increased exponentially, due to advances in material technology, manufacturing processes, rapid market penetration and planned obsolescence (Tansel, 2017). On the other hand, the development of appropriate technologies and policies that address the management of e-waste are just in the early stages. For instance, the preparation for reuse of WEEE brings challenges in terms of current operating technologies for desoldering and retinning components (ISQ, 2009). And still, many processes are manual and labour-intensive (manual separation, disassembly and shredding).

In addition, the design improvements that increase marketability and durability of high tech products pose challenges for repairing, for separation of the components and for materials recovery. For instance, Greenpeace[v] East Asia, in partnership with iFixit, assessed over 40 best-selling smartphones, tablets and laptops launched between 2015 and 2017, from 17 IT brands. The assessment was based on iFixit's repairability score, which considers the time required to repair the product, the device's

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upgradability and modularity, as well as the availability of spare parts and repair manuals. While the organisation found that designing for reparability is possible, there were a great number of products that presented obstacles to be fixed, which shortened the lifespan of the devices.

In particular, the product guide resulting from the Greenpeace analysis identified several practices that obstacle reparability, including: the design complexity, combined with the practice of soldering or gluing separate pieces together; the impossibility to replace batteries; the need for non-standard tools; and the lack of provision of repair manuals or spare parts.

On a minority basis, the EEE manufacturing sector is taking steps towards more sustainable production. In this case, technological developments are the key. For instance, Dell has developed closed loops for its processes and including some recycled and renewable materials for both products and packaging.

Design for durability, ease of repair and effective end-of-use disassembly for remanufacture and recycling has not still been taken seriously by EEE manufacturers though technical possibilities exist. 3D printing of customizable parts, apps and platforms for connecting like-minded consumers willing to share design ideas, repair skills and so on are an important enabler of a more circular EEE sector (Weetman, 2017).

2.2.6 Customer needs

In industrialized countries, consumers tend to renew their appliances more frequently, especially ICT appliances such as mobile phones, laptops and tablets. The decreasing longevity of products is driven by production and consumption patterns where consumers are fascinated by the modernity of EEE, low prices for new technology and new models and innovations that are frequently launched on the market (Mccann & Wittmann, 2015; Tansel, 2017; Weetman, 2017).

At the same time, there is some increasing awareness on environment and health impacts of WEEE, thus demand for second-hand products is increasing. Indeed, informal reuse and secondary market outlets have evolved, such as eBay and traditional refurbishes, to prolong the lifetime of equipment, in particular by giving the used equipment further lives (Mccann & Wittmann, 2015). Even world leading brands, such as Apple, are offering their customers the possibility to receive some money for their old devices.

Moreover, campaigns led by NGOs are an important element to increase consumers' awareness. Many NGOs campaigns are focused on WEEE (e.g., Greenpeace, Basel Action Network) dealing with a number of aspects, such as illegal exports to developing countries, recycling needs, pollutant components, planned obsolescence, etc. There are also networks of diverse organisations and NGOs working together. This is the case of Electronics TakeBack Coalition or International Campaign for responsible technology.

Based on Sigwatch (2015), Samsung Group is the first electronics, telecoms and digital corporation in number of activism campaigns around the world along 2014. These campaigns are mainly related to privacy rights and consumers' protection. There are also campaigns focusing on conflict minerals/ethical sourcing of components, electronic waste handling & recycling, product lifespan & planned obsolescence. Greenpeace (Cook & Jardim, 2017), for example, has developed a label for the main world's consumer electronic companies showing how they are addressing their environmental impacts in relation to energy, resources, and hazard chemicals consumption.

2.2.7 Uncertainties

Due to the increasing amounts of e-waste generated year after year, the electronics and electrical equipment circular activities (repairing, refurbishment, preparation for reuse, recycling, and so on) will face a number of challenges and uncertainties in the next years. A few of them are summarised below, based on literature review (Parajuly & Wenzel, 2017; Tansel, 2017; Weetman, 2017):

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- Uncontrolled e-waste flows due to the lack of effective accounting mechanisms, waste management programs and material recovery technologies;
- Challenges associated with lack of awareness and training for safe handling of materials and work environments, especially in unregulated regional small scale operations;
- Limitations due to the way WEEE is delivered by users, and collected, transported and stored by WEEE managers. Lack of awareness, motivation and care may block any chance to extend the life of EEE products through refurbishing and reconditioning.
- Increasing stress on the environment as the virgin materials are extracted and utilized at large quantities by the EEE industry; accordingly, increasing economic stress and price fluctuations due to limited availability. In addition, China, where a 97% of rare earth ores are concentrated, has set strict quotas on the exports. This factor will accentuate price increases;
- Trend towards using structurally integrated materials by EEE manufacturers, which make it difficult for disassembly and recovery of materials;
- Increasing regulatory requirements in developed countries may create bottlenecks for economically feasible and environmentally sound management options for e-waste. In relation to that, improving cross-border transportation of e-waste in a transparent and sustainable manner would be necessary to facilitate the economies of scale required for recycling some elements.

3 Business model assessment

This section focuses on the analysis of Revertia business model. The objectives are to gain a deeper understanding of the circular business model and to map out the value chain and interactions in more detail in order to enable an analysis of the strengths and weaknesses as well as to consider the replicability and transferability of such a model to other entities and sectors.

The business model assessment has been conducted through a combination of publicly available information, interviews with employees and stakeholders of Revertia and internal documents provided by the organisation.

3.1 Revertia business model

3.1.1 Business model overview

As has been mentioned in section 1.2, Revertia is an authorised WEEE manager. The business model is focused on offering value added services linked to WEEE management from corporate customers. By managing the e-waste flow, Revertia has taken advantage of a gap left by EEE manufacturers, which consists of preparation of IT equipment for reuse.

The key activities implemented by the company consist of disassembling, checking, cleaning and when necessary replacing or repairing computers and laptops in an industrial process. Parts and components obtained from discarded IT equipment are reused to the extent possible. The remanufactured product is sold in second-hand markets with the corresponding guarantee for 1 year.

The business model of Revertia is dependent to a large extent of the existing network of collective schemes but the main customer segment is represented by EEE corporate users and households as second-hand customers.

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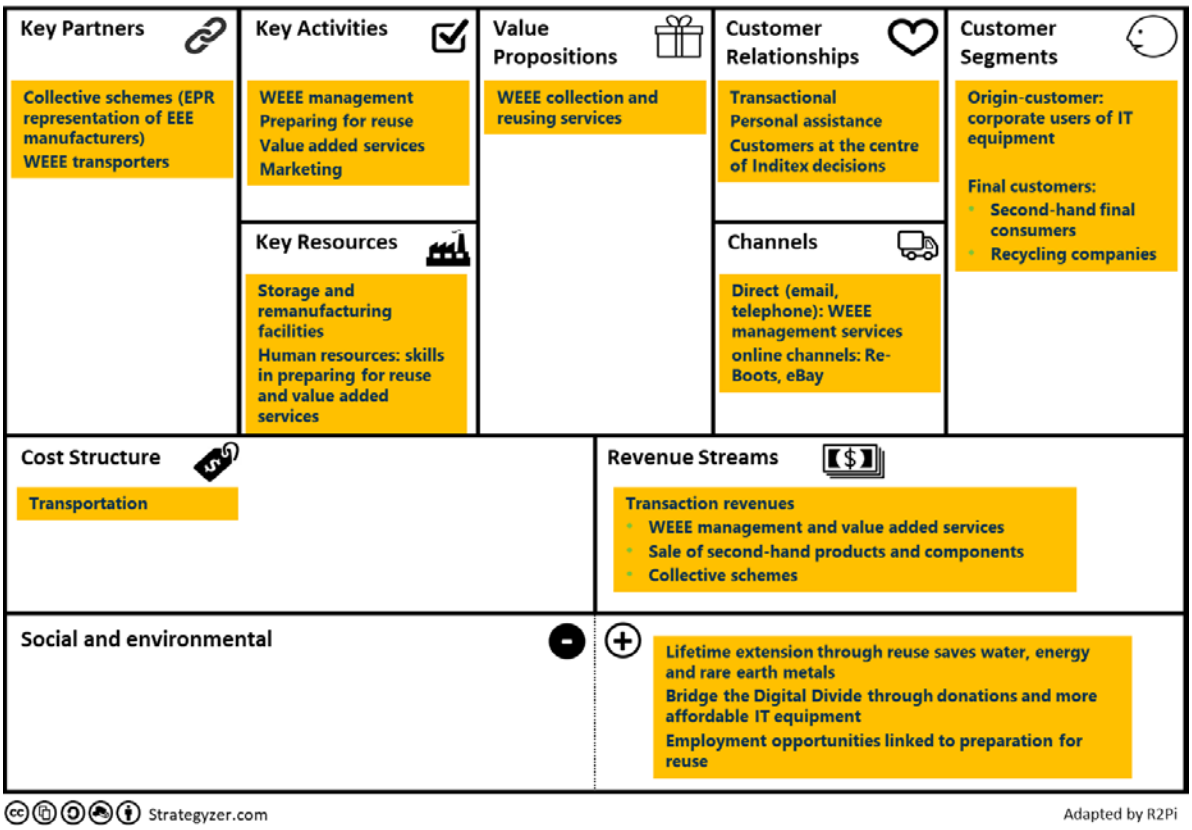
Depicting the Business Model Canvas

Figure 3 shows the visual visual representation of Revertia's business model, based on the Business Model Canvas. This is to incorporate the way in which: (i) the value proposition and customer needs assessment and; (ii) circular economy principles, are applied and embedded.

FIGURE 3. BUSINESS MODEL CANVAS



Source: own research

Revertia's value proposition consists of providing added value services for adequate management of waste electric and electronic equipment, with the ultimate objective of extending the life of IT equipment. Within the scope of this case study, Revertia's main customers are IT equipment corporate users that demand e-waste services (mainly large enterprises and public organisations) and final customers that buy second-hand IT equipment (mainly individuals and NGOs).

Through the value proposition Revertia satisfies the following customers' key needs: to comply with Corporate Social Responsibility, to guarantee data deletion and to fulfil reusing and recycling objectives. Those services are fundamental to enable the circular model of Revertia, which consists of extending the life of IT equipment. With regards to second-hand customers, Revertia offers refurbished IT equipment and components. Depending on the added services that are hired besides WEEE management, the source customer pays for the service according to several variables while the destination customers pay a reduced price for a full capacity IT equipment.

Collecting WEEE and preparing IT equipment for reuse provides additional benefits to customers such as a responsible and adequate management of WEEE, information to fill out CSR reports, complying with data deletion requirements, reach reusing and recycling targets, and working out the carbon footprint.

Revertia outsources transportation of WEEE to local carriers in order to avoid high costs and environmental impacts derived from long distances. The contract carrier is a key partner because it is the person responsible for making a first decision on the collection of WEEE. If IT equipment is found

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in very bad condition, it is delivered to the closest collective or recycling facility better than delivered to Revertia.

Revertia's relationship with origin-customer is collaborative and long-term, with an opportunity for frequent personalised interaction through the service bundle. On the other hand, the relationship with the final customer is sporadic and set on a transactional basis.

Each building block of the business model is described next:

3.1.1.1 Customer Segments

Revertia value proposition is oriented towards two main customer segments:

- The origin-customer: represented by large enterprises and local waste facilities. Revertia serves this segment with WEEE collection and management services and added value services, such as certificates of data records deletion and environmental footprint analysis.
    - Large enterprises are customers that intensively use and very frequently renew their IT equipment, e.g. financing entities, public organisms, listed companies, etc.
    - Local waste facilities may be publicly or privately managed. Those are the places where final users must deliver their e-waste.
- The destination-customer: it can be a generic and a specific customer. Revertia donates and sells IT equipment to different types of agents.
    - The generic final customer are NGOs, local associations, computers' second-hand market, computers repairing market and recycling companies.
    - The specific final customer is the final customer that the origin-customer chooses under some specific conditions.

The difference between the two customer segments lies in the fact that origin-customers demand e-waste management and other services to Revertia. Those customers and the services they demand are in practice the source of inputs for Revertia circular processes. The destination-customer is the user of the refurbished product.

There is still another type of destination-customer, which are the companies acting in the recycling market. Revertia sells WEEE that cannot be prepared for reuse to recyclers of components. It is worth to mention that the company keeps strong relationships with metallic and plastic recyclers, such as Lyrsa.

3.1.1.2 Value Proposition

Revertia offers waste electric and electronic equipment collecting and reusing services, while fulfilling several functions for the customers: supporting their compliance with Corporate Social Responsibility (CSR) objectives, guaranteeing deletion of private data and helping them to comply with reusing and recycling regulatory objectives. The WEEE collected is prepared for reuse, which is a strategy that supports Circular Economy as the products lives are extended.

Revertia business model creates value for its customers' segments in several ways: from support to an environmentally-friendly behaviour and complying with CSR of origin-customers, to access to lower price and even free IT equipment to several types of final customers.

3.1.1.3 Channels

Collection of WEEE at the customer facilities and added services are a part of Revertia production processes. They are based on a direct relation and coordination with the origin-customer. In addition, transportation is outsourced to local carriers.

The sale of reused equipment and parts implies different channels:

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- Reboots: is an online channel, a specific market channel for second-hand computers by Revertia;
- Re-sale channels for professional second-hand and repairing markets. Revertia sells components and parts through online channels (Ebay) and direct channels (recycling companies);
- Donations for NGOs and associations (specific destination-customer) chosen by origin-customers.

3.1.1.4 Customer Relationship

Relationships with origin-customers are stable and long-term, with regular contact to ensure that products are managed by Revertia. Additional services offered to the origin-customers contribute to keep close links with them. Indeed, Revertia informants state that the company has not lost any customer from the beginning.

Relationships with destination-customers of refurbished IT equipment and components are more sporadic, typically point of sale. Moreover, it is worth to highlight a close relationship that Revertia keeps with a metallic recycling company called Lyrsa. Revertia facilities are located within the facilities of Lyrsa. This is based on an agreement that facilitates that WEEE that cannot be prepared for reuse is immediately disposed of and treated by Lyrsa. This way, Revertia avoids economic costs and environmental impacts derived from the transportation of its own waste.

3.1.1.5 Revenue Streams

The business model of Revertia has different revenues sources:

- The origin-customer pays for WEEE collection, data deletion, and reusing. Price is variable depending on the distance from the customer facilities to Revertia treatment facilities, as well as on the amount and quality of WEEE. Revertia also offers value added services, such as environmental reporting and carbon footprint analysis, which may generate additional revenues.
- Revenues derived from sale of second-hand equipment to final customers (Reboots) and components to repairing and second hand companies;
- Revenues derived from sale of WEEE for recycling;
- Fees paid by EEE manufacturers through collective schemes, who are obliged due to the Extended Producer Responsibility (EPR) that applies according to the Directive 2012/19/EU.

3.1.1.6 Key Resources

Revertia business model is not dependent on very specific and advanced innovations and technologies. The features of the treatment facilities, safety measures and location are defined by Law (RD 110/2015). Necessary assets and processes are:

- Support structure, which hosts all the necessary processing elements;
- Electrical system;
- IT equipment and tools, necessary for carrying out the different tasks;
- Furniture for carrying out the processes and equipment, components and peripheral storage.

An important resource is the software used to delete information, which guarantees data protection requirements of origin-customers.

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Moreover, the company has specific knowledge related to WEEE handling, dismantling and reassembly. Additional important knowledge and skills have to do with WEEE legislation, LCA and carbon footprint analysis.

3.1.1.7 Key Activities

In relation to the origin-customer, the key activities have to do with commercial relations and distribution:

Provided that Revertia needs to collect IT equipment, the necessity to set stable and long-term relationships with origin-customers are one of the key activities. Once the relationship has been stablished, the process is as follows: the origin-customer describes the amount and type of WEEE that they want to dispose of and the location for collection. Revertia offers a budget according to distance, number and type of equipment, as well as to the data deletion model. After that, Revertia contracts the carrier and agrees on a collection date.

Logistic services are therefore another key activity, though Revertia outsources it to an authorised carrier. The carrier plays a key role for adequately handling and transporting WEEE in order to guarantee potential reuse.

Another key activity is related to the selection of equipment susceptible to be prepared for reuse. IT equipment is subject to a first check to know if the product works or not. In case the IT equipment does not work it is oriented to the specific recycling segment.

Once accepted for preparation for reuse secure data shredding is one of the delicate activities. Revertia carries out the secure deletion of hard drive by means of software that keeps right with more than 20 international rules on data compensation and disinfection. Revertia completely deletes data without any chance to recover them. Data access to the unit is made in a physical shot through BIOS (Basic Input-Output Subsystem), without any need to having direct access to information through the operational system. An individual certificate is emitted for each hard drive.

Managing information and complying with bureaucratic processes associated with WEEE is another key activity. Revertia takes care of all the documentation and all the procedures related to e-waste transportation (treatment contracts, transfer notifications to the Autonomous Community, waybills, identification files, and so on). Moreover, Revertia emits all the waste management certificates according to present legislation, data shredding certificates for that equipment that are required, as well as detailed reports including LCA assessments.

In relation to the destination-customer, the main activities have to do with marketing and distribution. Second hand IT equipment is placed in online markets based on an appealing and updated offering. Revertia is also responsible for organising the packaging and home-delivery.

3.1.1.8 Key Partners

Key partners of Revertia circular business model are carriers and collective systems, which represent EEE manufacturers. Due to EPR, EEE manufacturers are a key partner because through collective systems they finance part of the Revertia activity.

Transportation is sub-contracted to local carriers, in order to avoid long kilometres. Carriers are trained by Revertia to carry out the first visual check of equipment. They are responsible for making the first decision on whether WEEE is delivered to Revertia facilities or it is directly disposed of in recycling companies. In addition, packaging for delivering refurbished equipment is sub-contracted to local companies when their services are required.

3.1.1.9 Cost structure

The most important costs for Revertia are represented by WEEE transportation. For this reason, the company tries to make a smart decision at the origin-customers facilities. If WEEE is not susceptible

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to being refurbished, the best decision is to send it to the closest recycling centre, rather than to Revertia facilities.

3.1.2 The Value Network

The value network created through the circular business model of Revertia is shown in Figure 4. The value network is made of a number of stakeholders, which are located either upstream and downstream Revertia. First of all, there are a number of corporate customers, usually large enterprises and public administrations. Through Revertia business model, those customers get value from services linked to WEEE collection. Revertia contributes to satisfy the need of professional IT users of complying with the regulation on e-waste management. In addition, corporate IT users have the chance to get added value in terms of image and reputation by donating their old IT equipment.

Moreover, Revertia has agreements with a number of collective schemes, by which EEE manufacturers comply with the legal obligation of extended producer responsibility.

The activities developed by Revertia with old IT equipment for reusing allow for extending the life time of this equipment and hence, to keep value during extended time. Value preserved in IT equipment is then got by second-hand users. It is also important to remark that preparation for reuse and second-hand sales generate new jobs.

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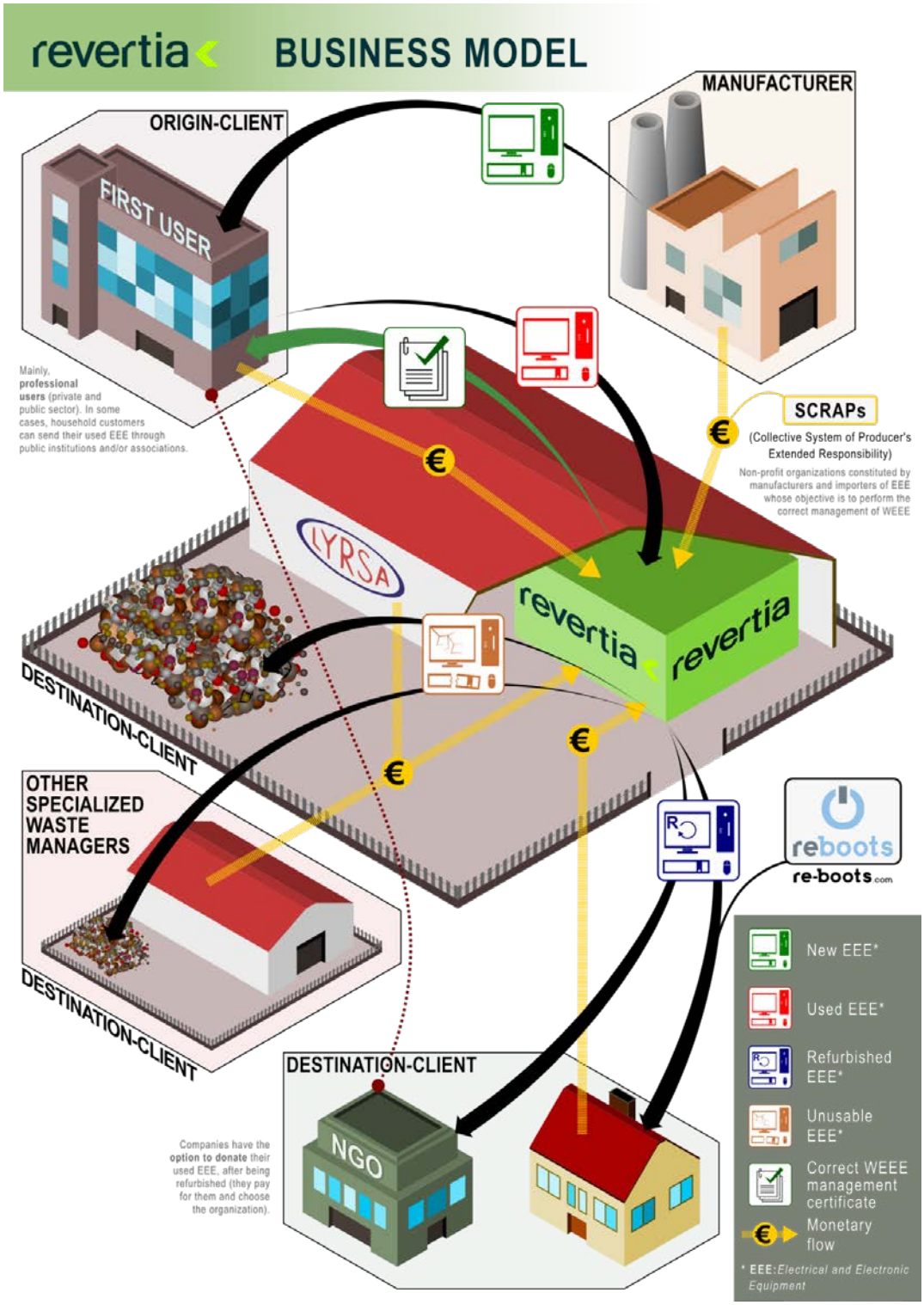
FIGURE 4. REVERTIA BUSINESS MODEL OVERVIEW



Source: own research

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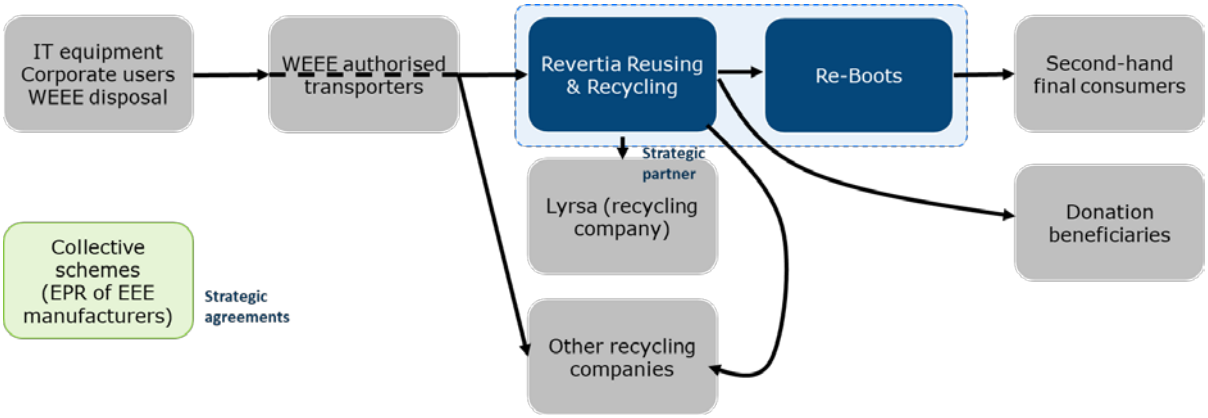
3.1.2.1 Material Flow

The material flow starts with WEEE generation by corporate users of IT equipment. After a first check by WEEE authorised transporters, e-waste is delivered to Revertia facilities or directly to recycling companies.

WEEE flows managed by Revertia are prepared for reuse, so the next material flows are composed of both e-waste, which is adequately treated by recycling companies, and refurbished computers, which are sold through the online platform Re-Boots to final consumers or donated to specific users chosen by the initial corporate users.

FIGURE 5. THE MATERIAL FLOW



Source: own research

In particular, Figure 6 shows the material flow of IT equipment that was managed by Revertia in 2017. 280 tonnes of old IT equipment were collected and received at Revertia facilities. From them, a 30.6 % were successfully refurbished and prepared for reuse. Regarding the destination-customer, most refurbished equipment (85%) was sold through online channels to second-hand users and the remaining 15% was donated according to origin-customer decisions.

Moreover, still the vast majority of IT equipment was allocated to recycling (194.3 tonnes), mainly to Lyrsa (one of the key partners of Revertia). It is worth to note that the amount of tonnes may undervalue the importance of reusing. IT equipment includes computers and laptops but also automated teller machines (ATM), which are very heavy and cannot be prepared for reuse.

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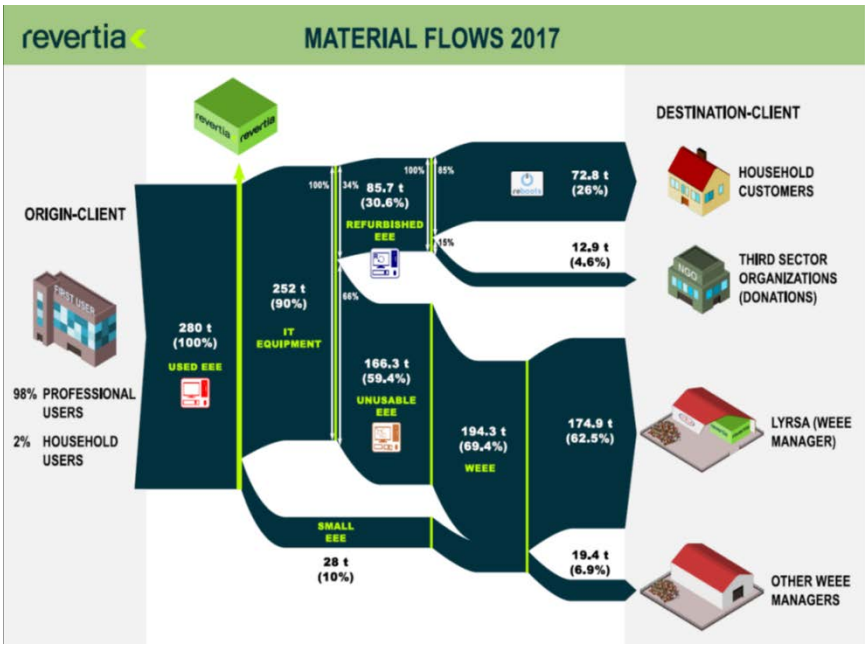
FIGURE 6. REVERTIA MATERIAL FLOWS



Source: own research

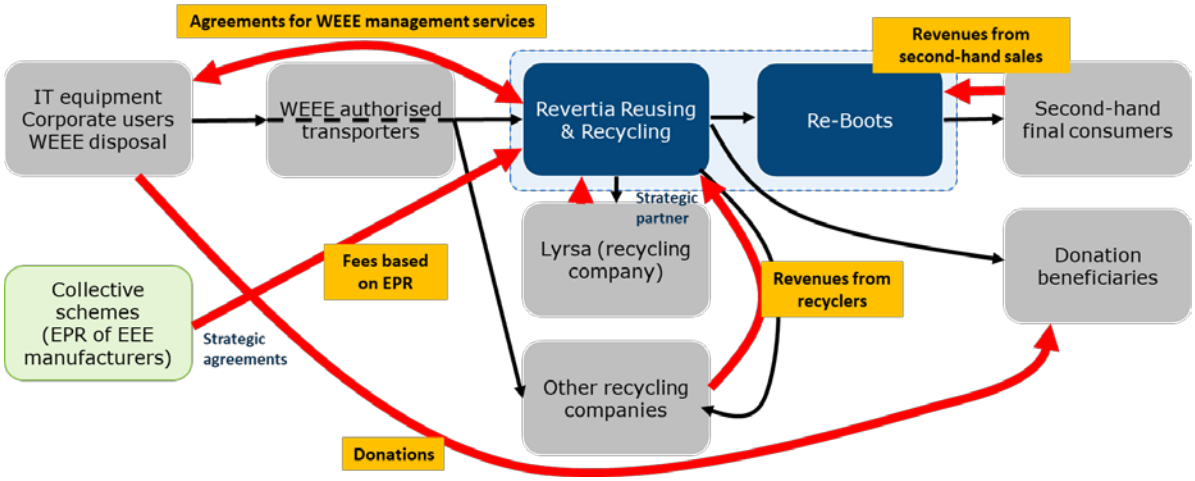
3.1.2.2 Value Flow

After the identification of the value network in the introduction of this section, Figure 7 presents the value flows. Based on WEEE management services, Revertia can exchange value with origin-customers. They can reach agreements in terms of revenues flows depending on the amount and state of used equipment to be managed, added services demanded by origin-customers as well as distance to Revertia facilities.

Revertia revenues flows come from the collective schemes that, due to EPR, finance WEEE recyclings, and from second-hand sales of refurbished computers and components.

Beneficiaries of donations receive value from origin-customers.

FIGURE 7. THE VALUE FLOW



Source: own research

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3.2 CEBM within the business context

After presenting the main features of Revertia business model that are supportive of a Circular Economy, the aim of this sub-section is to provide insights on how the contextual factors characterising Revertia can be mapped out with the CEBM Remake pattern and characteristics. The different contextual aspects were assessed by the CEO and the communication & environmental manager of Revertia as factors that affect or that might potentially affect in the future the implementation of circular business models built on the preparation for reuse model.

The set of **legal and regulatory conditions that apply to the WEEE industry** appears as the most influential framework for Revertia. As the company's CEO indicates, environmental legislation in general and specific legislation for the management of WEEE clearly set out the conditions that the company had to meet in its year of foundation, in 2010. In any case, he states that this regulation has not pushed the business model, it has simply conditioned it. The CEO does acknowledge that the regulatory framework can be a barrier to the entry of new companies, given its complexity. Nonetheless, he states that a company with capacity can see the current legislative framework as an opportunity given the importance the EU gives to Electronics as a priority sector in the transition towards a Circular Economy.

The WEEE management and treatment sector is very mature in Spain, where Revertia operates. However, the opportunity to prepare equipment for reuse is considered by the company to be something new and untapped. For this reason, the transposition of the European Directive into the Spanish legal system did represent an endorsement of Revertia's business model. In this regard, it should be remembered that Spanish legislation (RD 110/2015) establishes specific targets for reuse (4% for IT equipment since August 2018), which obliges the collective systems organised by the manufacturers of EEE to comply with them.

The existence of an **Extended Producer Responsibility system** in this sector is important. It conditions Revertia's circular business model because it finances part of its activity. As manufacturers are obliged to finance the end-of-life management of products placed on the market, they need to establish agreements with waste managers in order to comply with the objectives. In this sense, the CEO of Revertia indicates that at first they started with one of the schemes that operates in Spain and nowadays they have agreements with three different collective schemes. Providing the differential value of preparation for reuse is a strength of Revertia, given the obligation of EEE manufacturers to meet a specific reuse objective. Therefore, through collective schemes, EEE manufacturers are partners of Revertia. The service provided by Revertia consists of correctly managing the waste and providing information and traceability. This information is incorporated by the collective schemes into their responsibility reports.

However, Revertia's CEO acknowledges difficulties due to the **lack of transparency of the collective schemes** and the need to negotiate individually each agreement. The lack of transparent information on the costs of managing end-of-life for different categories of WEEE makes companies like Revertia dependent on their bargaining power. The value of WEEE is very variable, within each category there are elements that have a high value, such as noble and rare metals but there are also elements whose management is simply a cost.

Another important factor that conditions Revertia's business model is related to the legislation applicable to the shipment of waste. Given that each Autonomous Community in Spain has its own regulations in this regard, the movement of WEEE to Revertia's facilities is subject to **administrative obstacles** depending on the route the transport takes.

Revertia's informants also point to the **lack of awareness of public administrations** as an obstacle to its business model. They claim that they have tried to reach agreements with large users of computer equipment, such as public universities, to offer them proper waste management. Despite offering additional added value such as preparing for reuse and performing carbon footprint calculation

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services, they have not yet managed to enter this customer segment. On the other hand, they also consider that green public procurement could favour their business model, since equipment ready for reuse can perfectly meet the needs of various public administration positions.

In relation to the regulatory and legal framework, the general assessment is that it is an obstacle to Revertia business model to the extent it lacks transparency and adds a lot of bureaucratic charges to new businesses. However, it also opens opportunities for setting a strong reuse market by specifying targets.

Some factors that are not currently in place could favour the reuse business model in the future, for instance the implementation of reduced VAT for second-hand products and subsidies for financing eco-design, materials and components standards, as well as technologies for automation of reconditioning and remanufacturing processes.

With regards to market and economic factors, Revertia's informants point to the dependence of the business model on **seasonality and peaks in the economic cycle**. During the period of crisis in which Revertia started its activity, it was more difficult to obtain WEEE for management. Corporate clients were trying to extend the life of their equipment as much as possible, instead of renewing them so often. Furthermore, the maturity of the WEEE recycling sector in Spain implies a **high level of competition** for the collection of this type of waste, which exacerbates during crisis periods. Precisely the objective of reuse set in the RD 110/2015 has opened the door to the entry of new competitors, especially companies already established in the recycling market, which have good technology and deep knowledge of the legislation.

The **lack of information on the secondary raw materials market** also hampers the sector today. Establishing a transparent system would allow companies in the WEEE management sector to identify more precisely the advantages of preparing for re-use and recycling respectively.

Technological factors and the innovation system are also important to Revertia's business model. The company is based on the generation of WEEE. The fact that technological change in the EEE sector is proceeding so rapidly favours the flow of waste for treatment by Revertia. However, it also limits the possibilities of preparation for reuse. This is because the **rapid obsolescence** means that some products still able to provide a high level of performance, do no longer have a market outlet because of their technical or aesthetic characteristics. For this reason, instead of preparation for reuse, the products are directly send to recycling, which is a less preferred option following the waste hierarchy.

Moreover, it is important for Revertia's business model to collaborate with other agents **in R&D projects**. Thus, since the beginning of its activity, Revertia has participated in a number of international and national projects, collaborating with research centers and universities. One of the most important projects to support its business model was the Life ecoRaeee project, which estimated the scalability of Revertia's business model focused on reuse. Also in this project, a tool was developed to calculate the carbon footprint related to reuse and interesting comparisons were made between different reuse and recycling scenarios. At present, Revertia is integrated in several R&D consortia, participating in projects that are focused on aspects such as the development of technologies for the identification and separation of WEEE suitable for reuse and the development of protocols for handling and storage of WEEE at municipal waste collecting points to facilitate its subsequent preparation for reuse. Therefore, the **availability of funds for R&D** is important for supporting the development of circular business models.

In relation to socio-cultural aspects, Revertia's informants observe a certain growth in the **demand for second-hand products** in Spain. However, they claim that Spanish society is still a long way from others like the North-EU consumers in terms of awareness and interest in the reuse of products. In this respect, they indicate that information and awareness campaigns will be essential to encourage consumers to buy second-hand products. These products more than meet the needs of users (young

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and old people who do not make a professional use of IT equipment), at really competitive prices, and also with the added value of environmental sustainability.

Due to the importance of the costs of transporting WEEE to the Revertia facilities, an important factor conditioning the business model is the distribution **structure of the population**. It is much more advantageous to collect WEEE in towns with an urban structure and a high concentration of companies and corporate users. For this reason, Revertia has not yet made progress in moving into other market segments such as individual users. Although IT equipment renewal in this case is much lower than among corporate users, a high volume of waste is generated overall. One possibility, in this case, would be to reach agreements with municipal collection centres to concentrate a high volume of waste that could be treated by Revertia from an economic point of view.

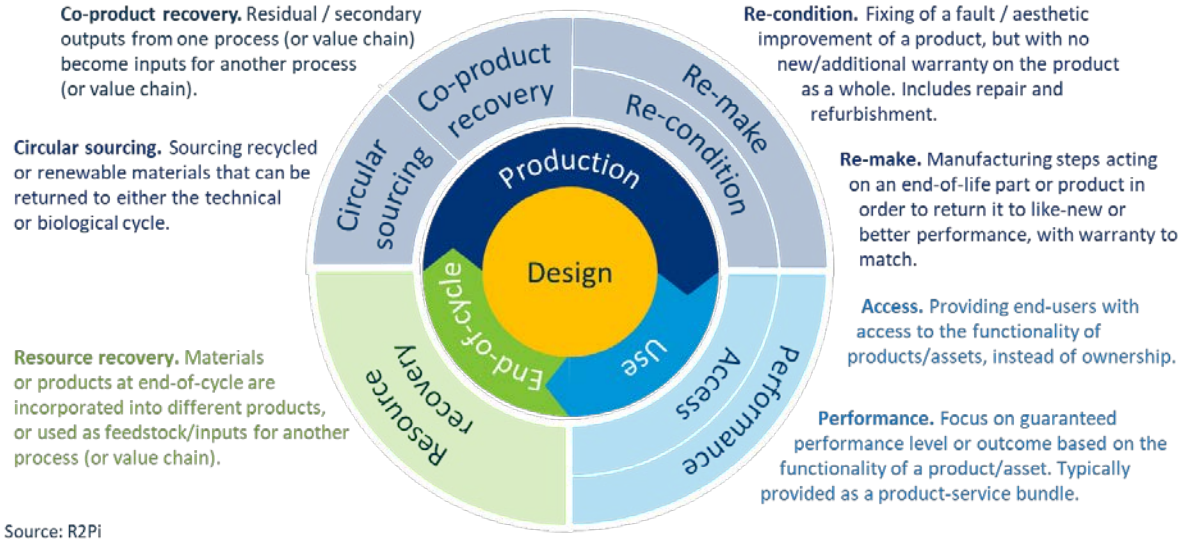
Another important cultural factor is the existence of **illegal scrap metal networks**. These agents cannibalize WEEE that could be better used through responsible management such as Revertia does. In this case, the solution would be to carry out stricter controls and establish clear sanctions. Other factor that could add would be the development of NGOs campaigns aimed at increasing users' awareness of environmental impacts due to WEEE.

3.3 Business model circularity assessment

The purpose of this section is to present an overall assessment of the business model 'state of play', following the seven Circular Economy Business Model patterns identified by the R2Pi project (Figure 8).

Firstly, the circularity assessment, based on a specific tool and discussion with Revertia informants is presented. Secondly, financial and non-financial outcomes of the business model are analysed, based on the case, literature and discussions with Revertia informants. The sub-section is closed with a discussion of the business model SWOT as well as enablers/ barriers to transitioning towards circular economy.

FIGURE 8. CIRCULAR ECONOMY BUSINESS MODEL PATTERNS



Source: own research

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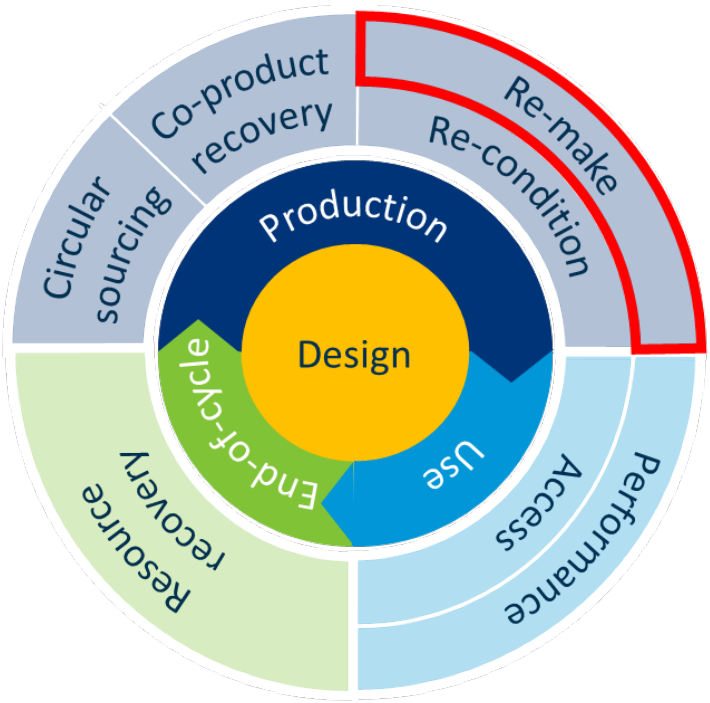
3.3.1 Circularity assessment

Following the CEBM patterns identified by the R2PI project, Revertia business model mostly matches with a "Re-make" pattern (Figure 9). In practice, the company exploits a market opportunity based on the gap left by the EEE manufacturing industry. Revertia takes advantage of residual value of products by collecting WEEE and preparing IT equipment for reuse.

FIGURE 9. RE-MAKE CEBM IMPLEMENTED BY REVERTIA



Re-make. Revertia collects e-waste and prepares computers and laptops for reuse. This business model pattern is key to extend the useful life of EEE products while reducing WEEE flows

Source: own research

Therefore, Revertia business model represents a key contributor towards circularity within the current linear model of WEEE. The assessment of circularity will help to identify different aspects that would need to be radically transformed in the context of a more circular EEE sector.

Following the business model assessment questionnaire (see Annex), the main aspects to be highlighted are based on discussion with Revertia informants.

3.3.1.1 Product circularity assessment

The strongest aspects of product circularity are related to the fact that Revertia tries to reuse components and parts that are obtained from other discarded products as much as possible. However, the does not have control about the composition of products that they prepare for reuse and it is not an objective in the short term. In particular, they lack capacity and they also notice that if stricter regulation, such as RoHS, was also applied to re-manufacturers, preparing for reuse would not be a viable business; in such as case, re-manufacturers would be expelled out of the market.

After second-hand products are sold, Revertia miss control and liability about those products. Notwithstanding, the company includes a letter for the customer that calls for their responsible behaviour, delivering the product to an authorized manager at product's end of life.

At present, Revertia lacks capacity to repair second-hand products. In the near future the company foresees the possibility that the reused product may be upgraded in the process of remanufacturing. For instance, that would be the case if new products were manufactured with standardized and more durable parts. Reparation of already refurbished products could be a possibility and would be an innovative step on behalf of Revertia.

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Other aspects aimed at assessing the product circularity do not apply to Revertia business model. Since Revertia is not a manufacturer, aspects related to design, obsolescence, and other aspects of original products is out of scope of their business model.

3.3.1.2 Business model circularity assessment

With regards to the business model, Revertia is focused on selling services and second-hand products. Thus, the business model is based on a traditional transaction and revenues come from the sale of waste management services and products. The added value lies in the environmentally-friendliness of the second-hand product per se, which can be appropriated by final customers and also by origin-customers in their CSR reports. The most important aspect in terms of circularity is the reuse of co-products and waste streams from Revertia own operations.

3.3.1.3 System circularity assessment

As far as the system is concerned, the most circular features of Revertia business model are the maximum reuse of co-products and waste streams from their own operations. The system also shows important strengths for circularity, due to the existence of an active repair service network in the market. However, as second-hand sellers, Revertia is not given further steps towards circularity, for instance taking control and having full visibility of the refurbished products.

Revertia fulfils a function towards the circularity of the sector by addressing one of the challenges linked to the linear model, i.e. the high volume of WEEE generated. Reuse is an important means of moderating the e-waste problem but it is not a permanent solution though. In the near future, depending on the manufacturers steps towards circular business models, Revertia could go further in circularity, taking complete control over their remanufactured products.

Another important aspect of system circularity is that a recycling industry is to a large extent available for WEEE. This industry supports the current linear system by sorting a few valuable components and making them available for new manufacturing processes.

3.3.2 Financial and non-financial outcomes assessment

3.3.2.1 Financial outcomes

In 2017 Revertia collected 280 tonnes of WEEE, mainly from IT equipment and treated them for reusing. The corresponding revenues sources, are shown in Figure 10. Services paid by IT professional users (origin-customers) represented a 22%; a greatest percentage of revenues were generated from agreements with collective schemes (41%).

As far as the destination-customers' segments are concerned, a 20% of revenues come from recycling companies, while the sale of second-hand computers represented a 17%.

Since its foundation in 2010 the company has increased turnover year after year. In 2017 the turnover amounted to more than 170,000 euro, a 70% more than in 2016.

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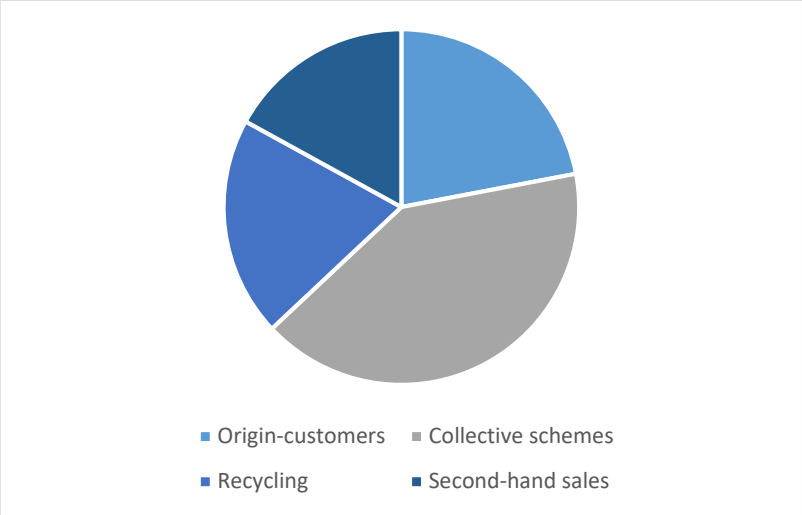
FIGURE 10. REVERTIA REVENUES SOURCES 2017



Source: own research

In order to understand the financial model, it is important to take into account that Revertia establishes different agreements with origin-customers. Depending on WEEE collecting costs (based on the WEEE amount and state of IT equipment), the agreement may rank from a fee to no cost or even to a payment for the e-waste producer. Also, due to the existence of EPR for EEE manufacturers, an important part of revenues come from agreements with collective schemes.

As far as the cost structure is concerned, logistic costs are a critical element of economic result. They represent the 75% of total direct costs of the process of preparation for reuse. Hence, minimizing this cost is a critical hot spot to make reusing a better alternative in comparison with recycling. Another critical cost point is due to new software.

Direct costs of the preparation procedures for reusing (including labour, transportation and inputs) amount to 6.06 € per unit (per complete computer). Total cost per reused equipment is 27.5€, once indirect costs (overheads), which are estimated in 21€ per computer, have been added.

Table 1 summarises the estimated financial gains of a second-hand computer for a scenario of non-cost for the e-waste producer. It reflects a profit margin of 14 euros per functional unit (35% on the sale value) (ecoRaee, 2015a, p. 11).

TABLE 1. FINANCIAL GAINS FROM A COMPUTER PREPARED FOR REUSE

Revenues	***42,21 €***
Second-hand sales	*38,40 €*
e-waste sales	*0,53 €*
Collective schemes	*3,28 €*
Costs	***27,47 €***
Variable	*6,06 €*
Fixed	*21,41 €*
Balance	***14,74 €***

Source: ecoRaee (2015a)

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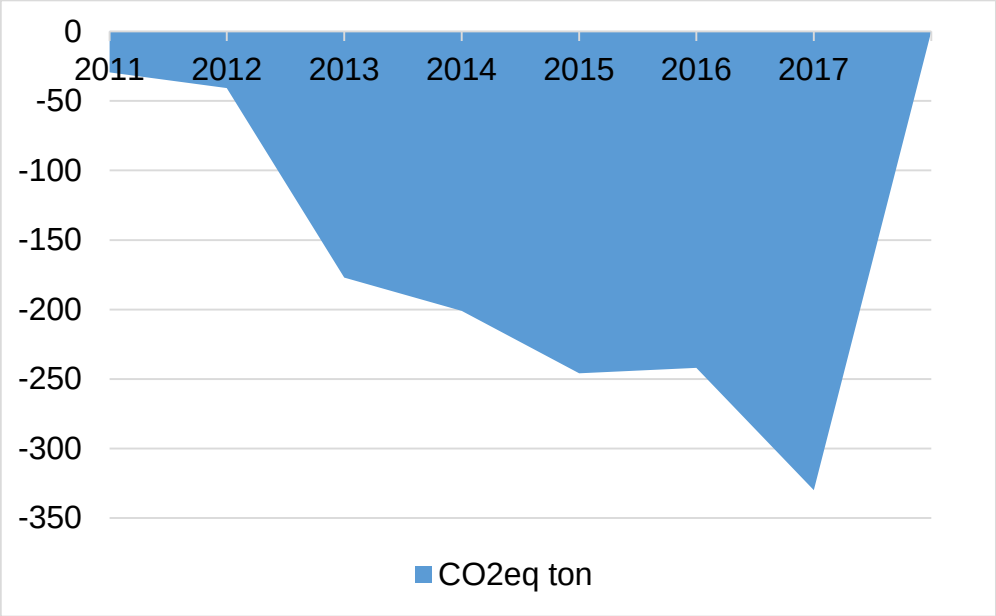
3.3.2.2 Non-financial outcomes

As has been previously stated, reuse is not the ultimate solution to e-waste problems. However, reuse can offer a number of economic, social and environmental benefits while the system is strongly linear. According to a literature review conducted by the StEP initiative (Mccann & Wittmann, 2015), reuse can provide an opportunity to conserve energy and water that would have been used to manufacture new equipment; it is also the most efficient use of scarce materials, as lifetime extension through reuse ensures that non-renewable minerals and material resources are sustained instead of dissipated or rendered unusable. Besides that, e-waste that is prepared for reuse prevents the uncontrolled movement of waste into the developing world.

Based on a Life Cycle Assessment (LCA) conducted in the ecoRaee project, a complete reused information system (CPU, monitor and keyboard) avoids 191 kg CO2eq emissions to the atmosphere (ecoRaee, 2015b). This amount of emissions is equivalent to one that a regular car produces after traveling 1,5M km. Based on the 2017 outcomes, Revertia collected 280 tonnes of WEEE and was able to prepare for reuse a 34% of all the collected IT equipment. That means that Revertia avoided 347 tonnes of CO2 emissions in the atmosphere. This amount equals the CO2 emitted by a car after driving 2.7 million kilometres.

Figure 11 shows the cumulative amount of CO2 emissions avoided by Revertia along the years since its beginning in 2011.

FIGURE 11. AVOIDED CO2 EMISSIONS



Source: Revertia

The environmental advantages of reusing in comparison with recycling depend on the product use after refurbishment. If the resulting product has the same use as the al product, reusing is a better alternative than recycling. On the contrary, if the product coming out of a refurbishment process has a different use than the original one (e.g. if only spare parts are reused) the environmental gain may be dramatically reduced. In particular, recycling is an optimal choice when as new products present a low quantity of material per unit of managed waste, a high electrical consumption and a significantly reduced life span in comparison with new products for the same use.

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Based on the case of Revertia, the ecoRaee project estimated that promoting reuse over recycling saves 45.20€ environmental costs per computer. Calculations for the Spanish market in 2015 show an important social benefit in the form of avoided negative externalities ranging from 5 to 104 million euro, for a conservative scenario of a 3% reuse success rate and an optimistic scenario of 80% reuse rate, respectively (González, Rodríguez, & Pena-Boquete, 2017).

Globally, the scenario of reuse generates fewer physical units of environmental impact in comparison with the recycling scenario in all the categories but land occupation. The reduced impact in reuse is due to processes to obtain the computer and to the transportation of computers. Particle material formation (37.2% of total impact reduction) and human toxicity (25.5% of total impact reduction) are the main categories of social benefit from reuse. The reuse scenario reflects a worse result than the recycling one with regards to energy consumption. The main difference between scenarios has to do with processes during the second useful life. During this stage there are different elements that affect the environmental impacts linked to the manufacture and delivery of equipment, to energy consumption during the use of equipment and to the amount of recycled material (González et al., 2017, p. 18). According to the StEP initiative, in 2014 Spain generated 817,000 tonnes of waste with computers, cell phones, game consoles and electrical appliances, which means more than 17.8 kg per inhabitant per year (www.step-initiative.org). Meanwhile, the Spanish Environmental Ministry quantifies in 140,000 tonnes the amount of WEEE recycled, which means just 3.1 kg per inhabitant per year.

With regards to socio-economic outcomes, reuse brings an important opportunity for creating employment as well as secondary markets. Firstly, a number of social organisations have been traditionally collecting and preparing IT equipment for reuse, which allows for offering jobs to disadvantaged people. According to the Spanish organisation Aeress (Asociación Española de Recuperadores de Economía Social y Solidaria), 10,000 tonnes of waste create 1 job when waste is burnt, 6 jobs when waste is dumped, 36 jobs when waste is recycled and 296 when waste is prepared for reuse. In the EU it is estimated that reuse and recycling of e-waste carried out by social enterprises can provide 10,000 jobs and collect / treat 200,000 tonnes of e-waste per year. In addition, other employment may be created around (Mccann & Wittmann, 2015). Potential jobs would be created in temporal storage centres, transportation services and consultancy firms focused on providing services for continuous improvement and optimisation of processes.

Secondly, second-hand markets are essential to provide access to education and basic appliances to low income and disadvantaged families in both the developing and developed world (Mccann & Wittmann, 2015). Reuse of IT equipment brings benefits in terms of reducing the digital divide. Access to low cost and good quality IT appliances supports the promotion and dissemination of knowledge and cultural exchanges, increased profitability and productivity at work, access to the world market, research and development activities, better communication and coordination between institutions and organisations, reduction of info-exclusion and improved social wellbeing in general (ISQ, 2010).

A part of the equipment that has been recovered by Revertia is donated for social projects, due to sponsoring and support from origin-customers. In 2017 Revertia donated a number of 696 computers to organisations in Spain and South America. IT equipment is used to favour access to information and communication technologies to vulnerable groups and low income households. Moreover, Revertia performs according to CSR across all the departments. Through Revertia services, origin-customers also comply better with CSR requirements, ISO 9001 and ISO 14001.

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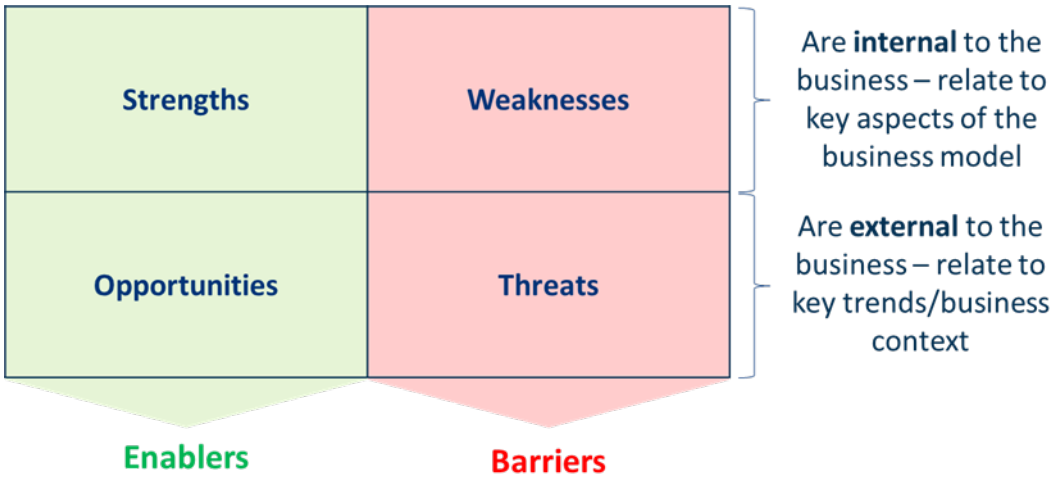
3.3.3 SWOT analysis

This section contains an analysis of the Strengths, Weaknesses, Opportunities and Threats (SWOT) associated with the circular business model of Revertia. As is customary in SWOT analyses, the Strengths and Weaknesses are internal to the case organisation's business model. Whereas, the Opportunities and Threats are external to the case organisation's business model, coming from the context in which they operate.

The purpose is to distil and highlight those key areas that result in enablers or barriers for the development of circular business models (Figure 12).

FIGURE 12. SWOT ANALYSIS FRAMEWORK



Firstly, the discussion about Revertia's strengths and weaknesses is referred to WEEE management services and secondly, to refurbished computers.

3.3.3.1 Value proposition – WEEE management services

In order to understand this assessment, it is necessary to keep in mind that Revertia is a waste management company. The key aspect contributing to circularity is the preparation of IT equipment for reuse. Thus, through a previous treatment, discarded EEE products have the chance to extend their useful life instead of been directly recycled for recovering valuable materials. Therefore, the activity of Revertia is clearly depending on the waste flow produced based on the linear model in the EEE sector. In order to develop this circular strategy, Revertia needs to undertake other activities, basically, capturing customers that need to manage the large amount of WEEE they generate. That is the reason why the main efforts of Revertia at present are focused on the services offered to the so-called origin-customers.

Therefore, the core of the business model relies on providing value added services linked to the waste management activity. In this sense, Revertia shows these important strengths: they have a good valuation of the value proposition referred to waste management services offered to origin-customers. The customer satisfaction is validated through a quality inquiry that is carried out every year. And the differentiation of their value proposition is the sustainability value created for origin-customers, namely the accomplishment of reuse and recycling objectives.

Further circularity in the EEE sector, for instance through designing long-lasting products, standardized and repairable parts and components, would mean a reduction in the e-waste flow. As WEEE constitutes the main input source for developing Revertia circular business model, the company will

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face a challenge. The opportunity in the future will be in setting partnerships with EEE manufacturers and become an authorized re-manufacturer or re-conditioner of more circular by design EEE products.

3.3.3.2 Cost / revenue – WEEE management services

Concerning costs and revenues, strengths are mainly related to the added value services, which allow Revertia to get higher revenues and also to keep them along the time, due to customers' loyalty. In terms of costs, Revertia benefits from high predictability, high scale economies and low fixed costs. On the contrary, there are also important weaknesses, because revenues are not predictable, they are highly fluctuant and dependent on the WEEE flow generated by the origin-customer segment and the cost structure is not well-aligned with the customers' segments.

3.3.3.3 Operating model – WEEE management services

The main strengths have to do with the key activities and key resources, since they are aligned with the circular economy business model of Revertia as it is at present. On the other hand, there are also some important weaknesses, which are represented by the fact the key activities and key resources can be easily copied and acquired by competitors, and also because a high investment is necessary for the company to grow.

Regarding key partners, Revertia benefits from the existence of collective schemes, which represent the EEE manufacturers responsibility for their products end-of-life and thus collaborate with the Circular Economy paradigm. Revertia has gained a competitive advantage by providing services and contributing to the regulation objective of preparation for reuse.

3.3.3.4 Customer interface – WEEE management services

Customer segments represent another important strength of Revertia business model focused on services. The company has a good understanding of the total potential value that can be created for origin-customers. Based on the services offered, the company has gained a great loyalty and accordingly a low turn. However, the main weakness comes from the low rate of new customers, which has to do with the maturity of the market and the high number of competitors offering waste management services. In addition, the period to get new customers is very long.

Revertia informants state that the main weaknesses in the customer interface have to do with customer channels. In general, they think that they lack important marketing and communication skills; strengthening them would help Revertia to efficiently communicate and deliver the value proposition and to better respond to specific customer segment needs. Notwithstanding, Revertia relationships with origin-customers represent a key strength of the circular business model. Indeed, since the company started its activity, they have just lost two customers.

Another SWOT may be referred to refurbished computers, which represent the other key outcome of Revertia circular business model. Strengths and weaknesses associated with this business model are summarised below:

3.3.3.5 Refurbished IT equipment SWOT

The product is not characterised in terms of generic materials or chemical composition because Revertia is not a manufacturing company. However, strengths in the product come from the maximum use of recycled materials from pre- and post-consumer waste and also from third party waste streams, as well as from maximum use of refurbished and repaired parts and components. This is indeed a key aspect that supports the profitability of the business model. If the parts and components for reconditioning computers were necessarily new, the model would not be financially viable. Provided the product is a second-hand product, there are a number of aspects that may be considered

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weaknesses: as such, a refurbished computer is not a durable product, its technical lifetime is limited and the warranty is extended for one year. Currently, the second-hand computer is not designed to be repairable or upgradable. Notwithstanding, Revertia informants consider those as potential opportunities within the scenario of more circular by design EEE products.

The sale of second-hand computers also represents weaknesses in a context of Circular Economy. The value proposition is focused on the product and revenues depend on the transaction. Maintenance and value added services are not linked to this value proposition.

The assessment of the system as a whole indicates that the circular business model benefits from some aspects: repair services and spare parts are widely established in the market, which facilitates securing spare parts; the reuse of co-products and waste streams from Revertia operations is possible due to the close relationship with key partners such as metallic recycling companies. The business model also benefits from the existing network of collective schemes and the recycling infrastructure that covers all components of second-hand computers at their end of life. However, currently, Revertia does not have full visibility on the actual effectiveness or on the destination of material recycling from its products recovered at end of life.

Figure 13 below summarises the mains Strengths and Weaknesses derived from the internal analysis of Revertia business model. Opportunities and Threats are based on the contextual analysis described in Sections 2.2. and 3.2.

FIGURE 13. SWOT ANALYSIS OF REVERTIA BUSINESS MODEL RELATED TO RE-MAKE CEBM

Strengths	Weaknesses
• Training and team expertise • First mover advantages (pioneering company) • Participation in R&D projects • Unique differentiated service values and well-regarded by origin-customers (long-term relationships) • Agreements with collective schemes	• High dependence of preparation for reuse on the lineal model: dependence on e-waste flow conditioned by seasonality and peaks in the economic cycle • High dependence of revenues on collective schemes (EPR), which lack transparency • Limited revenues coming from second-hand products sales at present
Opportunities	**Threats**
• Legislation promotes reuse and recycling by setting specific targets • Growing sensitiveness for responsible consumption and sustainability	• High competition - mature recycling market • Illegal scrap dealers • High bureaucracy and regulation complexity • EEE manufacturers are not in favour of reuse • The EEE sector sells more complex products • Uncertain performance and lack of transparency of collective schemes (EPR) • Lack of information on the secondary raw materials market

Source: own research

3.3.4 Final assessments

Revertia's business model has been analysed as the “Re-make” pattern among those identified by the R2PI project. As aforementioned, Revertia is a WEEE management company and it carries out reuse preparation activity as a separate business, i.e. without specific agreements with EEE manufacturing companies. Therefore, their capacity to act in relation to Circular Economy is limited to exploiting a gap: sorting equipment from e-waste that can be reused and finding a second-hand market for it.

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Throughout section 3, the strengths and weaknesses of Revertia circular business model have been analysed from different perspectives. Likewise, barriers and opportunities have been identified. The most important of them are summarized below, referring mainly to the CEBM and only secondarily to Revertia:

From the point of view of the broad context of the WEEE recycling and reuse sector, the regulatory and legal framework is the most relevant conditioning factor. By setting specific targets for reuse and recycling, the WEEE Directive and the Spanish RD 110/2015 create, in principle, an opportunity for the development of business models focused on reuse. Within this context, the establishment of collective EPR schemes can be seen as an enabler because EEE producers are obliged to finance the end of life of products sold to the market. They therefore support the establishment of reuse and recycling businesses. However, the concrete functioning of these schemes presents certain characteristics that end up becoming barriers for the reuse and recycling businesses: the lack of transparency regarding the products managed, the costs of reuse and recycling, the heavy bureaucratic burdens, different legislations within territories for the transfer of waste, etc. In addition, the EPR leads EEE manufacturers to focus on the products end-of-life, rather than on developing new strategies aimed at designing EEE for durability, upgradability, reparability, etc.

Given the economic and market context, there are a number of factors that pose a threat to the "Re-make" pattern. The WEEE recycling industry is very mature in Spain and therefore, there is a high competition for the collection of e-waste. Besides the lack of information on the value of secondary raw materials, the model focusing on reuse faces certain difficulties.

With regard to the technological aspects, the rapid obsolescence and continuous developments in the EEE sector allow for a continuous e-waste stream, which ensures that inputs are obtained by companies dealing with the "Re-make" CEBM and carrying out preparation for reuse activities. However, these same factors can become a threat, making the product suitable for reuse unable to find a demand in the outlet market –due to obsolescence even for the second-hand market. In relation to processes, the activity of preparation for reuse presents currently the disadvantage of being highly manual. Further development of technologies to sort and efficiently and effectively decide the destination of products is needed.

The evaluation of Revertia's circularity also allowed identifying a number of internal weaknesses and strengths. The key ones will be highlighted next, in accordance to the Re-make CEBM. On the one hand, preparation for reuse supports the circularity of the EEE sector by extending the shelf life of products that would otherwise be discarded. Thus, the strength of the product lies in the extension of the life of a product previously considered waste, as well as in the integration of parts and components that were also discarded.

However, preparation for reuse is not a definitive solution. And in fact, the weaknesses of the model are related to the limited control that an organisation like Revertia has over the conception of the products. Therefore, because of not being a manufacturer, there is no possibility of affecting the design, durability, upgradability, reparability, and so on of EEE products. The lack of agreements with manufacturers of EEE products means that organisations such as Revertia carry out the activity independently, exploiting a gap, and they need to seek a second-hand market for the products that they recondition or remanufacture. But this does not guarantee that the product, at the end of its limited extended shelf life, will return to the source, and thus closing the loop. In the best of cases, the equipment will be disposed of and adequately treated by WEEE managers.

The system in which the "Re-make" CEBM is based is dominated by companies in the recycling sector, which are very mature and therefore, they set an important level of competition for the collection of e-waste. The repair activity, aimed at prolonging the useful life of the equipment before it is discarded, is also well established in the market. As far as EEE manufacturers are concerned, the existence of collective schemes based on the EPR obligation implies a certain opportunity for the "Re-make" CEBM. However, it is also a limited way to respond to the challenge of the Circular Economy because those

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collective schemes do not lead to better design, transparency, durability, etc. of the products EEE manufacturers put on the market.

In this sense, discussions with Revertia and the evaluation of its business model allows the identification of more ambitious options for a higher level of circularity. In particular, further circularity could be achieved through greater integration in the system. Through agreements with EEE manufacturers, many companies might become intermediary agents for the repair, refurbishment, and remanufacturing of equipment. Even agreements between manufacturers and recycling companies might support more closed loops, facilitating the recovery of components at the end of the products extended life cycle and introducing them in the productive processes of EEE manufacturers.

The “Re-make” CEBM that has been analysed in this report is perfectly replicable and scalable. Indeed, as long as the linear model remains dominant, preparation for reuse will remain a better solution for discarded EEE products than recycling. In addition, by acting at the level of the consumer (both private and public), it is possible to expand the market for second-hand products. However, the model also faces some challenges, namely: seasonality and economic cycles peaks that affect the WEEE flow; lack of information from EEE manufacturers that can be essential to make a decision on preparing for reusing or recycling; risks of inadequate management, transportation and storage of WEEE before being delivered to treatment facilities; and WEEE leakages due to illegal scrap metallers networks and irresponsibility of final consumers.

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4 Discussion & Conclusions

In this report the analysis of the Circular Economy Business Model of Revertia, focused on the preparation of IT equipment for reuse has been presented. The company is an authorised WEEE manager that has been able to exploit a market opportunity focused on offering value-added services to corporate users of IT equipment. In short, through the responsible collection and management of WEEE, Revertia obtains a flow of equipment that is prepared for reuse. Thus, through a series of processes aimed at reconditioning the equipment, Revertia obtains a second hand product, with a 1-year warranty, which is sold through specific channels to second hand consumers or donated –in those cases in which it is decided by the origin-customer.

The main strength of the Revertia business model, which is classified as a "Re-make" CEBM following the R2PI framework, is meant by extending the useful life of EEE products. The reuse of products is much more preferable than recycling in terms of the waste hierarchy. As shown in the report, reuse of IT computers generates several environmental, economic and social benefits in comparison with a recycling scenario. However, the model is clearly dependent on the linear paradigm of EEE production and consumption.

Throughout the report, based on the use of different methods, enablers and barriers have been described. In this concluding section, the key enablers and barriers are synthetized:

Among the enablers, the existing regulatory framework should be first highlighted. The WEEE Directive 2012/19/EU and, above all, its transposition in the Spanish State, RD 110/2015, by setting specific targets for recycling and reuse, favour the activity of the businesses in the sector. However, this is not enough for efficient and effective market and fully circular models. In fact, the current collective schemes according to the EPR obligation in Spain and other European countries suffer from a lack of transparency and do not encourage EEE manufacturers to make a greater effort in designing products that are more circular, durable, modular, easy to repair, etc.

The regulatory framework considers e-waste as dangerous waste; thus, it also creates (especially bureaucratic) obstacles to the preparation for reuse model by requiring stricter requirements than repair activities, although the activity itself does not differ much in many cases.

Technological change in the EEE sector can be seen as an enabler of the "Re-make" business model. The rapid renewal of products means that there is a flow of products that can extend their life before they are discarded. In this sense, the existence of a demand for second-hand products can be considered another important enabler of the business model and conversely, the lack of demand, an obstacle to the model.

The EEE sector is highly technological. However, the "Re-make" CEBM analysed in this report, which focuses on preparation for reuse of discarded IT equipment, is not particularly dependent on technological advances. Most of the processes are manual, except for the secure deletion of data. In this sense, technology could be an enabler if it allowed a higher level of processes automation as well as better tracking of EEE products and components.

The "Re-make" CEBM is easily replicable and transferable. Indeed, the model has a great potential in the context of the incumbent linear paradigm and can extend the useful life of EEE products. However, it is also necessary to bear in mind that the "Re-make" pattern is subject to competition from the very mature WEEE recycling industry. For this reason, the philosophy of the model could be used to make a more ambitious proposal for circularity, which we indicate below as recommendations for companies.

Business guidelines

Companies that may want to adopt circular business models such as the Re-make should focus their efforts on establishing agreements with other agents in the EEE value chain. The ideal model would

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be to reach agreements with the manufacturers themselves in order to extend the useful life of their products and finally support the final recovery to obtain the valuable components remaining in them.

Some key issues for companies adopting this model are:

- Necessity of manufacturing processes transparency for further reparability and remanufacturing;
- Identification and decision making at source on the expedience of preparing EEE for reuse;
- Careful handling and management of the EEE, ensuring product traceability;
- Include used and recycled components in products prepared for reuse;
- Extend the responsibility at the reused product end of life.

Moreover, the case analysed allows to indicate a series of recommendations to promote the business model focused on reuse, associated with the "Re-make" pattern defined in the R2PI framework.

Policy recommendations

- Firstly, it is necessary to take actions at the level of the EEE conception, reinforcing the obligations of EEE producers to promote eco-design, modularity and greater durability of these products. This can be done through different measures, such as stricter eco-design obligations and the correction of weaknesses associated with current EPR schemes.
- Secondly, there is a need to improve the management of the equipment during its lifetime. Therefore, establishing incentives for products to be repaired and upgraded. This includes the establishment of transparent information systems by manufacturers, incentives for reuse and second-hand sales, promotion of service-based models for these products, etc.
- Thirdly, it would also be appropriate to address the end of life of EEE with more specific measures to promote the recovery of valuable components. In this context, measures to encourage users to take responsibility for EEE, such as clear handling and disposal instructions for discarded products, and to encourage producers to set up systems for the recovery of their products at the end of their life.
- Fourthly, to clearly address issues related to illegal e-waste trade in and across territories. To this aim, besides clear mechanisms for traceability, a strict inspections and penalties system should be set.

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Appendix A: Revertia business context analysis tool

DRIVER						Please, rank the following according to how much of a driver / barrier you think they represented for implementing your CEBM (put an X where appropriate)	BARRIER					
Not at all important	Slightly important	Moderately important	Very important	Extremely important	N/A		Not at all important	Slightly important	Moderately important	Very important	Extremely important	N/A
			X			CE roadmap / initiative at the national / regional / local level						
		X				Setting of end-goals and monitoring (CO_2, noise, movements) at the national / regional level						
						Activity permit (license)				X		
						Warranties law (e.g. second-hand products)			X			
						Intellectual property rights (e.g. components susceptibles of being reused)			X			
						International trade agreements (e.g. requirements in certain markets)			X			
					X	Dramatic change in a target market regulation (e.g. banning the use of plastic bags in China)						
						Competition regulation (e.g. positive discrimination for CE products is not permitted in public procurement)				X		
						Public subsidies that support linear economy (e.g. subsidies to fossil fuels, car purchase incentives)		X				
				X		Resource efficiency targets, requirements of reusing percentage of components and raw materials in new products						
			X			Waste regulation, recycling regulation, water regulation, energy regulation and choice restriction						
			X			End of life regulations						
					X	Mandatory take-backs						
			X			Extended Producer Responsibility						
			X			Material and design standards (national and across industries)						
						Controls and penalties (e.g. controls and sanctions on the use of specific products)		X				
			X			Fiscal measures (green taxes): land-value taxes, value-extracted tax, product levy and recovery rewards			X			
			X			Differentiated VAT rates (e.g. products with high recycled content included among VAT reduced goods)						
			X			Green public procurement (e.g. performance procurement by public sector)						
		X				Public subsidies for eco-innovation, eco-design						
	X					Public support for demonstration and commercialisation of innovation in Circular Economy (technology platforms, pre-commercial procurement, lead markets)						
						Availability or prices of raw materials that support linear economy (water and energy included)				X		
			X			Availability or prices of raw materials and products that support CE						
			X			General economic "health"of incumbent companies in a sector (crisis, decline, stability, growth)						
						Competition trends in the market			X			
			X			CE-supportive business environment (technology providers, advanced services, eco-design businesses…)						
			X			Relevant and expanding CE / environmentally oriented market segment in the country / region						
				X		Market purchase capacity						
						Suitable infrastructure for recycling and recovery / other (e.g. supporting shared use)			X			
						IT-infrastructure (supporting transparency and information sharing; joint collection systems; match-maker mechanisms)			X			
			X			Extensive raw materials information service						
			X			Funding opportunities / venture capital for CE-related investment						
		X				(Green) lending programmes from banks						
	X					Apropriated technologies for CE						
	X					Major technological trends in the sector; new sectoral developments						
		X				R&D capacities and strengths (innovation agency, university research groups supportive to CE)						
			X			R&D capacities and strenghts in green energy						
			X			Public support for CE-related R&D (new materials, new products/services, supply chain resource tracking)						
				X		Training in CE-oriented activities						
						Rural vs urban distribution of population				X		
				X		Ratio of young vs old population						
				X		Social attitudes towards waste and recycling in the country			X			
				X		Social attitudes towards eco-friendly production and consumption in the country			X			
						Social attitudes towards water use in the country	X					
	X					Social attitudes towards energy use in the country						
						Social movements pressure regarding environmental problems (NGOs, civil society)	X					
						Preference for green brands / products, services by consumers in the country			X			
						Perception of environmental problems by businesses in the sector / country				X		

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Appendix B: Revertia business model circularity

		Tending towards LINEAR model	N/A	1	2	3	4	5		Tending towards CIRCULAR model
PRODUCT	1	We have not characterised the identity of our products in terms of generic materials (e.g., aluminum, polyethylene, steel etc.)		X						The product is 100% characterized by its generic materials (e.g., aluminum, polyethylene, steel etc.) and/or product categories and names (e.g., coatings, paints, detergents, seating furniture).
	2	We have not assessed the chemical composition of materials (recycled materials included) used within our product.		X						We have fully assessed the chemical composition of all materials (recycled materials included) used within our product.
	3	We do not seek to use recycled materials in our product						X		We maximise the use of recycled materials from pre- or post consumer waste in our product and source these from outside of the manufacturer's facility.
	4	We do not seek to use third party co-product or waste streams as an input to our own production						X		We maximise the use of third party co-product or waste streams as an input to our own production
	5	We do not seek to use remanufactured, refurbished, or repaired parts and components within our products						X		We maximise the use of remanufactured, refurbished, or repaired parts and components within our products
	6	We do not not seek to use rapidly renewable materials in our product	X							We maximise use of rapidly renewable* materials in our product
	7	We do not not seek to use compostable/biodegradable materials in our product	X							We maximise use of materials in our product that are commonly known to biodegrade or are able to undergo biological decomposition
	8	We do not consider the 'recyclability' of materials used in our products	X	X						We only use materials in our products that are proven to be technically and economically recyclable (e.g. non-toxic, separatable into material streams, etc.)
	9	Planned obsolescence is built into product design	X							Product is designed for durability
	10	Product technical lifetime is below industry average	X							Product technical lifetime is above industry average
	11	Product functional lifetime is below industry average	X							Product functional lifetime is above industry average
	12	Product warranty period is below industry average	X							Product warranty period is above industry average
	13	Product is not designed for disassembly to enable component/material recovery or reuse; nor is it biodegradable	X							Product is designed to be economically disassembled enabling component/material recovery or reuse; OR is biodegradable with no further intervention needed to reclaim the nutrients
	14	Product is not designed with the intention to return to a 'technical' or 'biological' cycle, nor is there a defined plan for product recovery and reutilization.	X	X						Product designed to return to a 'technical' or 'biological' cycle, and a plan for product recovery and reutilization is defined.
	15	Product is not designed to be repairable	X	X						Product designed to be economically repairable (by user or third party)
	16	Product not designed to be upgradable	X	X						Product designed to be upgradeable, adapting to changing customer needs (e.g. by being modular, via software upgrades, etc.)
	17	Re-manufacturing is not taken into account in product design	X	X						Product is designed to be economically re-manufactured
BUSINESS MODEL	18	Revenue driven mainly by asset sale		X						Revenue driven mainly by monetising usage and/or performance of asset
	19	Value exchange mainly focused on driving a product sale transaction (e.g. competitive price)		X						Value exchange focuses on customer lifetime benefit (including reducing/controlling cost of ownership; asset performance)
	20	Value proposition focuses on the product		X						Value proposition is positioned as a service (including product/service bundle)
	21	Value proposition does not include maintenance or other value-added services				X				Value proposition includes bundled maintenance or other value-added services
	22	We do not seek to reuse and put back into our production the co-products or waste streams from our operations.						X		We maximise the reuse of co-products or waste streams from our operations, putting them back into our production.
SYSTEM	23	Repair services and availability of spare parts are not actively established						X		Repair service network and spare parts are actively established in the market
	24	Re-manufacturing services not actively established in market						X		Re-manufacturing services actively established in market (own, or third party)
	25	We do not seek to reuse co-products or waste streams from our operations as an input to third party production (e.g. through direct or indirect supply relationships)						X		We maximise the reuse of co-products or waste streams from our operations by supplying them to third parties as an input into their production (e.g. through direct or indirect supply relationships)
	26	We do not have in place a take-back or recovery scheme for our products at end-of-life (own or via a third party)		X						We have in place a take-back or recovery scheme that fully covers all our products at end-of-life (own or via a third party, e.g. EPR arrangement)
	27	We do not have in place a take-back or recovery scheme for components our products at end-of-life (own or via a third party)		X						We have in place a take-back or recovery scheme that fully covers all components from our products at end-of-life (own or via a third party)
	28	We do not have in place a recycling arrangement for materials within our products at end-of-life (own or via a third party)				X				A recycling infrastructure is widely available for this type of product, and the material is already commonly recycled in practice with no special disassembly required
	29	We do not provide incentives to return our product at end-of-life		X						We provides incentives to return our product at end-of-life (e.g. deposit, exchange, cash)
	30	We have no visibility on the actual effectiveness of our product take-back at end-of-life		X						We have full visibility on the actual effectiveness of our product take-back at end-of-life
	31	We have no visibility on the destination of our products taken back at end-of-life		X						We have full visibility on the destination of our products taken back at end-of-life
	32	We have no visibility on the actual effectiveness of material recycling from our products recovered at end-of-life		X						We have full visibility on the actual effectiveness of material recycling from our products recovered at end-of-life
	33	We have no visibility on the destination of materials recycled from our products at end-of-life		X						We have full visibility on the destination of materials recycled from our products at end-of-life

Notes

6 'Rapidly renewable' is defined as being harvested in cycles of 10 years or fewer, or from controlled growth forestry plantation such as FSC and PEFC]

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Appendix C: Revertia business model (WEEE services) strengths & weaknesses

		Weaknesses	N/A	1	2	3	4	5	Strengths
Value Proposition									
	1	Our value proposition leaves significant customer segments' needs unmet					X		Our value proposition fulfils all significant needs of target customer segments
	2	Customer satisfaction is low						X	Customer satisfaction is high
	3	Our value proposition has no network effects					X		Our value proposition has strong network effects
	4	Our charging and pricing models don't meet customer needs and expectations					X		Our charging and pricing models effectively meet customer needs and expectations
	5	*We do not capture 'sustainability value' created for customers*					X		*We fully capture 'sustainability value' created for customers*
Cost/Revenue									
Margins	6	Our margins are low compared with competitors					X		Our margins are high compared with competitors
Revenues	7	Our revenues are unpredictable			X				Our revenues are predictable
	8	Each sale requires additional effort						X	Each sale generates follow-on recurring revenue / repeat purchases
	9	We earn no revenue before incurring costs of goods/services sold		X					We earn revenue before incurring costs of goods/services sold
Costs	10	Our costs are unpredictable						X	Our costs are predictable
	11	Our product cost structure is substantially higher than that of competitors			X				Our product cost structure is substantially lower than that of competitors
	12	Our service cost structure is substantially higher than that of competitors				X			Our service cost structure is substantially lower than that of competitors
	13	Our cost structue has low economies of scale						X	Our cost structure has high economies of scale
	14	Our cost structure is asset-heavy and costs are mainly fixed						X	Our cost structure is asset light and costs are mainly variable
	15	Our cost to serve customers is misaligned with customer segments		X					Our cost to serve customers is aligned with customer segments
Operating Model									
Key Activities	16	Our key activities can be easily copied by competitors				X			Our key activities are hard to copy by competitors
	17	Our key activities need significant investment in order to scale with growth			X				Our key activities easily scale with growth without needing significant investment
	18	Our key activities do not fulfil the core competencies we need						X	Our key activities match the core competencies we need
	19	*Our key activities poorly support circular economy within our business model*						X	*Our key activities fully support circular economy within our business model*
Key Resources	20	Our key resources do not meet the needs of our business model						X	Our key resources fully support the needs of our business model
	21	*Our key resources poorly support circular economy in our business model*						X	*Our key resources fully support circular economy in our business model*
	22	Our key resources can be easily built or acquired by competitors		X					Our key resources are very hard to build or acquire by competitors
Key Partners	23	Key partners do not provide us with competitive advantage		X					Key partners provide us with exclusive competitive advantage
	24	*Key partners poorly support circular economy within our business model*						X	*Key partners enable circular economy within our business model*
	25	Key partners do not contribute any value to us for free		X					Key partners contribute value to us for free
	26	Customers do not contribute any value to us		X					Customers contribute value to us (for free)
Customer Interface									
Customer Segments	27	We do not understand the full potential value that could be created for customers						X	We understand the full potential value that could be created for customers
	28	Customer loyalty is low						X	Customer loyalty is high
	29	Customer churn is high (customer retention is low)						X	Customer churn is low (customer retention is high)
	30	New customer acquisition rate is low			X				New customer acquisition rate is high
	31	Our market share is shrinking						X	Our market share is growing
Customer Channels	32	Our customer channels do not effectively communicate our value proposition			X				Our customer channels effectively communicate our value proposition
	33	Our customer channels do not effectively deliver our value proposition			X				Our customer channels effectively deliver our value proposition
	34	Our customer channels are misaligned to target customer segments			X				Our customer channels are well aligned to target customer segments
	35	Our customer channels do not effectively reach target customer segments			X				Our customer channels effectively reach target customer segments
Customer Relationships	36	Our customer relationships are weak						X	Our customer relationships are strong
	37	Our customer relationship model(s) are misaligned with customer expectations						X	Our customer relationship model(s) are aligned with customer expectations
	38	Our customer relationship model(s) are misaligned with our value proposition						X	Our customer relationship model(s) enhance our value proposition
	39	Our customers can switch to a competitor at any time						X	Our customers are locked into long-term relationships

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Appendix D: Revertia Re-make CEBM strengths & weaknesses

		Weaknesses	N/A	1	2	3	4	5	Strengths
Value Proposition									
	1	Our value proposition leaves significant customer segments' needs unmet					X		Our value proposition fulfils all significant needs of target customer segments
	2	Customer satisfaction is low					X		Customer satisfaction is high
	3	Our value proposition has no network effects				X			Our value proposition has strong network effects
	4	Our charging and pricing models don't meet customer needs and expectations						X	Our charging and pricing models effectively meet customer needs and expectations
	5	*We do not capture 'sustainability value' created for customers*					X		*We fully capture 'sustainability value' created for customers*
Cost/Revenue									
Margins	6	Our margins are low compared with competitors				X			Our margins are high compared with competitors
Revenues	7	Our revenues are unpredictable		X					Our revenues are predictable
	8	Each sale requires additional effort		X					Each sale generates follow-on recurring revenue / repeat purchases
	9	We earn no revenue before incurring costs of goods/services sold			X				We earn revenue before incurring costs of goods/services sold
Costs	10	Our costs are unpredictable					X		Our costs are predictable
	11	Our product cost structure is substantially higher than that of competitors				X			Our product cost structure is substantially lower than that of competitors
	12	Our service cost structure is substantially higher than that of competitors				X			Our service cost structure is substantially lower than that of competitors
	13	Our cost structue has low economies of scale		X					Our cost structure has high economies of scale
	14	Our cost structure is asset-heavy and costs are mainly fixed					X		Our cost structure is asset light and costs are mainly variable
	15	Our cost to serve customers is misaligned with customer segments	X						Our cost to serve customers is aligned with customer segments
Operating Model									
Key Activi	16	Our key activities can be easily copied by competitors		X					Our key activities are hard to copy by competitors
	17	Our key activities need significant investment in order to scale with growth				X			Our key activities easily scale with growth without needing significant investment
	18	Our key activities do not fulfil the core competencies we need						X	Our key activities match the core competencies we need
	19	*Our key activities poorly support circular economy within our business model*						X	*Our key activities fully support circular economy within our business model*
Key Resou	20	Our key resources do not meet the needs of our business model						X	Our key resources fully support the needs of our business model
	21	*Our key resources poorly support circular economy in our business model*						X	*Our key resources fully support circular economy in our business model*
	22	Our key resources can be easily built or acquired by competitors		X					Our key resources are very hard to build or acquire by competitors
Key Partne	23	Key partners do not provide us with competitive advantage		X					Key partners provide us with exclusive competitive advantage
	24	*Key partners poorly support circular economy within our business model*					X		*Key partners enable circular economy within our business model*
	25	Key partners do not contribute any value to us for free			X				Key partners contribute value to us for free
	26	Customers do not contribute any value to us		X					Customers contribute value to us (for free)
Customer Interface									
Customer	27	We do not understand the full potential value that could be created for customers						X	We understand the full potential value that could be created for customers
Segments	28	Customer loyalty is low		X					Customer loyalty is high
	29	Customer churn is high (customer retention is low)		X					Customer churn is low (customer retention is high)
	30	New customer acquisition rate is low		X					New customer acquisition rate is high
	31	Our market share is shrinking					X		Our market share is growing
Customer	32	Our customer channels do not effectively communicate our value proposition					X		Our customer channels effectively communicate our value proposition
Channels	33	Our customer channels do not effectively deliver our value proposition							Our customer channels effectively deliver our value proposition
	34	Our customer channels are misaligned to target customer segments		X					Our customer channels are well aligned to target customer segments
	35	Our customer channels do not effectively reach target customer segments		X					Our customer channels effectively reach target customer segments
Customer	36	Our customer relationships are weak			X				Our customer relationships are strong
Relationsl	37	Our customer relationship model(s) are misaligned with customer expectations			X				Our customer relationship model(s) are aligned with customer expectations
	38	Our customer relationship model(s) are misaligned with our value proposition				X			Our customer relationship model(s) enhance our value proposition
	39	Our customers can switch to a competitor at any time		X					Our customers are locked into long-term relationships

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[i] The WEEE Directive 2012/19/EU considers that "according to current estimates, a collection rate of 85 % of WEEE generated is broadly equivalent to a collection rate of 65 % of the average weight of EEE placed on the market in the three preceding years."

[ii] http://www.step-initiative.org/Overview_Spain.html#Regulatory

[iii] http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[iv] http://ec.europa.eu/eurostat/statistics-explained/index.php/Computer_and_personal_and_household_goods_repair_statistics_-_NACE_Rev._2

[v] https://www.greenpeace.org/international/press-release/7450/apple-samsung-products-among-least-repairable-in-new-greenpeace-assessment-of-tech-brands/

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