Double Degree Program

Master's Degree in Entrepreneurship and Innovation
Master's Degree in Innovation and Industrial Management

Challenges and organizational capabilities to implement circularity in the automotive industry. A multiple case study

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Abstract

The market for electric vehicles has been growing rapidly in recent years. As a result, the largest share of emissions along the life cycle of vehicles will no longer come from the combustion of waste gases but from manufacturing materials. To cope with this change, implementing the operational principles of circular economy within the business model is an effective solution for vehicle manufacturers. The study therefore aims to identify the challenges that companies in the automotive industry are facing for the circular transition and the organizational capabilities to be used to overcome them.

To achieve the purpose of the research, a multiple case study was used: the sample consists of three automotive companies based in Sweden, whose representatives were interviewed through semi-structured interviews. Using thematic analysis, challenges for the circular transition were identified and grouped into two categories: *business related* and *cultural related challenges*. In addition, organizational capabilities that companies need to use to cope with the transition were identified. These were categorized into 8 categories: *ways to ensure employees' commitment to circularity*, *management skills*, *green culture creation*, *management and people practices for circularity*, *product development and production processes*, *best practices to create circular products*, *relationship with suppliers*, *relationship with other external stakeholders*.

Thus, the contribution of the study is to provide a systematic categorization to the challenges and organizational capabilities for implementing circularity in the automotive industry. In addition, it enables industry players to identify and develop the capabilities needed to gain a competitive advantage in a circular business model.

Keywords: circular economy, circularity, circular business model, capabilities, automotive industry.

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List of abbreviations

AI – Artificial intelligence

B2B – Business to business

BM – Business model

CBM – Circular business model

CBMI – Circular business model innovation

CE – Circular economy

DFR – Design for recycling

GDP – Gross domestic product

ICT – Information and communication technologies

ISO – International organization for standardization

KPI – Key performance indicator

LCA – Lifecycle assessment

OEM – Original equipment manufacturer

PLE – Product life extension

R&D – Research and development

ROI – Return on investments

RPO – Retain product ownership

1 - Introduction

The chapter introduces the topic chosen for this thesis: challenges and organizational capabilities to implement circular economy in the automotive manufacturers' business models. The background and problem formulation sections lay the foundation for introducing the research questions. Finally, the delimitations and structure of the research are presented.

1.1 - Background

The circular economy is a topic we have been hearing a lot about in recent years: the scarcity of resources and the degradation of the environment are forcing us to review the traditional linear model of take-make-dispose production and consumption. With the circular economy, those outputs that were previously seen as waste, now become resources that can create value by redesigning products and extending their life cycle. To transform the economy by eliminating production waste, reusing materials used in production and regenerating the surrounding environment in which the business operates, a decisive step change is needed to put circularity at the heart of business activities (Ahmad, et al., 2023).

The automotive sector is among the pioneers of the circular economy, an indispensable strategy for achieving climate neutrality. It is going through a period of drastic change because of new alliances, cutting-edge products, and access to untapped markets. The automotive sector has the reduction of its environmental impact as its main and inevitable future goal in response to the institutions' need for environmental order.
One strategy to accomplish this goal, though not the only one, is to produce electric and hybrid vehicles with ever decreasing emissions. However, without a fresh perspective on working practices and manufacturing processes that incorporate the disposal and recycling of end-of-life products, true carbon neutrality cannot be reached (World Economic Forum, 2023).

Circularity, especially when considering mobility-as-a-service business models, can increase profitability by 1.5 times along the entire value chain and increase revenue per vehicle by 15-20 times its sales value. This is due to the extension of useful life from

the current three years to more than ten, which is made possible by predictive maintenance and increasingly advanced after-sales services. In addition, the cost structure also improves due to the reuse and recycling of raw materials and modularity-based production. The implementation of circularity is therefore positive for both the more widespread sales-related business model and the increasingly popular mobility-as-a-service models (World Economic Forum, 2022).

By implementing the circular economy, negative externalities on the environment are reduced and sustainable development is promoted. CE represents a new way for companies to create and extract value from their business by exploiting the paradigms of reuse, repair, remanufacturing and recycling. The positive effect of circularity manifests itself not only on the company that implements these practices but on the entire supply chain: the transition to a more sustainable business, one that considers environmental impacts and is concerned with reducing pollution levels, is only made possible through the collaboration of all business partners (Rodriguez-Gonzalez, et al., 2022).

1.2 - Problem discussion

The transition to a circular business model for automotive manufacturers requires a change of strategy of all actors involved. Together with the importance of powertrain electrification, the automotive sector must address pollutants that are inherent in car materials. Considering the widespread use of electric mobility, lifecycle emissions from vehicles will be increasingly ascribed to the materials from which they are manufactured: for this reason, the time to implement circularity in the automotive industry is now (World Economic Forum, 2023). However, the path towards circularity is plenty of barriers and new organizational capabilities need to be developed.

Given the increasing emphasis on the topic, business research has produced a considerable amount of knowledge on the circular economy and its management. The literature review revealed that management scholars have focused on defining the meaning of circular business models, mostly expanding the definition of BM considering the operational principles of the circular economy. Strategies to innovate business models and make them circular were also analyzed: the focus was thus on the

creation of circular business models and their implementation in specific industries. Other scholars have instead focused on enablers and barriers towards the circular transition of business models, providing a categorization based on several levels: from product and process design to value chain management. Additionally, also enablers and barriers at the financial, organizational and market level were analyzed. Nevertheless, few of the existing studies have deepened the role of organizational capabilities for a successful transition to a circular business model and the main challenges to be overcome.

To fill this gap, the author chose to analyze three companies in the automotive sector that have been investing a lot of resources in recent years to make their business circular. The companies examined are Polestar, AB Volvo and Volvo Cars. The targets of these three companies are different segments of the automotive industry. In particular, Polestar deals with the production of full electric vehicles, AB Volvo is the world's largest manufacturer of trucks, buses and construction machinery while Volvo Cars specializes in light vehicles. The choice fell on these three companies to provide a comprehensive view of the challenges they face and the organizational capabilities they deploy for the circular transition: indeed, involving different target segments increases the credibility of the research.

1.3 - Research purpose and research questions

The purpose of this research is to help identify the challenges that automotive manufacturers are facing in transforming their business from linear to circular. In addition, the study aims to identify the organizational capabilities that the companies surveyed are deploying to cope with these challenges and enable the transition towards circular business models.

The study therefore aims to provide evidence on the challenges that automotive companies are facing for the circular transition and on the new organizational capabilities to be developed in terms of human resource management, product development, processes, and relationships within the value chain. Consequently, the author identified the following research questions:

Research question 1:

"What are the challenges to implement circularity in the business models of automotive manufacturers?"

Research question 2:

"What organizational capabilities are required for this implementation?"

The choice of these research questions is because the author wants to fill a gap that exists in the literature on the challenges to implement circularity in the business models of automotive companies and on the organizational capabilities to be developed to address them and succeed in the transition towards the circular economy. At the same time, the results may be useful to practitioners in this industry so that they know what skills and capabilities to be leveraged to implement circularity in their business.

1.4 - Delimitations

There are mainly three delimitations in this research. The first is the fact that the companies under study are all based in Sweden and, although they are now autonomous corporate entities, they share common roots and culture. Another aspect to consider is that the managers interviewed operate mainly in Europe. The results would have been different if executives operating in other socio-cultural contexts had been taken into account. Finally, the results are to be looked at from a purely managerial perspective: the organizational capabilities for the implementation of circularity, in particular those related to the design and production processes of components, are analyzed from a business perspective, leaving out the technicalities.

1.5 - Research structure

As shown in figure 1, this report consists of six sections. In the first, the research purpose is outlined and the research questions are defined. The second section consists of a review of academic papers concerning the circular economy and its application in the automotive industry, circular business models and organizational capabilities for the circular transition. The third section is dedicated to the methodology used to conduct the research: elements concerning strategy and design are discussed, as well as the

method used to collect and analyze data. The fourth chapter presents the results of the interviews conducted with representatives of the surveyed companies. The following chapter aims to discuss the empirical results by relating them to the theory. Finally, Chapter 6 highlights the results obtained from this research and presents aspects worth analyzing in future research.

Figure 1 Research structure

2 - Literature review

This chapter, divided into four sections, represents the theoretical foundation for conducting the research.

The first section provides an overview of the circular economy and its operating principles. The 6R framework is presented, which on the one hand provides the course of action that companies must follow to make their business circular, and on the other identifies potential new sources of value creation.

The following section is devoted to circular business models; a definition is provided, four strategies for their implementation are presented, and how they impact value proposition, creation and capture is analyzed. Finally, barriers to circular business model innovation are examined.

The third section focuses on circularity in the automotive industry, with special reference to enablers and barriers.

In the last section, three dimensions of organizational capabilities for making business circular are identified and a categorization is provided.

2.1 - Circular economy

2.1.1 - Limits of linear consumption

The current production and consumption model is linear and follows a take-make-dispose pattern. Companies extract raw materials, put them through a transformation process using labor and energy, and then sell the finished product to the end consumer who, at the end of its useful life, disposes of it (Ellen MacArthur Foundation, 2013). The approach behind this model is to consider resources as unlimited and therefore use processes with open flows of energy and materials, followed by outflows of pollutants such as greenhouse gases, wastewater, and processing waste (ISPRA, 2018). In order to make the most of the current production paradigm, numerous efforts have been made to improve the efficiency of the resources used in the system. These efforts are not sufficient to improve significant losses throughout the value chain as these are inherent in any system based on consumption rather than the restorative use of resources (Ellen MacArthur Foundation, 2013).

Throughout the last century, low commodity prices favored the growth of the economies of developed countries. In fact, the cost of resources was very low compared to the cost of labor and as a result, immoderate use of them was made, especially electricity, in order to create capital intensive production processes and lower labor costs. All this without taking into account the negative externalities generated and the waste of limited resources (Toni, 2015).

The linear production model is characterized by resource losses at several points in the value chain. The Ellen MacArthur Foundation (2013), in its book *Towards the circular economy*, has identified the sources of loss typical of the take-make-dispose model.

Waste in the production chain. During the production of goods, many of the materials extracted do not actually enter the production cycle. The Sustainable Europe Research Institute estimates that each year 21 billion tons of extracted materials are not incorporated into the final product (Ellen MacArthur Foundation, 2013).

End of life waste. The recovery rate of materials at the end of their first functional cycle is rather low: in 2010, only 40 per cent of the 23 billion tons of waste that was generated in Europe was then reused, recycled, composted or digested (Ellen MacArthur Foundation, 2013). According to 2020 statistics, this figure is gradually improving but some countries are ahead of others: from Germany, with 67.1% material recovery waste, to Portugal, which recovers only 27.6% of waste (Tiseo, 2023).

Energy use. In the take-make-dispose model, the disposal of waste in a landfill result in all the residual energy incorporated in it being lost. Incineration and recycling are energy-intensive processes and allow only a small part of the residual energy to be recovered. Reuse, on the contrary, allows much more energy recovery (Ellen MacArthur Foundation, 2013).

Erosion of ecosystem. Following the linear model, humanity currently consumes more than the Earth's ecosystems can sustainably produce, and this generates a reduction in natural capital. The current growth model is generating irreversible effects on the ecosystem: melting glaciers, rising sea levels, depletion of timber and fuel stocks, and declining agricultural productivity. All this not only generates systemic damage, but also leads to a waste of financial resources for activities related to soil conservation and flood prevention (Ellen MacArthur Foundation, 2013).

In today's context of rapid population growth, geopolitical risks, globalized markets and climate change, a production and consumption model characterized by all these losses is no longer sustainable. In particular, emerging powers such as China and India are experiencing strong population growth and likewise increasing GDP per capita. This will lead to an increase in middle-class consumers to around 3 billion by 2030 (McKinsey Global Institute, 2011), an increased demand for consumer goods and an exponential increase in the demand for commodities, resulting in higher prices and volatility. Moreover, some of the key raw materials, and the conflict between Russia and Ukraine is a very current example, are located in highly unstable countries, whose domestic and foreign policy decisions could make access to resources even more difficult. At the same time, the integration of financial markets and the ease of transporting goods means that a price shock at the local level resonates worldwide and an issue that is local becomes global. Lastly, climate change is leading to a decrease in the availability of fresh water and a reduction in arable land, thus constricting the supply of agricultural products (Ellen MacArthur Foundation, 2013).

The linear system does not fit the current scenario since, by not taking into account the limited resources available, it exposes companies and consumers more to the risks of increasing resource costs and increased volatility (Ellen MacArthur Foundation, 2013). It is necessary to identify a new development paradigm in which GDP growth is decoupled from the exploitation of virgin raw materials (ISPRA, 2018).

2.1.2 - New economic model: from linear to circular

The linear model can be optimized and made more efficient but as long as process waste, pollutants and waste are not eliminated, production and consumption will continue to generate negative externalities (Toni, 2015). In contrast, the circular economy is based on an industrial economy that is regenerative, exploits renewable energies, minimizes and, when possible, eliminates the use of toxic substances and eradicates waste through careful product design (Ellen MacArthur Foundation, 2013). The aim of the circular economy is to preserve the highest intrinsic value of materials and to keep products and components within cycles as long as possible to reduce waste and minimize the use of virgin raw materials (Ekins, et al., 2019). This lays the foundations for sustainable development that aims to create an environment of quality

and economic prosperity, in accordance with the principle of generational equity (Dey, et al., 2020). Indeed, circular practices have a positive impact on resource productivity and consequently on economic growth (Vuță, et al., 2018): these would lead to total savings of EUR 630 billion in Europe alone (Herrero-Luna, Ferrer-Serrano, & Pilar, 2022).

In summary, the CE is "*an economic system based on business models that replace the concept of end-of-life with the reduction, reuse, recycling of materials used in production and consumption processes, operating at the micro-level (products, companies, consumers), meso-level (eco-industrial parks) and macro-level (city, region and nation), with the aim of achieving sustainable development, creating environmental quality, economic and social prosperity that benefits current and future generations*" (Kirchherr, Reike, & Hekkert, 2017). In order to successfully implement the circular economy, the process must start with the companies, at the micro-level, thus laying the foundation for implementation at the meso and macro-level (Kumar, et al., 2019). To this end, the 6R framework, an evolution of the 3R framework, defines a course of action for companies (Kumar, et al., 2019). The 6R stands for *reduce*, *repair*, *reuse*, *recover*, *remanufacturing* and *recycling*. According to this framework, companies must *reduce* their environmental impact by using fewer resources so that there are fewer emissions and waste during the product life cycle. The product must be conceived and designed to minimize its environmental impact: the design aims at conserving resources and slowing down their flows (Ghisellini & Ulgiati, 2020). This is made possible by design for product integrity (to avoid obsolescence of products and components) and design for recycling (to avoid obsolescence of materials) (den Hollander, Bakker, & Hultink, 2017). With the *repair* strategy, a damaged or worn-out product is brought back into service by replacing components or fixing existing ones. *Reuse* consists of using the product, retaining its original function, several times in multiple cycles. *Recover*, on the other hand, involves dismantling the original product and sorting its components, which then become part of a new system. With *remanufacturing*, companies subject the used product to a process of restoration to its original state by reusing existing parts and replacing those that no longer function or are aesthetically unacceptable. When the previous actions cannot be pursued, *recycling* is a good

alternative that allows the raw materials constituting a product to re-enter the economic cycle, avoiding landfill and incineration (Ghisellini & Ulgiati, 2020).

What results from the application of the 6R framework is summarized in the butterfly diagram illustrating the continuous flow of materials in a circular economy (Ellen MacArthur Foundation, 2013).

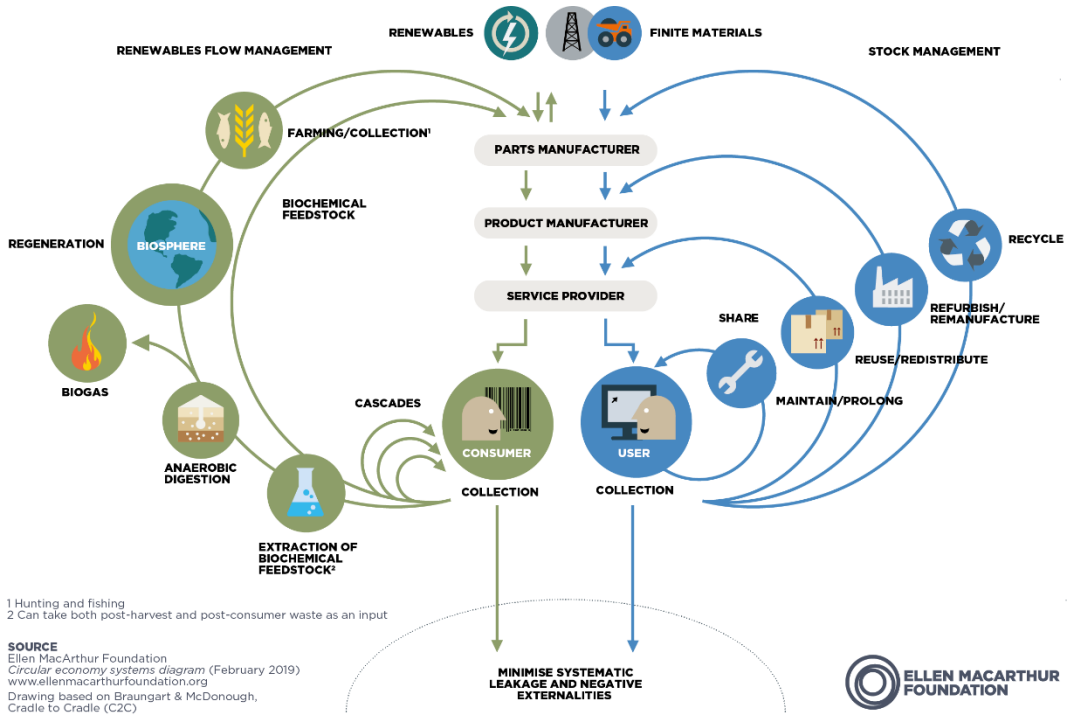

Figure 2 The butterfly diagram
Source: Ellen MacArthur Foundation. (2013). Towards the Circular Economy

The butterfly diagram is a visual representation of the CE: the diagram depicts a butterfly, with its wings representing the biological cycle and the technical cycle.

The biological cycle is a regenerative system, where biological materials are used and then returned to the earth, either through composting or natural decomposition. In this cycle, nutrients are regenerated and reused, creating a closed-loop system that mimics natural ecosystems. The biological cycle includes agriculture, forestry, and fishing, as well as food and organic waste management.

The technical cycle, on the other hand, is a restorative system that uses non-biological materials and keeps them in use for as long as possible. This cycle aims to minimize the consumption of non-renewable resources by reusing and recycling materials, thereby reducing the need for new raw materials.

The butterfly diagram emphasizes the importance of a systemic approach to resource use and waste management. It shows how the cycles of nature, and the cycles of human production can be interconnected and mutually supportive, leading to a more sustainable and resilient economy.
Through this powerful visual representation of the circular economy concept, it can be seen how the two cycles of the economy can work together to create a more sustainable and resilient system, where waste is minimized, resources are conserved, and ecosystems are protected (Ellen MacArthur Foundation, 2013).

2.1.3 - Operating principles of circular economy

The circular economy involves careful management of the material flows of which each good is made. The materials are divided into biological nutrients, which at the end of the product's useful life return to the biosphere to regenerate natural capital, and technological nutrients, which are designed to last and circulate through a functional service in which producers sell the use of the product while retaining ownership. This allows them to retain control over the products and, at the end of the first life cycle, they can use their components to generate new goods. In fact, the aim of the circular model is to design goods that are easily disassembled and constructed from reusable materials to minimize waste and landfill (Ellen MacArthur Foundation, 2013). The Ellen MacArthur Foundation (2013) has outlined operational principles for the transition to a circular economy:

- *Design out waste.* When a product's biological and technical components (or "nutrients") are consciously created to be disassembled and repurposed as part of a biological or technical materials cycle, waste is not present. The biological nutrients can be easily composted because they are non-toxic. Technical nutrients - polymers, alloys, and other synthetic materials - are made to be reused repeatedly while requiring the least amount of energy and retaining the greatest levels of quality (whereas recycling as commonly understood results in a reduction in quality and feeds back into the process as a crude feedstock).
- *Build resilience through diversity.* In a world that is uncertain and changing quickly, it is important to prioritize traits like modularity, versatility, and adaptability. Diverse systems with numerous linkages and scales are more

resilient to external shocks than systems designed only for efficiency; excessive throughput maximization leads to fragility.

- *Rely on energy from renewable sources.* Any circular loop should begin by considering the energy required for production. Ultimately, systems should strive to be powered by renewable energy.
- *Think in systems.* Understanding how different components interact with one another within a larger whole, as well as how the total relates to its constituent parts, is essential. The relationship between an element and its infrastructure, environment, and social context must be taken into account.
- *Waste is food.* In the circular model there is no waste, every waste, whatever its nature, is valorized so that it becomes an input for another production process.

The implementation of a circular economy can bring numerous benefits, including reducing waste and pollution, increasing resource efficiency, and stimulating economic growth. By reducing waste, the circular economy can help address environmental challenges, such as climate change, water scarcity, and air pollution. Moreover, it can contribute to the conservation of natural resources, such as water, minerals, and forests, by reducing the demand for primary materials. The circular economy can also create new business opportunities, foster innovation, and increase competitiveness by promoting resource-efficient practices (OECD, 2021).

For the implementation of these principles, various approaches have been identified in the literature including the promotion of product life extension, material substitution, and resource recovery. Product life extension, for example, involves designing products that are durable and repairable, reducing the need for replacement and waste generation. Material substitution involves replacing unsustainable materials with more sustainable ones, such as bioplastics, to reduce the demand for finite resources. Resource recovery involves the collection, treatment, and reuse of waste materials to conserve resources and reduce environmental impacts (Bocken, et al., 2014).

2.1.4 - Value creation in circular economy

The 6R framework lays the foundation for identifying potential sources of economic value creation in the circular model. Depending on the product, the components and the type of material used, one strategy may be more advantageous than the other. Nevertheless, the Ellen MacArthur Foundation (2013) has identified four models for value creation that can be applied independently of product and stage in the value chain.

Figure 3 Power of the inner circle
Source: Ellen MacArthur Foundation. (2013). Towards the Circular Economy

Power of the inner circle. This concept refers to the idea that the shorter the cycle, the more successful the strategy. The more the material enters the process near the end of its life cycle, the shorter the cycles are and preserve the value of the product. For example, the repair and maintenance of a product retains most of its value. If it is no longer possible to repair, the individual components can be reused or reconstituted. This retains much more value than material recycling. Short cycles conserve more the integrity and the complexity of a product. Eventually, considering that the material enters again in the process quickly, without undertaken additional processes, the number of externalities generated, such as emissions of greenhouse gases or toxic substances, is significantly reduced (Ellen MacArthur Foundation, 2013).

Figure 4 Power of circling longer
Source: Ellen MacArthur Foundation. (2013). Towards the Circular Economy

Power of circling longer. Maximizing the number of consecutive cycles and/or the time of each cycle of a product (e.g., reusing a product for a number of times or extending product life), avoids the use of material, energy and labor required to create a new product. Value creation benefits from keeping more products, components and materials in the process of the circular economy. This can be done either by going through several consecutive cycles (e.g., reconditioning an engine) or by making a single cycle last longer. These extended uses replace virgin material flows and counteract the dispersion of material out of the active economy (Ellen MacArthur Foundation, 2013).

Figure 5 Power of cascaded use and inbound material/product substitution
Source: Ellen MacArthur Foundation. (2013). Towards the Circular Economy

Power of cascaded use and inbound material/product substitution. Value creation can also be achieved by diversifying reuse through the value chain, i.e., by reusing the material in successive cycles belonging to different industrial sectors. For example, a cotton suit is first reused as second-hand clothing, then it is processed into upholstery for chairs and sofas, next, it is recovered as insulation material in the form of rock wool and finally it is disposed of in the biosphere as a biological nutrient (Ellen MacArthur Foundation, 2013).

Figure 6 Power of pure, non-toxic, or at least easier-to-separate inputs and design
Source: Ellen MacArthur Foundation. (2013). Towards the Circular Economy

Power of pure, non-toxic, or at least easier-to-separate inputs and design. Components should be designed to retain their purity as far as possible so that they can be easily separated and recovered. For greater value creation, a certain level of material purity and good product and component quality is required. Economies of scale and greater efficiency in reverse cycles can be achieved through improvements in the upstream design of products, in order to have greater ease of separation, better identification of the components of a product and materials substitutes (Ellen MacArthur Foundation, 2013). These product and process improvements in reverse cycles generate cost reductions compared to linear processes, preserving higher component quality throughout the cycle, extending material longevity and, thus, increasing system-wide resource productivity (ISPRA, 2018).

These different types of cycles can be applied to all products regardless of the type of components and materials. However, to maximize their benefits, it is important to select the best cycle type also taking into account the different stages of the supply chain (ISPRA, 2018).

2.2 - Circular business model

2.2.1 - Concepts and definitions of CBM

In the literature, there is no single definition of what a business model is. It can be defined as "*the set of elements through which a company creates, transfers to others and at the same time captures to its advantage that value (of various kinds) that, on the one hand, satisfies the needs of its stakeholders and, on the other, allows it to evolve in a physiological manner*" (Fontana & Caroli, 2017) or, in other words, "*a model that describes the logic according to which an organization creates, distributes and captures value*" (Osterwalder & Pigneur, 2010). In short, the business model explains how a company does business (Richardson, 2005).

The business model consists of three interdependent macro-dimensions: value proposition, value creation and value capture (Bocken, et al., 2016). The value proposition comprises the company's product and service offerings, how they are used and a description of the type of customers these offerings are intended for (Baden-Fuller & Haefliger, 2013). The value creation dimension provides an answer to the question of how the company can develop this value proposition. It therefore deals with the internal and external competences of the company, the technical infrastructure and the value generation processes (Clauss, 2017). By examining the costs related to value creation, as well as the revenue sources and models connected to the value proposition, the value capture dimension focuses on the issue of how the company makes money (Baden-Fuller & Haefliger, 2013). The business model concept offers a framework for comprehending how businesses propose, produce, and capture value while implementing the circular economy's principles and practices (Ferasso, et al., 2020). According to the definition by Geissdoerfer et al. (2020), circular business models are those that "*are cycling, extending, intensifying, and dematerializing material and energy loops to reduce the resource inputs into and the waste and emission leakage out of an organizational system. This comprises recycling measures (cycling), use phase extensions (extending), a more intensive use phase (intensifying), and the substitution of products by service and software solutions (dematerializing)*". It is useful to elaborate on the second part of the definition in which the four strategies for a circular business model are highlighted:

- Cycling is the process of reusing, remanufacturing, refurbishing and recycling materials and energy within a system.
- Extending resource loops means that the product's use phase is extended by using durable and timeless design, marketing that promotes prolonged use phases, maintenance and repair.
- Increasing resource loops entails enhancing the product's use phase through initiatives like sharing economy and public transport.
- Dematerializing resource loops is the term used to describe the delivery of product utility without hardware, through the use of service and software solutions. For instance, giving services or product service systems in place of tangible things that serve the same purpose for the user can lower the amount of items produced while improving the customer experience.

In other words, companies can create a circular business model using a combination of three strategies (Atasu, Dumas, & Van Wassenhove, 2021).

Retain product ownership (RPO). This strategy consists of leasing the product to the consumer instead of selling it. RPO is particularly suitable for companies that offer complex products with high intrinsic value. This approach requires companies to spend a lot on after-sales support and maintenance services that could be very expensive. RPO can also work with simpler products that are rather expensive but fulfil secondary needs.

Product life extension (PLE). Companies that adopt this strategy focus on designing products that last a long time and consequently have a strong second-hand market. Durability is also a strong differentiator that justifies premium pricing.

Design for recycling (DFR). This strategy consists of designing products and production processes in such a way as to maximize the recovery of the materials involved for use in new products.

The combination of these three strategies depends on how well the company is able to get the product back from the customer and whether it can be transported and remanufactured. To understand which combination of strategies to adopt, companies need to understand how easy it is to get access to the product and how easy it is to

extract the value in it. The matrix below shows the best strategies taking these two dimensions into account (Atasu, Dumas, & Van Wassenhove, 2021).

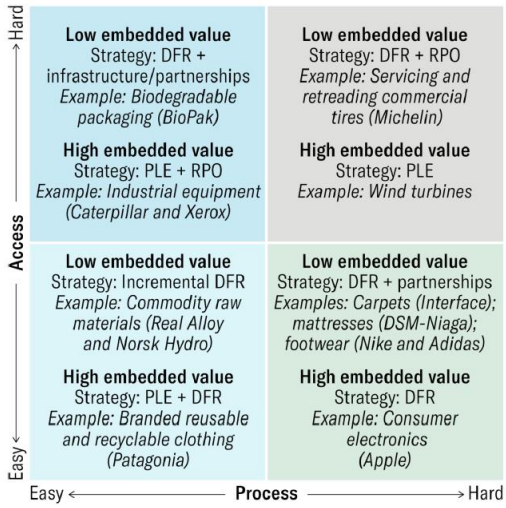

Figure 7 The circularity matrix
Source: Atasu, A., Dumas, C., & Van Wassenhove, L. N. (2021). The Circular Business Model. Harvard Business Review

The products in the top right-hand quadrant are subject to a high level of wear and tear that precludes easy repair and remanufacturing. For products with low embedded value, the best strategies are DFR and RPO. For products with high embedded value, the best strategy is PLE.

Products in the bottom right quadrant are easy to get back because for high embedded value products, companies have created ecosystems with barriers to exit, whereas low embedded value products have no second-hand market. However, these products are characterized by an integral design whose components are difficult to reuse. For these reasons, DFR is the best strategy.

The upper left quadrant includes those products that are difficult to get back due to their use. In the case of low embedded value products, DFR can be used, and one must focus on the creation of adequate infrastructure for the collection and sorting of materials. In the case of high embedded value products the best strategies are RPO and PLE.

The products in the lower left quadrant are usually components for which a solid recycling infrastructure already exists. The strategies to be followed here are more of incremental innovations in terms of DFR and PLE.

It is important to notice that the circular matrix should only be seen as an analysis tool. Indeed, the success or failure of the transition to a circular business model depends on the resources, capabilities and operational limitations of the company (Atasu, Dumas, & Van Wassenhove, 2021).

2.2.2 - Circular business model innovation

Business model innovation refers to the process of modifying current business models or creating entirely new ones to create, deliver and capture value in novel ways (Mitchell & Coles, 2003). From this definition, it is possible to derive that of circular

business model innovation, which is the transition from a linear to a circular business model (Geissdoerfer, et al., 2020). However, this turns out to be rather simplistic and some authors have better defined the concept of circular business model innovation: "*CE-oriented business model innovation incorporates principles or practices from circular economy as guidelines for business model design. It aims at boosting resource efficiency and effectiveness (by narrowing or slowing energy and resource loops) and ultimately closing energy and resource flows by changing the way economic value and the interpretation of products are approached*" (Pieroni, McAloone, & Pigosso, 2019). Four different types of circular business model innovation have been identified in the literature (Geissdoerfer, et al., 2020):

1. *Circular business model transformation*. The current business model is modified in accordance with circular strategies.
2. *Circular start-ups*. In this case there is no starting business model. The CBM emerges outside the boundaries of an existing enterprise.
3. *Circular business model diversification*. The current business model of the enterprise remains unchanged but another one is added that incorporates CE strategies. The latter is either integrated into the organization as a new business or is incorporated as a separate unit.
4. *Circular business model acquisition*. This methodology consists of identifying existing CBMs and incorporating them within the organization through M&A transactions.

These CBMI strategies should not be seen as alternatives but as complementary: for example, a company can hold stakes in circular start-ups (CBM acquisition) and at the same time create an additional circular business model (CBM diversification).

2.2.3 - Circular business model strategies and business model dimensions

Interestingly, the four strategies for a circular business model - cycling, extending, intensifying, and dematerializing - impact the business model in terms of value proposition, value creation and value capture.

As seen in the section on CBMs, cycling involves the implementation of certain strategies such as reuse, repair and remanufacturing. An effective take-back system that enables the company to regain ownership and repurpose end-of-life products into new

resources becomes central in terms of value proposition and value creation (Lüdeke-Freund, Gold, & Bocken, 2019). Consequently, value capture is mainly linked to lower costs than those incurred by using virgin raw materials and higher revenues made possible by the creation of new business lines dedicated to the treatment and distribution of end-of-life products (Bocken, et al., 2016).

Extending is about keeping the product in use as long as possible. The value proposition is characterized by products designed with integrity and easy to maintain. This allows the creation of a long-lasting relationship (value creation) and the sources of revenue are distributed throughout the life of the product by exploiting ad hoc maintenance packages (Bocken, et al., 2016).

By intensifying, new value propositions are created based on sharing models. The product becomes a service and consumers do not pay for ownership but for the use they make of it. Consequently, revenues are not derived from the sale but from the recurring use of the product by a multitude of users (Bocken, et al., 2016).

By enhancing the value produced by intangible solutions, such as service models and software, dematerialization reduces the consumption of physical resources. Value generation is ensured via collaborations and close-loop capabilities. Key aspects of value capture include greater profit margins, recurring revenues, and innovative pricing strategies (Bocken, et al., 2016).

2.2.4 - Barriers to circular business model innovation

There are various barriers to the implementation of circular business models. Analyzing the literature, barriers to CBMI can be categorized into external at the market, institutional and value chain level and internal at the organizational and employee level (Guldmann & Huulgaard, 2020).

At the market and institutional level, there are regulatory barriers. Often, in fact, some materials, such as packaging, are legally considered as waste, which makes it impossible to reuse or recycle them where they were generated (ISPRA, 2018). Furthermore, at European level the nomenclature of waste materials (difference between waste and byproduct) is not uniform, and this makes it more difficult to transfer products for reuse from one country to another (Rizos, et al., 2016). The choice to tax labor rather than the use of raw materials is also among the institutional barriers.

Enabling activities for the reuse, repair, remanufacturing and recycling of materials are labor intensive and consequently involve higher costs than the production of goods from virgin materials (Kissling, et al., 2013). Furthermore, companies hold patents on the components of some products and consequently these cannot be recovered and used by third parties (ISPRA, 2018).

At the value chain level, the most important barriers are the difficulties in ensuring that all actors involved have a circular business (Kissling, et al., 2013) and that returned and recycled products or materials are not of inferior quality (Bocken, Rana, & Short, 2015), which could lead to image damage for the company (Rizos, et al., 2016).

For what concerns the internal barriers at the organizational level, it is worth highlighting the fact that considering environmental issues in product development is often perceived negatively as it could lead to an increase in time to market (Mont, 2002). Another barrier is the need to redesign processes and products from a circular perspective (Sundin, Lindahl, & Ijomah, 2009), which requires considerable investment (ISPRA, 2018). In fact, products are often not designed to be reused or recycled at the end of their life, which means that the residual value at the end of the first use cycle is minimal (Singh & Ordoñez, 2016). The implementation of circularity requires a cultural paradigm shift within the company, at all organizational levels. However, not everyone is willing to accept the change (Rizos, et al., 2016). In this sense, even traditional business performance measurement systems such as ROI and payback period constitute an obstacle to circular business model innovation. By its very nature, CBM hardly meets the requirements imposed on linear business models (Linder & Williander, 2017). An incentive system based on these indicators discourages the implementation of the circular paradigm (Mont, 2002).

Internal barriers at the employee level include a lack of commitment on the part of top management (ISPRA, 2018), poor knowledge about the circular economy in terms of reuse, remanufacturing, recycling etc. and a lack of tools and technical capabilities to create a circular business model (Rizos, et al., 2016).

2.3 - Circularity in the automotive industry

2.3.1 - Paradigm shift towards circularity

The automotive sector has been undergoing a profound transformation in recent years and current trends include the electrification of the range, the transformation of the mobility experience and the transition towards sustainability. These elements are leading automotive companies to review their strategic vision and business models. Circularity is one of the tools to face these new challenges and improve the resilience of the entire value chain. The focus is therefore no longer on sales volumes but on the additional services linked to each vehicle and the improvement of its lifecycle: thus, the amount of revenue per vehicle increases (World Economic Forum, 2020).

Through the implementation of circularity, car manufacturers and suppliers improve their current business models and profitability is no longer only linked to the sale of vehicles, but revenues are spread over the entire product life cycle. This can be achieved either by implementing 'as a service' business models or by exploiting remanufacturing, repair and recycling services for materials and components. The use of recycled raw materials, more standardized production and greater modularity of manufactured vehicles would lead to increased production and sales (World Economic Forum, 2020). For this reason, companies in the sector are already pursuing a number of initiatives related to circularity: from increasing the use of components from recycled materials to large investments in recycling plants, through leasing and mobility-as-a-service. Circularity is thus a way to overcome the challenges posed to current business models, in particular those related to the limited growth potential of revenues from vehicle sales and the increasing reduction of margins due to rising costs caused by the scarcity of raw materials. In fact, by creating high-quality recycling methods for the most important materials for production, the entire supply chain is less volatile, more resilient and predictable (World Economic Forum, 2022).

Circularity changes the way companies extract value from their business: value is no longer extracted only from the sale of the car, but throughout the life of the vehicles. Cost and revenue synergies are created between production, additional and after-sales services, and end-of-life product management. Therefore, the focus shifts from the

optimization of internal processes and operating margins alone, to the efficiency and effectiveness of the entire value chain (World Economic Forum, 2022).

However, the current business models of automotive players are linear and their transformation into circular models implies a drastic paradigm shift for most of them. Players, therefore, need to review their production strategies and their entire supply chain, both with regard to sales and distribution and to the reuse, recycling and remanufacturing of vehicles (World Economic Forum, 2020).

Manufacturers must broaden their perspective, where previously the focus was more on selling end products, the focus must now be on the entire vehicle life cycle. Greater collaboration from all players is required in the value chain, who must work closely together to develop new partnerships based on a clear and transparent exchange of information. The latter is made possible by the creation of common platforms through which to share the data necessary to foster alignment between the various players.

Car manufacturers must therefore develop new capabilities and technologies to govern and manage collaborations in order to optimize the life cycle of vehicles and their components (World Economic Forum, 2020).

2.3.2 - Enablers and barriers for circularity in the automotive industry

Urbinati et al. (2021), focusing on the company level, identified enablers and barriers to the implementation of circularity in automotive industry business models. They categorized them in four areas related to product and process, economic/financial, organizational, and supply chain/customer management.

Product and process-related enablers are all the technologies and methods that facilitate resource optimization, remanufacturing, and regeneration of by-products as input to other processes (so-called Rs practices) and foster the development of sharing solutions with superior consumer experience and convenience (Bakker, et al., 2014). Other enablers are the opportunities for improving existing operations of companies and supply chain stakeholders through the implementation of new technologies for Design for X practices and reverse supply chain and using enhanced ICT platforms for information sharing (Mathews & Tan, 2011). Product and process-related barriers may be the characteristics of returned products (e.g., weight, if high may increase transportation costs), quality and quantity of them (den Hollander, Bakker, & Hultink,

2017), return flows uncertainty (quantity variability over time could become a serious issue for capacity planning) (Cucchiella, et al., 2015), lack of know-how in repairing products of an OEM by a third-party (Whalen, Milios, & Nussholz, 2018).

Economic/financial enablers refer to the scarcity of resources and their increasing price that can stimulate companies to achieve resource efficiency (Ghisellini, Cialani, & Ulgiati, 2016), reducing the costs and the risks of accessing virgin materials, new revenue streams and new value creation, business growth and increase in margin and profits (Linder & Williander, 2017). On the contrary, large capital requirements due to the cost of new technologies and the uncertain returns of the investments, that often require a long-time horizon, constitute barriers (Gumley, 2014).

Organizational enablers refer to environmental awareness, increasing understanding of sustainability demands, involvement of circularity as a priority within a company strategy, and the development of internal skills and capabilities for CE (Bocken, et al., 2016). Organizational barriers refer to the existing linear operations and development targets, as well as conflicts with existing organizational culture, due to heavy organizational inertia (Liu & Bai, 2014), and management risk aversion (Lacy & Rutqvist, 2015).

Supply chain/customer management enablers are represented by the availability and geographical proximity of suitable supply chain partners: these aspects ease coordination, information sharing, and product traceability, essential for managing and coordinating a complex reverse supply chain (Bakker, et al., 2014). On the other hand, geographical and numerical dispersion of supply chain partners and end users, which results in complexities in logistics management and high transportation costs, represents the most important supply chain barrier (Bakker, et al., 2014). Customer related barriers are mainly associated with users' behavior in terms of continuous changing demand and increasing requests for customization (Bressanelli, Perona, & Saccani, 2019).

2.4 - Organizational capabilities for circularity

2.4.1 - Categorization of organizational capabilities

The transition to circularity is full of challenges and difficulties that require a complete paradigm shift within organizations. This process can lead to confrontation with

financial, structural, operational and technological issues (Ritzén & Sandström, 2017). Therefore, it is important to examine what organizational capabilities[1] a company must have and must develop for the transition to circularity. According to the classification by Sehnem et al. (2022), these can be distinguished into dynamic, relational, innovation and absorptive capabilities.

Dynamic capabilities concern the ability of an organization to adapt and innovate in response to changing market conditions and consumer needs. They are therefore the organization's ability to continuously renew and develop its resources, capabilities and competencies in order to achieve and sustain a competitive advantage in a changing environment. Some examples of dynamic capabilities are the ability to quickly develop and launch new products, the ability to reconfigure organizational structure and processes to respond to new opportunities or threats, and the ability to maintain relationships with customers and suppliers (Teece, Pisano, & Shuen, 1997).

Relational capabilities are those that enable the company to build and maintain relationships with stakeholders and in particular with customers, suppliers, partners and other external parties. Relational capabilities are a wide range of skills and practices such as effective communication, trust building and collaborative problem solving. These capabilities are particularly important in industries that require close collaboration with external partners in terms of supply chain management, strategic alliances and joint ventures. Developing these capabilities allows access to new markets, technologies and resources. In addition, transaction costs are reduced, innovation is increased and risks are reduced due to a more collaborative business environment (Czakon, 2009).

Innovation capabilities refer to an organization's ability to generate and implement new ideas that create value for its customers and stakeholders. These involve the creation of an inclusive culture, where everyone is involved in the development of products and processes, encouraging creativity and feedback sharing (Sehnem, et al., 2022).

Absorptive capabilities refer to an organization's ability to identify, assimilate and apply external knowledge, information and resources to enhance its innovation and

[1] According to Smallwood and Ulrich (2004), organizational capabilities refer to the collective skills, competencies, knowledge, resources, and processes that an organization possesses and utilizes to achieve its strategic objectives and maintain a competitive advantage in the marketplace.

performance. These capabilities require continuous investments in knowledge management, learning and collaboration and the creation of an organizational culture that encourages knowledge creation and sharing (Zahra & George, 2002).

2.4.2 - Dimension of organizational capabilities

Pais Seles et al. (2022) grouped the organizational capabilities for circularity into three dimensions: "management and people", "structure, product and process", and "relationship with stakeholders".

The first category includes those capabilities that enable the understanding of the regulatory framework in order to anticipate possible problems and align strategies for circularity with laws (Sousa-Zomer, et al., 2018). Furthermore, the ability to understand the needs of customers and to involve them in the design of sustainable products is a prerequisite for the creation of valued and successful products (Prieto-Sandoval, et al., 2019). These capabilities also include the ability of top management to support the transition to the circular economy (Rattalino, 2018). Included in this dimension is the ability to change, redesign and improve business models, also through restructuring operations such as the acquisition of a company, the creation of a new business unit or the sale of an existing one (Khan, Daddi, & Iraldo, 2020). Finally, this dimension includes the ability to measure and evaluate sustainability performance (Rattalino, 2018), the ability to attract talent with environmental awareness in order to create a green culture (Prieto-Sandoval, et al., 2019) and the ability to develop training courses on the subject at all levels of the organization (Mura, Longo, & Zanni, 2020).

The “structure, product and process” category includes the ability to use innovative technologies for eco-design (Scarpellini, et al., 2020), the ability to reconcile high quality production with the use of recycled or remanufactured materials (Hsieh, et al., 2017) and the creation of an efficient R&D department (Prieto-Sandoval, et al., 2019). The ability to create processes and infrastructures for the remanufacturing of products and the provision of efficient maintenance services are also part of the “structure, product and process” dimension (Prieto-Sandoval, et al., 2019). Finally, this dimension concerns the offer of product service systems in line with consumer needs (Sousa-Zomer, et al., 2018) and the use of digitization to dematerialize physical products (Neligan, 2018).

The last dimension, “relationship with stakeholders”, includes the ability to identify suppliers with a low environmental impact (Mura, Longo, & Zanni, 2020) and the development of a material and component system that ensures compliance with certain sustainable standards (Sousa-Zomer, et al., 2018). Co-operation with suppliers is therefore crucial and is made possible through information sharing via integrated supplier management platforms, through the creation of long-term relationships and the implementation of sustainability and circularity incentive programs (Sousa-Zomer, et al., 2018).

Finally, this dimension also includes the ability to develop partnerships with governments to influence the adoption of eco-friendly practices (Sousa-Zomer, et al., 2018).

3 - Methodology

The following chapter covers the methodology applied to conduct the research, relating it to the purpose of the thesis. In the chapter, the research strategy and design are introduced. Then, the methodology related to data collection and analysis is outlined.

3.1 - Research strategy

The researcher aims to discover new concepts and produce generalizable explanations based on empirical observation of a phenomenon (Harley, Bell, & Bryman, 2018). Particularly, organizational capabilities to implement circularity in the automotive industry business models are an unexplored aspect of the current literature. The challenges associated with this implementation also need to be investigated further. For this reason, an inductive approach is the most suitable for this exploratory research. The latter is not intended to test hypotheses already formulated in literature but aims to answer the research questions set out in section 1.3.

Considering the use of the inductive strategy to link empirical evidence and theory, the qualitative approach is particularly suitable for answering the research questions. It focuses on words rather than numbers (Harley, Bell, & Bryman, 2018), so it is able to investigate the challenges that vehicles manufacturers are facing in the implementation of circularity in their business and what are the organizational capabilities to cope with them. The direct experience of the actors dealing with circularity favors the acquisition of empirical evidence on the topic under analysis. The qualitative approach allows for a more extensive explanation of various aspects of the observed phenomenon according to the issues addressed in the interviews by the different respondents involved in the implementation of CE. Furthermore, considering that the implementation of circularity requires the deployment of new organizational capabilities, from product design and production to stakeholder relations and employees' management, qualitative analysis can highlight practices, procedures and standards used to cascade the circular paradigm within the organization. All these aspects cannot be expressed by the conciseness of a number.

Furthermore, in choosing the qualitative strategy, the author considered critical issues inherent in it. Particular care is given to aspects concerning the subjectivity and

transparency of the research. To minimize the subjectivity of the researcher, interviews were recorded, transcribed in their entirety and sent to the respondent for validation. Furthermore, the research process was documented in detail, including the decisions made regarding data collection and analysis. Indeed, defining the path leading to the presentation of results not only minimizes subjectivity but also increases the degree of transparency (Harley, Bell, & Bryman, 2018).

3.2 - Research design

3.2.1 - Multiple case study

The framework for data collection and analysis starts with the definition of the research design. To answer the research questions, the author considers it appropriate to use a multiple case study: the results are obtained based on a detailed and in-depth analysis of three cases. The analysis of relevant case studies leads to the production and formalization of new theories and thus it is in line with the aim of the thesis to address a research gap. Furthermore, case studies permit to investigate all those activities carried out within an organization on a daily basis, in particular those related to circularity, which however are not the subject of explication except by observing them directly from the inside.

The inductive approach with consequent qualitative strategy is suitable for the analysis of a case study (Harley, Bell, & Bryman, 2018). Through this, it is possible to study rather unexplored phenomena such as circularity in the automotive industry. The research question aims to identify what challenges are faced for an effective implementation of circularity in business and what are the organizational capabilities to do so. Multiple case study design is particularly suitable when one wants to identify "how" and "why" a certain phenomenon occurs. Furthermore, it allows the results from the analysis of each case to be compared and contrasted in order to reflect both the common elements and the uniqueness of each one (Harley, Bell, & Bryman, 2018).

The case studies to be examined were identified by the author with the help of FIRST TO KNOW, a Swedish consultancy company present within Handels with a participatory space that acts as a bridge between academia and the world of work. Through personal discussions and email exchanges, the general topic of the thesis was

first identified, specifically the circular economy, and then, considering the author's passion and the large cluster of automotive companies in Gothenburg, the focus on this specific industry was outlined.
With this as a starting point, the companies were identified: three manufacturers, with whom FIRST TO KNOW collaborates. The organizations in question are Polestar, a Swedish company specialized in the production of full electric performance cars, AB Volvo, a company active in the manufacture of trucks, buses and machinery, and Volvo Cars, producers of light vehicles.

These companies were chosen because they are leaders in the circularity of the vehicles they produce. They embarked on a journey to make their vehicles as circular as possible and did so much earlier than their competitors. This implies that they faced and developed the capabilities to overcome the challenges of circularity earlier than others. For this reason, the case studies should be considered revelatory (Harley, Bell, & Bryman, 2018): the author has the opportunity to study a specific phenomenon that was previously rather unexplored. This latter aspect further strengthens the choice of the inductive approach and qualitative strategy, which are particularly suitable for theory building.

3.2.2 - Units of analysis description

Polestar

Polestar is a Swedish luxury electric car manufacturer: founded in 1996 as a private racing team, it is controlled by Volvo Cars and its parent company Geely.
Polestar's ambition is to become a completely climate neutral company and wants to reduce its carbon emissions to zero by 2030 (Polestar, 2023a).
It has long introduced initiatives to reduce the environmental impact of its products. It is committed to using sustainable and recyclable materials in the production of its vehicles: for example, the interior of Polestar 2, the company's best-selling model, is made from fabrics derived from plastic bottles or vegetable leather (Banks, 2020). In addition, the Polestar 0 project, the first production car with zero climate impact by 2030, began in 2021: the project will not only reduce but eliminate all greenhouse gas emissions from every aspect of production (Polestar, 2023b).

AB Volvo

AB Volvo is a Swedish company specializing in the production of commercial and industrial vehicles, as well as marine and aircraft engines.

The company is committed to reducing CO2 emissions from its vehicles by 100 percent by 2050 and is also working to reduce its environmental impact through waste management and the use of renewable energy sources: the goal is to power its factories with 100 percent renewable energy by 2030 and have a carbon-neutral value chain by 2040 (AB Volvo, 2023a).

In line with its environmental sustainability mission, the company has undertaken a number of circularity initiatives. One of the main initiatives is the vehicle recycling program, which allows the majority of the components of each vehicle that reaches the end of its useful life to be reused. This is achieved by dismantling components, sorting and recovering materials such as steel, plastic and glass (AB Volvo, 2023b). In addition, following the introduction of electric-drive vehicles, programs have been put in place to reduce the environmental impact of batteries that are repaired and reconditioned for use in other products (AB Volvo, 2020).

Finally, AB Volvo is collaborating with other companies and organizations to promote circularity and sustainability in the transportation sector. The company is committed to sharing its knowledge and best practices to accelerate the transition to a circular and low-carbon economy (AB Volvo, 2023c).

Volvo Cars

Volvo Cars, is a Swedish automotive company, specializing in the production of light vehicles. The company has made innovation and sustainability its core principles and has a goal of becoming completely carbon neutral by 2040. To do this, one of its main goals is to reduce the environmental impact of its vehicles throughout their life cycle (Volvo Cars, 2023).

On the one hand, the company is developing a range of all-electric vehicles, with the goal of achieving full electrification by 2030; on the other hand, it is working to increase the use of sustainable and recycled materials, such as plastic and wood, in vehicle production (Volvo Cars, 2023).

Finally, the company is implementing measures to reduce waste and energy consumption in its factories and is working with manufacturers and suppliers to develop innovative solutions for recycling and reusing materials used in vehicles (Volvo Cars, 2023).

3.3 - Research method

3.3.1 - Systematic literature review

To understand what is already known about the topic, to provide a theoretical foundation and a starting point for the research work, it is necessary to gather what has already been written in literature about circularity transition.

Considering that circularity is a topic involving several academic fields, the number of academic papers to be found is enormous, almost disorienting for the researcher. To overcome this problem, the author performed a systematic literature review. The output of a systematic literature review consists of a smaller number of papers that are easy to analyze, so that useful elements can be found in each of them to outline a theoretical framework from which to start (Harley, Bell, & Bryman, 2018). Through systematic literature review, the aim is to ascertain what the state of the art is in the literature and to understand what the research project can add to the current knowledge on the implementation of circularity in the automotive industry. Furthermore, this review method requires a well-defined procedure which minimizes the subjectivity of the researcher. In fact, it is necessary to establish which inclusion and exclusion criteria are adopted when consulting the existing literature (Harley, Bell, & Bryman, 2018). These are shown in the table below and were worked out both at the preliminary stage of the study and iteratively as the focus of the research narrowed.

Inclusion criteria	Exclusion criteria
Papers dealing with: • Circular economy definition • Circularity in the manufacturing industry • Circularity in the automotive industry • Sustainable and circular business model • Organizational capabilities for circularity	Papers that: • Analyze circular economy from a technical perspective • Analyze circularity in industries other than those considered in the inclusion criteria • Are not related to the discipline of business, management and accounting

Table 1 Inclusion and exclusion criteria

For the collection of the literature relevant to the project, the author made use of online databases such as Scopus and Google Scholar, as well as the online resources of the GU and LUISS University Library. The following keywords were used: "circular economy", "circularity", "business model", "sustainable business model", "circular business model", "business model innovation", "organizational capabilities", "circularity" AND "manufacturing industry", "circularity" AND "automotive industry", "circular economy" AND "manufacturing industry", "circular economy" AND "automotive industry", "sustainable business model" AND "manufacturing industry", "sustainable business model" AND "automotive industry", "circular business model" AND "manufacturing industry", "circular business model" AND "automotive industry", "organizational capabilities" AND "circularity".

In order to have a wider pool of academic papers, the keywords were entered into search engines in both English and Italian.

3.3.2 - Primary data collection

Primary data were collected using semi-structured interviews. This decision is in line with the qualitative nature of the research strategy. The focus must be on the words of the interviewees in order to obtain detailed information useful for bridging the literature gap by formulating new theories on the implementation of CE in the automotive sector. The interviewees had the opportunity to express their knowledge in depth as semi-structured interviews guarantee complete freedom of expression. Thus, it can be seen that the choice of the semi-structured interview serves the inductive approach of the research (Harley, Bell, & Bryman, 2018).

In addition, semi-structured interviews represent the ideal balance between topic focus and adaptability: while giving the interviewer a structure to follow, it also gives the interviewee freedom to respond. The use of an interview guide (attached in Appendix) helps the interviewer to know which key topics to cover during the interview and facilitates analysis. By its very nature, in the semi-structured interview the answers of the respondents and consequently the questions asked may differ in their order. The guide therefore helps to ensure the comparability of the interviews by making sure that all topics of interest are covered: in this way, the replicability of the study is facilitated (Harley, Bell, & Bryman, 2018).

The interview guide consists of five sections. An introductory one aimed at understanding the role of the interviewee within the companies and how it relates to the implementation of circularity in the business. The second section is dedicated to questions regarding circularity initiatives put in place in the companies. The other three sections are more specific and deal with organizational capabilities to implement circularity within the business models of the organizations. Particularly, the focus is on human resource management, processes, new product development and relationships within their value chains.

The sample of interviewees were identified following the purposive sample approach. The interviewees have a good knowledge of the subject matter and, above all, hands-on experience: they have a relevant role within the organizations under analysis and in particular it is related to the implementation of circularity in the business model. The contacts were facilitated by the intermediation of FIRST TO KNOW and, according to the snowball sampling, at the end of the interviews, the interviewees were asked to point out other key respondents. In addition, some interviewees were found by the researcher by entering the word “circularity” followed by the name of the companies being studied in the LinkedIn search bar. Once a list of potential interviewees had been drawn up, they were contacted by private message to arrange a meeting.

Finally, they were asked to point out some documents that are complementary to the interviews and that contain data useful for research purposes. Nevertheless, this last aspect is to be considered conditioned and limited by the fact that these documents often contain information for internal use only, the disclosure of which may be prohibited.

The use of these documents is, however, conditional on compliance with Scott's four criteria on their quality, with particular reference to credibility and representativeness, as for organizational documents authenticity and meaningfulness are taken for granted (Harley, Bell, & Bryman, 2018). Table 2 shows the details of the interview with particular reference to the set-up, the company and the role of the interviewee in it, the date and length of the meeting.

Interviewee	Job position and organization	Set-up	Date	Length
A	Circularity lead, Polestar	Online	02/23/2023	25 mins
B	Sustainability attribute lead, Polestar	Online	03/17/2023	30 mins
C	Director Environment and Innovation, AB Volvo	Online	03/24/2023	25 mins
D	Director Circular Development, AB Volvo	Online	03/29/2023	31 mins
E	Director Circular Economy, Volvo Cars	Online	04/19/2023	32 mins
F	Technical Expert Occupational Health Effects - Sustainability Centre, Volvo Cars	Online	04/27/2023	34 mins

Table 2 Interviews details

Interviews were conducted online, according to the preference of the interviewees. The latter were contacted in advance so that they could agree on a date convenient to them for the interview. Before starting, the interviewer briefly provided useful information to better understand the purpose of the research. The interview, conducted according to the interview guide, was recorded and then transcribed with artificial intelligence software so that all the interviewees' words were faithfully reported to make the subsequent analysis as objective as possible.

3.3.3 - Secondary data collection

To provide a comprehensive view of the sustainability and circularity plans implemented by the three companies, the author also made use of secondary data

extracted from publicly available company documents, from the press releases of the companies under investigation and from their websites.

3.3.4 - Data analysis

The interview transcripts were analyzed using thematic analysis. The latter is a valuable tool for rigorously analyzing the content of the transcripts and tracing common themes throughout the interviews. Considering the inductive approach and exploratory nature of the research, the freedom with which labels can be attributed facilitates the interpretation of a large amount of text and makes it easier to identify connections between concepts. Such a rigorous approach is therefore very useful for new theory building (Gioia, Corley, & Hamilton, 2013).

Thematic analysis involved three steps. Each sentence or group of sentences in the transcripts were labeled using an open coding process in order to generate first-order codes. This step reduced the amount of data to be analyzed and favored the detection of macro-themes common to the interviews (what Gioia calls 2nd order themes) useful for answering the research question. Furthermore, to address the second research question, the 2nd order themes traced were condensed into aggregate constructs which were identified using the categorization of organizational capabilities discussed in section 2.4.2.

3.4 - Research quality

To assess the quality of the research, Harley et al. (2018) provided four criteria which are specifically suitable for qualitative studies: credibility, transferability, dependability and confirmability.

3.4.1 - Credibility

In order to comply with the credibility criterion, the entire research process was carried out following good practice: the purpose of the research was communicated to the interviewees and the transcript of the interview was submitted to them for respondent validation.

3.4.2 - Transferability

The most challenging criterion to meet was the transferability of the results. This is because the qualitative strategy is inherently less objective than the quantitative one. Moreover, the use of case studies further limits generalizability as the results of the analysis are linked to the specific context of the case. To overcome this problem, the only way is to provide detailed information on target organizations, their peculiarities and the reasons that convinced the author to choose them. Then, it will be up to the reader himself to decide whether it is possible to transfer the results obtained to other players in the automotive sector.

3.4.3 - Dependability

As far as dependability is concerned, it was the author's responsibility to keep track of all stages of the research: in particular, copies of emails, transcripts and recordings of interviews, as well as copies of all documents used, were kept in a special cloud folder.

3.4.4 - Confirmability

To meet this criteria and guarantee that the empirical findings were reported as objectively as possible, the subjectivity of the researcher in the collection of data was minimized by trying to ask questions in a way that was understandable and relevant to the purpose of the research so that the respondents could express themselves in the best possible way, leading questions were avoided and further explanations were requested if the answers were not clear.

4 - Empirical findings

This chapter presents the empirical results that emerged from the interviews conducted with representatives of the companies under study. To present them effectively, the chapter is divided into three sections, each devoted to one company. Within each section the findings are grouped into aggregate themes, each of which has subcategories. An overview of the categorization adopted is provided at the beginning of the chapter, and then the findings are presented by subcategories for each case study.

4.1 - Overview of empirical findings

Before exploring the organizational capabilities required to implement circularity in the business model, the author aims to investigate the challenges that the companies under consideration face in transforming their traditionally linear business to circular. The challenges identified relate to both the increased complexity of the value chain and the need for a change in organizational culture. Next, based on the current literature, organizational capabilities are distinguished in relation to three dimensions: "Management and people", "Structure, product and process" and "Relationship with stakeholders". Several aspects for each of them have emerged and are presented in detail later in the chapter. Table 3 provides an overview of the categories identified with the empirical investigation.

Challenges to implement circularity in the business		**Organizational capabilities for circularity**		
Business related challenges	**Cultural related challenges**	**Management and people** - Ways to ensure employees' commitment to circularity - Management skills - Green culture creation -Management and people practices	**Structure, product, processes** - Product development and production processes - Best practices to create circular products	**Stakeholders relationship** - Relationships with suppliers - Relationships with other external stakeholders

Table 3 Overview of empirical findings

Findings Polestar

4.2 - Challenges to implement circularity in the business

4.2.1 - Business related challenges

As Polestar is a company focused on the production of full-electric cars, the biggest challenge is to minimize the impact on the ecosystem of end-of-life electric motor batteries. Therefore, it is crucial to work on collaborations with other companies to find a second life for the batteries. Indeed, used batteries may not be suitable for building new vehicles but still useful for powering other products (Respondent A, p.c., 2023).

> "*In terms of circularity, we see that we have the biggest impact on biodiversity with our batteries and engines. We are working on collaborations with other businesses and companies to find a second life of batteries. So, once the batteries have been used in our vehicles, and we can't put them back into other vehicles, we're trying to figure out how we can use them" – Respondent A*

Another challenge is due to the complexity of the OEM (original equipment manufacturers) supply chain, which involves suppliers from all over the world who are extremely geographically dispersed. The more complex and dispersed the supply chain, the more difficult it is to ensure circularity of materials and the adoption of ad hoc standards (Respondent A, p.c., 2023).

> *"One of the biggest challenges is the complexity of our supply chains. I think any OEM has such a complex supply chain all over the world. So, when you start looking at circularity, the more complex your supply chain is, the more difficult it is to circulate materials, and ensure common standards across the whole value chain" – Respondent A*

In addition, considering the specificity of the construction materials currently used, it is difficult to guarantee that a component made from recycled materials can have the same standards as one made from virgin materials (Respondents A and B, p.c., 2023). Polestar currently has partners who supply it with nearly 100 percent recycled products made from post-industrial waste. However, considering that post-industrial waste has the same carbon burden as virgin materials, Polestar is cooperating to replace post-

industrial content with post-consumer waste. Thus, the challenge is to find a solution to the uncertainty of post-consumer waste streams (Respondent B, p.c., 2023).

> "*The reason they use post industrial waste now is because they're sure that they can have a constant supply from other industries or other companies. But with post-consumer waste, no one knows the future of the market. So, we're working with them to see if we can swap the post-industrial content that they currently use for post-consumer waste*" – *Respondent B*

A similar problem, again concerning the availability of recycled materials, is the fact that the demand for recycled content is soaring and is not available to everyone. As a result, there is a need to develop products with low-emission virgin materials (Respondent B, p.c., 2023).

4.2.2 - Cultural related challenges

Other challenges that respondents highlighted relate to the need for a change in organizational culture: circularity must be made a priority in business strategy. The automotive industry traditionally adopts a linear model of production, and the challenge is to change this way of thinking about vehicle production (Respondent A, p.c, 2023).

> *"I think the automotive industry has a very legacy way of thinking about things. It is a very linear model: we buy this, we make it, we assemble it, and then after we've sold it, it is as if this had nothing to do with us anymore. That's the traditional kind of vehicle thinking. So, a big challenge I see is trying to change that and start to think about circularity" – Respondent A*

4.3 - Organizational capabilities for circularity

4.3.1 - Organizational capabilities related to management and people

Ways to ensure employees' commitment to circularity

The interview shows that the implementation of circularity and the subsequent production of sustainable vehicles requires the involvement of all company employees, at all levels. Making sure this happens is relatively easy at Polestar because sustainability is part of its DNA. All the people in Polestar know how important

sustainability is and it is therefore very easy to mobilize them for change and make them active participants (Respondent A, p.c, 2023).

> *"Gain employees' commitment is relatively easy because the idea of sustainability is part of our DNA. In Polestar it's just as important that we are creating sustainable cars as some of the other things like we consider design, for example. So, everyone who comes into Polestar knows how important sustainability is. So usually, it's a lot easier here to try and implement change and influence that" – Respondent A*

It is also important to work on the creation of common tools and standards that will enable alignment of all functions involved. There is a need to add specific circularity metrics to the existing ISO standards, mainly concerning lifecycle analysis. These have not yet been developed internationally and consequently need to be created internally, also taking into consideration the increasingly stringent environmental regulations (Respondent A, p.c, 2023).

> *"We are working on tools and standards, of course, we use the ISO standards for lifecycle analysis and things like that. Speaking of circularity, specifically, we don't yet have any standards, global or anything that we kind of follow. We have internal targets and ways of working that we use. But of course, new legislation like the battery passport, for example, is something that we will integrate into the way we work, the how we handle the end-of-life vehicles as well. That's something that will need to develop. And I think that will come with more learning and knowledge about tools that we can give to our business and engineers on how to design more circular things" – Respondent A*

Finally, it is important to set standards to be used internally at the engineering level so that the materials used in production are sustainable but at the same time have appropriate technical characteristics (Respondent B, p.c., 2023).

> *"In terms of standards, we have engineering standards that we can use internally to direct engineers to or away from materials. A good example is that we have a list of materials that we want engineers to avoid" – Respondent B*

Management skills

Managers need to understand where the circular transition can lead and what exactly is the goal to be achieved. At Polestar, many managers have a genuine interest in sustainability and circularity, so it is easy to justify the time and resources invested in their implementation (Respondent A, p.c., 2023).

In addition, all engineers in management positions are required to view the sustainability targets that affect their area of focus and are responsible for conveying them to their staff. They are therefore required to have both good technical knowledge of materials and components but also excellent communication skills to interact with other business functions (Respondent B, p.c., 2023).

Finally, it is crucial for managers to have high aspirations to push toward circularity; they must have a positive attitude to implement change (Respondent B, p.c., 2023).

> *"Managers need to have a lot of aspiration, most people pushing circularity have a very positive attitude, because they have to try and make a good change" – Respondent B*

Green culture creation

Creating a culture of sustainability within the company is critical; there is a lot of knowledge sharing to succeed in this at Polestar. There are leaders in different areas of sustainability who focus on issues such as climate neutrality, transparency, inclusion, and circularity. It is important to try to transfer knowledge and information from the top down to all areas of the company. This includes dedicated training sessions, every quarter there are group meetings where the sustainability team presents their achievements and updates on ongoing projects; in this way, the whole team feels involved. At the same time, group members can ask questions about topics that are unclear to them or in case they need additional information (Respondent A, p.c., 2023).

It is also important to consider circularity as one of the elements to leverage for sustainability: an integrated approach that takes into account the interdependence of all areas of sustainability is needed (Respondent A, p.c., 2023).

"I think that for me the most important thing to consider is how interlinked different areas and topics of sustainability are. We have climate, circularity, transparency and things. But I think it's important that we remember that all of this is joined up. Like, for example, you couldn't have a world where you have net zero, but it's not circular. Those two don't really happen. So as much as we should push for everything, I think it's important to underline that all areas of sustainability are linked, so that we don't put all our energy into one particular area and then not see any change or improvement in the others" – Respondent A

For Polestar, sustainability is a value included in every operation that is carried out. All employees have access to the tools and metrics that measure the sustainability of the business. In this way they are all aligned and informed about the actions being pursued for sustainability (Respondent B, p.c., 2023).

"Sustainability is a key brand value of what we do. In terms of green culture, the brand is so obvious when it comes to what we're trying to do. Everyone knows it's important, because it's in the news, it gets talked about and it is represented internally" – Respondent B

Management and people practices for circular transition

In terms of behaviors, it is necessary to change the way vehicle components are designed, engineered, and bought. Linear thinking is inherent in many of the operations Polestar carries out when developing a vehicle. Therefore, there is the need to have an overview of the entire life cycle of components (Respondent A, p.c., 2023).

"I think it's really taking the view of the whole lifecycle of a part. The requirements that we have, for a traditional car part, might be that needs to last 200,000 kilometers. But we need to step away from that kind of thinking: 'I just need to choose a material and the component that is going to last for that'. Instead, after I design or choose the material for this part, I need to worry about how I can make sure that it lasts, and then used in another vehicle, and then in another vehicle and in another vehicle" – Respondent A

To make this possible, the company must set requirements and invest substantial resources in new technologies (Respondent A, p.c., 2023). Engineers and staff must

work by following processes that have stringent, specific, and different requirements for each vehicle model (Respondent B, p.c., 2023).

4.3.2 - Organizational capabilities related to structure, product and processes

Product development and production processes

The most important focus is on batteries; these are designed to be easily reused, remanufactured, disassembled from the vehicle, and recycled at the end of their life. Repaired and remanufactured components are used in their production. Some of the other vehicle components are also made from recycled or biomass-derived materials (Respondent A, p.c., 2023). In this regard, there are many pilot projects underway to investigate how to integrate components with a high degree of recycled content into vehicles (Respondent B, p.c., 2023).

The biggest challenge that modifies component production relates to the technical properties of recycled materials. Metals, from a circular point of view, do not present particular problems because they retain their mechanical properties for a long time, even after multiple recycling cycles. In contrast, plastics, due to their molecular structure, have lower performance following recycling. For this reason, it is important to collect and use data on the behavior of plastic components after recycling. Once the loss in mechanical performance is understood, it needs to be taken into account at the design stage and decide whether to make the component thicker or add more fasteners (Respondent A, p.c., 2023).

In addition, circular design leads to the use of fewer materials, and this may compromise the aesthetics of the product. For this reason, the design steps need to be reversed: first, the focus must be on the material, understand what it can do and what its application can be. In the past, in fact, the material to be used was the last factor considered before production (Respondent B, p.c., 2023).

Finally, in terms of production, no significant changes are expected, the real difference is the decrease in supply chain steps (Respondent B, p.c., 2023).

Best practices to create circular products

In Polestar, the engineering skills are excellent but there are no experts in materials science. So, there is a gap to be bridged between the application of new materials within vehicle production and materials science. For this reason, there is a need to create new professionals who have both the engineering skills to design the vehicle and a good understanding of materials behavior (Respondent A, p.c., 2023). Polestar's other representative is also on the same page: choosing the right materials and avoiding a single component being made from more than one material is critical. In addition, involvement and collaboration between engineering and design play an important role. (Respondent B, p.c., 2023).

> *"It is important to put in place a partnership between engineering and design. Because it's possible that you can design a part that dictates the material you need but it's also possible to dictate the material which then forces design. So, the two functions need to be together" – Respondent B*

4.3.3 - Organizational capabilities related to stakeholders relationship

Relationship with suppliers

The traditional relationship with suppliers is governed by a contract specifying the object of supply, duration, and compensation. At Polestar, this relationship is also influenced by the circular approach: what is currently a supplier may in the future become a customer, or many components may come from end-of-life vehicles. If you think about closed material cycles, you also have to close your supply chain cycles. The key is to create partnerships where you establish a long-term relationship with suppliers to make sure that the materials you need are reused as much as possible (Respondent A, p.c., 2023).

In addition, it is necessary to establish many requirements, especially in terms of sustainability, that suppliers must adhere to. These cover areas of sustainability such as business transparency, respect for workers' rights, safe sources of material sourcing, use of materials with recycled content, responsible use of water in production, percentage of waste going to landfill, and use of electricity from renewable sources (Respondent A, p.c., 2023).

"In Polestar we also need to ensure that we're not creating environmental damage further to our supply chain because it's still our responsibility" – Respondent A

Therefore, there is a need to establish requirements for suppliers on the recycled content of materials but at the same time they must also be able to track circular processes in their supply chain (Respondent B, p.c., 2023).

Finally, considering that the availability of materials for recycling is not infinite there is a need to create partnerships with suppliers of components made from virgin raw materials that have environmentally friendly processes. Thus, by using these components and then recycling and using them again, on the one hand low impact strategies are implemented and on the other hand cycles are closed (Respondent B, p.c., 2023).

Relationship with other external stakeholders

The transition to a circular business model requires collaboration with actors who previously had little involvement in the relationship with automotive manufacturers. Specifically, in the traditional linear model of production and consumption, car companies and wreckers had no connection because the consumer used the car and then scrapped it. In the circular model, on the other hand, the more collaborations and partnerships you can create with recyclers and scrap dealers, the more materials you can get back and then put into new vehicles: the focus needs to be on creating a reverse supply chain, especially for components such as batteries and electric motors (Respondent A, p.c., 2023). All operators involved in end-of-life product treatment have a key role because Polestar has no control over their operations. Therefore, the better the relationship that is created with these actors, the more likely the end-of-life processes will be better (Respondent B, p.c., 2023).

Another important relationship to cultivate is with customers: to be sure of getting the car back, one needs to know the users, their habits, and learn from the input they give throughout the car's life cycle (Respondent A, p.c., 2023).

The relationships Polestar establishes must be under the banner of transparency to highlight brand values and make all stakeholders involved aware of the actions taken

for a sustainable transition. Sharing achievements, on the one hand, it contributes to the development of the entire industry, and on the other hand, it can identify areas for improvement where there is a need to develop collaborations with new partners (Respondent B, p.c., 2023).

Findings AB Volvo

4.4 - Challenges to implement circularity in the business

4.4.1 - Business related challenges

Interviews with AB Volvo representatives show that the challenges for the circular transition are global in scope as actions to implement circularity affect Volvo's operations in more than 140 countries (Respondent C, p.c., 2023). Similarly, the circular transition must be pursued simultaneously with the technological transformation that is sweeping the automotive industry (Respondent D, p.c., 2023).

> "*The challenge is that we have so much to do. There are so many things going on at the same time with the whole technology transformation from dieselized products to electromobility products and a lot of new technologies that we need to learn and develop. And, as the Volvo Group has decided to invest in all technologies, meaning both battery electric vehicles, full cells electric vehicles, the workload is simply quite enormous and there's so many things to learn*" – *Respondent D*

4.4.2 - Cultural related challenges

The representative of AB Volvo pointed out that the commercial vehicle and construction equipment industry is very conservative, both in terms of manufacturers and consumers (Respondent C, p.c., 2023).

> *"It is challenging to address the business models for circular transition, considering both we and our customers are operating in a conservative industry like that. So, I think that's an area where we need to work hard going forward" - Respondent C*

Circularity must be seen as a driver for value creation. Companies must be an active part of the transition to circularity and must leverage it as an asset for value creation (Respondent C, p.c., 2023).

Moreover, the transition to circular economy challenges everything we know because it changes the way we act toward society. It is difficult to understand what the priorities are for implementing this change because the effects are not immediately visible (Respondent D, p.c., 2023).

> *"The circular economy transformation is putting everything that we know at stake because it changes the way we act towards society. It is quite difficult to manage such a cultural change. And then it is difficult to get the priority for that since it has not an immediate effect. It is more long term" – Respondent D*

4.5 - Organizational capabilities for circularity

4.5.1 - Organizational capabilities related to management and people

Ways to ensure employees' commitment to circularity

The first action that needs to be taken to get all employees aligned on circular transition initiatives is to define a clear direction that the entire company should be striving toward. There is a need to have medium- to long-term targets that are like checklists for all initiatives undertaken. In addition, effective communication at all levels of the organization is essential to ensure that goals and targets are received by all functions involved. Knowledge transmission is also important so that all employees know how to take action to achieve the goals in terms of circularity and sustainability in general. In this regard, the creation of specific training courses, delivered through Volvo Group University, is essential to develop new knowledge and skills in the workforce and support the management of changes brought about by the transition to a circular business model. In addition, the internal development of guidelines, metrics and tools for assessing circularity also facilitates the sharing of intent and consequently its implementation (Respondent C, p.c., 2023).

Work needs to be done to increase knowledge of what the circular economy is and the benefits it brings over a linear economy. A change in mindset is needed, and every

person within the organization needs to know what they can do to facilitate the transition. This starts with studying materials to understand their characteristics and current and future availability; it is important to understand which materials need to be eliminated from production and those that require closed loops to be created instead. Therefore, knowledge of new environmental regulations and forecasts of the availability of materials destined to be scarce is critical (Respondent D, p.c., 2023).

Current metrics and targets need to be improved or new ones invented. The current focus is primarily on a linear business model in which the more vehicles are sold, the better: this is currently the most important indicator for measuring performance. A circular business model requires the development of new KPIs that measure and support transformation (Respondent D, p.c., 2023).

> *"What we also are doing is to further improve on our measurement and targets. Today we are very much focused on a linear business model where the more we sell, the better. That is how we are measured. So, we are looking into the creation of new type of KPIs that can support and benefit the circular transformation" – Respondent D*

Tools and indicators supporting circularity must be implemented throughout the decision-making process so as to be sure that aspects related to the circular economy are taken into account in every choice inherent to the business: from the start of new projects to the material procurement stages (Respondent D, p.c., 2023).

Finally, considering the size of the company, which has more than 100000 employees, knowledge-sharing mechanisms have been institutionalized: there is a governance structure in which representations from different business functions meet to share news, experiences, tools, and results of pilot projects so that individual circular transition initiatives have greater resonance and consequently a broader implementation (Respondent D, p.c., 2023).

Management skills

The roles and capacities of managers differ according to the level they hold in the organization: those at the top must ensure that the direction taken is unified and shared by all functions, while the levels below need to set the right priorities and make sure

that each team has the resources and people with the necessary skills to take actions to support circularity (Respondent C, p.c., 2023).

In addition, at all levels managers need to be able to balance all the different priorities according to the limited resources available, making sure that all teams and departments in the group have the right tools and knowledge to achieve their goals (Respondent C, p.c., 2023).

Green culture creation

Corporate culture is not something you change overnight: this is an integral part of the history and people who work at AB Volvo. At the same time, however, managers must change it to adapt to the changing external environment. To do this, they must make sure that employees understand the necessity of the actions taken for circularity (Respondent C, p.c., 2023).

To foster a green culture, it is necessary to establish targets, some of which are easier to set than others. For instance, carbon emissions targets have been defined at both the group and division levels. However, specific targets related to the circular economy have not been set yet. The company is currently in the preparatory phase in this regard, and setting these targets will be the next step (Respondent D, p.c., 2023).

Management and people practices for circular transition

For AB Volvo representatives, there is a need to invest in the creation of new knowledge for circular business models: this is both in terms of technical skills on materials but also on the benefits of the circular model. People in the group must be able to quickly learn and unlearn new skills to keep up with change. In addition, especially for a B2B company like AB Volvo, sharing company values and goals to be achieved in terms of circularity with customers allows for effective and lasting partnerships (Respondent C, p.c., 2023).

Finally, people in the group must act according to good sustainable and circular practices not only in all departments of the company but also in society to spread the culture (Respondent D, p.c., 2023).

4.5.2 - Organizational capabilities related to structure, product and processes

Product development and production processes

In terms of product development, AB Volvo attempts to incorporate the principles of the 6R framework. The focus is on transportation efficiency, meaning that it aims to design multifunctional products so that customers can use the same vehicle for different uses. In addition, the company has a long tradition of extending the life of its products with different kinds of services both in terms of the product as a whole and its components. In fact, it has its own business unit, active in parts remanufacturing, where it takes old components and makes them as good as new (Respondent C, p.c., 2023).

Also, regarding components, in the future Volvo plans to design them modularly to be able to use the same component in multiple vehicles. In addition, products must be designed to last longer and to make the materials from which they are made suitable for being part of closed cycles. This is possible by using the right materials from the first production cycle, making sure they are not scarce and harmful to the environment, and designing components that are easy to repair, remanufacture, and refurbish. (Respondent D, p.c., 2023).

In addition, product development is the result of cooperation between production and purchasing. Therefore, product development requires partnerships between these two functions and suppliers. Designing and manufacturing products that are easy to assemble also makes disassembly and repairs easy to do. A holistic approach to product development is needed, and everyone, based on the work they are doing, needs to understand how they can contribute (Respondent C, p.c., 2023).

The implementation of circularity also requires a change in the way machines and robots in production processes are managed. There is a need to work to extend the life of this equipment: through collaboration with multiple partners, it is possible to extend the life of machines and robots by repairing, refurbishing and remanufacturing them. (Respondent D, p.c., 2023).

In addition, it is important to manage production waste responsibly, making proper sorting of waste to create closed loops of materials within the company boundaries or to send them to recycling partners (Respondent D, p.c., 2023).

> *"During operations, we strive to see our waste as a value, which means that it is not only necessary to go for recycling. You can also consider whether you can use them in other ways before recycling them. Thus, a part that cannot be used in our products can be repaired and sold in the aftermarket" – Respondent D*

Finally, over a medium to long time frame, production processes will be affected by the integration of end-of-life activities such as disassembly and refurbishment into the production cycle (Respondent D, p.c., 2023).

Best practices to create circular products

An important aspect to consider when talking about circular products is being able to provide the right tools to evaluate the pros and cons of the new type of products compared to those made according to the traditional linear production system. At the same time, it is needed that everyone involved is able to use them (Respondent C, p.c., 2023).

Another best practice that the AB Volvo representative shared, concerns the creation of an ad hoc function within the purchasing business unit that deals with initiatives related to circularity but also fossil free and renewable materials (Respondent C, p.c., 2023).

In addition, AB Volvo has great interest in recycling and reuse of its products at the end of life (Respondent C, p.c., 2023). To do this, several reverse logistics programs are in place: in particular, a logistics chain has been created for the creation of remanufactured parts, which operates worldwide and is able to collect used parts and bring them back to the parent company where they are remanufactured and put back on the market. These programs currently cover large powertrain components such as engines and transmissions but are currently being implemented for those components of new electric mobility products as well. On the other hand, as far as Volvo Construction Equipment is concerned, activities are being put in place to remanufacture machines in their entirety and there are specific programs for selling certified used equipment (Respondent D, p.c., 2023).

In addition, the group has great capabilities in terms of waste sorting and recycling, also since most of the components are made of steel. The focus should therefore be on

recycling and reuse of production waste to minimize the use of virgin raw materials (Respondent D, p.c., 2023).

4.5.3 - Organizational capabilities related to stakeholders relationship

Relationship with suppliers

For AB Volvo, the relationship with suppliers should not undergo major changes as they have always played a crucial role in the success of the product and consequently must be in line with the stringent requirements set by the company. Therefore, considering the transition to a circular model, AB Volvo expects the same level of innovation and commitment to sustainability and circularity from suppliers who must also impose stringent requirements on their subcontractors. In this regard, it is necessary to cultivate the relationship with suppliers and also to encourage interactions among them so as to share the best practices that each of them adopts for the design and construction of circular components (Respondent C, p.c., 2023).

The relationship with suppliers will no longer be based on supply and demand alone but will be based on partnerships and sharing of challenges to address the complexities of the transition to circularity (Respondent D, p.c., 2023).

Relationship with other external stakeholders

For a B2B company like AB Volvo, the relationship with customers is crucial to explore opportunities for circularity and, especially in terms of business models, one example is the product as a service. It is necessary to involve the entire customer value chain to build fruitful partnerships. Also, for the part concerning the treatment of materials at the end of the last life cycle, there is a need to build trusting relationships with companies specialized in recycling. In this regard, it is important to point out that it is difficult for manufacturers to cover the end-of-life treatment aspects of vehicles and, although Volvo AB has operations dedicated to dismantling old trucks, recycling, and selling used parts, an important role is played by regulators, which impose requirements to ensure that dismantlers operate properly (Respondent C, p.c., 2023).

> *"Normally we are not in control of our trucks during their whole life. As the trucks get older, we are getting less and less in touch with the truck, meaning that when*

it comes to the end of life, that is normally in a stage where we are not so much involved. Therefore, it is very important that there are legal requirements, making sure that the ones involved in that area are adopting good practices" – Respondent C

Other stakeholders to build relationships with are research institutions with which to cooperate to develop useful tools and metrics for the circular transition. Indeed, the goal is to build an ecosystem within an increasingly complex value chain (Respondent D, p.c., 2023).

Findings Volvo Cars

4.6 - Challenges to implement circularity in the business

4.6.1 - Business related challenges

The biggest challenge is the difficulty in embarking on the path to circularity because multiple business units are involved and the activities to be implemented affect all levels of the organization. For a company like Volvo, it is difficult to manage the various interdependencies that a circular business model entails. In addition, the transition to circularity must be carried out hand in hand with the other priorities of the business, and it is essential to incorporate into the business strategy actions that relate to circularity that until then had only been discussed on a conceptual level (Respondent E, p.c., 2023).

Finally, in the current linear economic model, it is a difficult challenge to get resources to continue satisfy customer expectations and at the same time respect the sustainability target and goals set by the company (Respondent F, p.c., 2023).

4.6.2 - Cultural related challenges

The automotive sector has traditionally followed a linear model of production and consumption that is also ingrained in the way of thinking of those involved. A change in thinking is therefore necessary for the circular transition, and for this reason there is a need to include education on the circular economy within training processes, customizing training according to the role held (Respondent F, p.c., 2023)

4.7 - Organizational capabilities for circularity

4.7.1 - Organizational capabilities related to management and people

Ways to ensure employees' commitment to circularity

To make sure that all employees involved are aligned on the work to be carried out there is a need to set ad hoc targets and indicators for circularity, customizing them by organizational function and, at the same time, training staff to achieve and execute them (Respondent E, p.c., 2023). Volvo Cars uses several tools, and among them is Circulytics, a compact metric that encapsulates the largest set of circular economy indicators currently available. This indicator gives companies a comprehensive picture of their circular economy performance, opportunities for innovation, and the ability to measure progress (Respondent F, p.c., 2023).

Sustainability and circularity are now priorities for Volvo Cars, on par with vehicle safety. For leaders, sustainability must be part of the strategy, and they are working to ensure that knowledge about the circular economy is spread throughout the company through the use of guidelines and tools to guide all employees involved in the right direction (Respondent F, p.c., 2023).

Management skills

Managers are called upon to manage this transformation and are faced with the ambiguous situations that such a radical change entails (Respondent E, p.c., 2023). Managers must have the right knowledge, ability to adapt quickly to the changes that sustainability brings and must have a forward-looking vision of the future (Respondent F, p.c., 2023).

In addition, top managers must have good listening skills and be open to initiatives and ideas proposed by sustainability experts working at all levels within the organization (Respondent F, p.c., 2023).

Green culture creation

Creating a green culture starts with the ability to assemble the right talent pool: new professionals who have the skills to deal with issues related to circularity are needed. Therefore, one must have the ability to attract people with specific skills. In addition,

sustainability and circularity must become clear priorities in the company's mission statement, on par with vehicle safety (Respondent E, p.c., 2023).

Moreover, a green culture is instilled through open discussions in which the achievements of different business units in terms of sustainability and circularity are shared. Finally, managers also play an important role because many of them have a genuine interest in circularity and talk about it all the time: this is certainly a clear signal to the whole organization and gives an idea of the direction to be taken (Respondent F, p.c., 2023).

Management and people practices for circular transition

It is critical that people are involved in circular transition initiatives but at the same time do not lose focus on the other activities they carry out on a daily basis. In addition, some areas of the organization are more mature than others to embrace circular transition, so this needs to be leveraged to carry out pilot projects, within which people with different backgrounds work together. The goal is to create new knowledge about circularity and update targets, metrics, and tools related to it (Respondent E, p.c., 2023).

Moreover, Volvo Cars representative pointed out that a change in people's behaviors within the organization is needed to implement circularity. Nevertheless, this aspect should be the easiest to manage since there are people who can lead the change and establish a roadmap. More difficult, on the other hand, is to adapt the change to consumers so that they, too, understand the circular transition: thus, it is clear how some roles need to work on this (Respondent F, p.c., 2023).

4.7.2 - Organizational capabilities related to structure, product and processes

Product development and production processes

Product development has changed significantly because there must be great attention paid to the way resources are used. Before, the main concern was to satisfy the customer, and the relationship with the vehicle ended with its delivery. Now there is a lot of concern about the type of materials used, how they are used, and how the customer enjoys the vehicle, thinking of it more as a service than a product. All these considerations must be incorporated into the construction of the vehicle. The

manufacturing side is indeed required to be more flexible and to have the ability to use new components with recycled content in production (Respondent F, p.c., 2023).

Best practices to create circular products

The development of circular products requires substantial changes from a component design and assembly perspective, so there is a need for careful planning on a rather large time scale (Respondent E, p.c., 2023).

It is important to work with recycled content and study how to use these materials. In the past, a demo vehicle project was set up to see how much recycled material could be built with. Volvo Cars is currently conducting many projects on circular economy, on how to reuse components and materials. There is great focus on vehicle footprint and already in 2021, the life cycle assessment report (LCA) of the Volvo C40 was released (Respondent F, p.c., 2023).

4.7.3 - Organizational capabilities related to stakeholders relationship

Relationship with suppliers

Volvo Cars' supply chain is extensive, and to close loops, supplier relationships become even more complex as the company becomes a supplier to its own suppliers. In addition, the demands on suppliers are increasingly challenging and they must prepare in time to meet the increasingly stringent requirements imposed by Volvo Cars. The relationship with suppliers must therefore be a partnership based on transparency so that the company's direction is clear and they adjust their production standards. To do this, it is important to put in place specific training programs for suppliers and set shared targets (Respondent E, p.c., 2023).

Indeed, to make business more sustainable and implement circularity, suppliers play a key role. It is important to establish new requirements that they must meet: in addition to those on how the component works, there are now stringent requirements on how they must be assembled while also incorporating recycled content. In addition, the requirements also affect the suppliers' manufacturing processes, which must meet certain carbon emission standards (Respondent F, p.c., 2023).

Relationship with other external stakeholders

Important stakeholders with whom to maintain close relationships are retailers as they often also service the car and consequently are also responsible for sending back components at the end of their useful life. For the same reason, partnerships with recyclers and dismantlers are also important (Respondent E, p.c., 2023) and collaborations are currently being developed to have a constant flow of incoming materials from end-of-life components to close the loop (Respondent F, p.c., 2023).

Volvo Cars does not own the retailers and consequently cannot force them to take certain actions to make the business circular. It must therefore focus on spreading knowledge about the circular economy so that retailers understand its benefits both for the environment and in terms of business profitability. Developing specific knowledge is therefore crucial, and partnerships with research centers are important for this (Respondent E and F, p.c., 2023).

In addition, because Volvo has taken steps toward circularity before other industry players, there is a need to interact with institutions and legislators to work together to create laws to support the transition and circular practices (Respondent E, p.c., 2023).

Finally, although they do not play a key role in the transformation of operations to circular, it is important to keep consumers up to date on initiatives taken regarding circularity and to consider their feedback (Respondent E, p.c., 2023).

	Challenges to implement circularity in the business	
	Business related	*Cultural related*
Polestar	• Complexity of the supply chain • Difficulties in reconciling recycled materials with product specifications • Find alternative use of batteries in other industries • Minimize the impact of batteries and electric motors • Swap post industrial waste for post-consumer waste • Overcome the uncertainty in post-consumer waste streams • Minimize the uncertainty about the performance of recycled materials • Make up for the lack of recycled materials with zero emission virgin materials	• Change of mindset within the industry
AB Volvo	• Need to extend circularity policies in all of the nations in which the company operates • Circularity is just one of the challenges that the business has to face • Carry forward the circular transition in parallel with ongoing technological transformation	• Raise awareness on the efforts to be made to change the business model • Start considering circularity as an environmental value and an economic value • Think about circularity as an asset for the whole value chain • Difficulties in achieving cultural change as the effects of circular transition are seen in the long term
Volvo Cars	• Difficulties in undertaking the path towards circularity • Advance circularity initiatives in tandem with other business priorities • Different interdependences between functions compared to a linear business model • Choose the right timing in implementing conceptual solutions in the strategy • Satisfy the customers while meeting sustainability goals	• Rethink employee training by incorporating training on sustainability and circularity

Table 4 Summary of findings about challenges to implement circularity in the business

	Management and people capabilities for circularity implementation			
	Ways to ensure employees commitment	*Management skills*	*Green culture creation*	*Management and people practices*
Polestar	• ISO standards for lifecycle analysis • Filling the lack of international standards • Creation of internal standards and targets • Internal development of guidelines to calculate environmental impact • Integrate future regulations into corporate standards • Creation of a list of materials to avoid	• Managers need to understand what circularity really means and what are its benefits • Good level of technical knowledge • Good communication skills • Positive attitude towards circularity • Global vision of the necessary changes	• Knowledge sharing through the organization • Sharing values and information on sustainability and circularity with all workers • Sustainability training • Use of tools to measure sustainability by all workers	• Massive investment for new technologies • Each production process has requirements for engineers and workers • Need to follow a specific process for each model • Think about the durability of a component but also about its subsequent reuse
AB Volvo	• Clarity of goals and strategy • Communication and knowledge sharing to give everyone the skills related to their work • Company schools for skills and change • Train the workforce on the differences between linear and circular economy and the benefits of the latter • Guidelines and tools to assess and develop change towards circularity • Develop new KPIs to measure the transition • Tools and indicators to understand if circularity related aspects have been considered in the decision making process • Create structures for sharing results and best practices from the pilot projects across departments	• Top management plans the way forward and lower levels ensure priorities, resources and skills diffusion • Management must reconciliate different priorities, often proceed with limited resources, make sure that all teams have the appropriate tools and competences • Cultural change takes time and management must make people understand what the company wants to do, how and why • Ability to push the organization to achieve the new KPIs targets	• Setting targets for CO_2 emissions • Circularity culture is still under development while zero emissions culture has been well achieved	• Knowledge and values sharing with customers and society • Ability to explain the circular transition to consumers • Figure out what goals are to be achieved • Workers must be capable of competence change • Act for sustainability and circularity in the whole company departments and in society to spread the culture
Volvo Cars	• Customized targets according to the functions • Company indicators to align employees at all levels • Circularity as a priority and spread of its knowledge by managers	• Change management skills • Managers prone to listening	• Ability to attract people with specific skills • Putting sustainability and circularity among the priorities • Dialogue and transparency about ongoing operations on sustainability and circularity	• Implement the circular transition without losing the focus on other activities • Create pilot projects to update procedures • Knowledge sharing through cross functional work

Table 5 Summary of findings about management and people capabilities for circularity implementation

	Structure, product and processes capabilities for circularity implementation	
	Product development and production processes	*Best practices to create circular products*
Polestar	• Search new technologies to avoid loss of performance in recycled materials • Projects for increasing recycled content in the products • Design influenced by the lower number of materials used • Circular battery design • Analysis of a materials to be used as a first step in design	• Being able to apply material science in car construction • Synergy between engineering and design • Monomaterial components to ease recycling
AB Volvo	• Circularity projects based on the 6R framework • Efficiency obtained through few versatile products • Improve design of components to enable them to be used in multiple applications • Remanufacturing activities to extend the life of products and components • Remanufacturing of spare parts • Design for longer product life • Design the product to make repair, refurbishment and remanufacturing easier • Design for recycling • Avoid the use of scarce materials • Partnership between company and suppliers for product development • Circularity also in terms of production equipment • Evaluate alternatives to recycling such as selling the waste for use in other industries	• Set in place activities to recycle end-of-life products • Being able to use the right tools to provide the right solutions • Implementation of a purchasing unit specialized in circular and renewable materials • Set up reverse logistic programs • Implement certified second hand programs • Realize specific programs to regenerate construction equipment • Carry out pilot projects to implement circularity in various areas of the business • Develop waste sorting and recycling capabilities • Recycle and reuse waste and minimize virgin material use
Volvo Cars	• Greater attention to the type of materials used	• Need for planning in changing product development • Pilot projects to study new materials with recycled content • Tracking the environmental impact of vehicles through life cycle assessment

Table 6 Summary of findings about structure, product and processes capabilities for circularity implementation

	Stakeholder relationship capabilities for circularity implementation	
	Relationship with suppliers	*Relationship with other external stakeholders*
Polestar	• Simple suppliers become partners • Partnership with zero - emission suppliers • Set values to which suppliers must comply • Impose new material requirements • Circularity requirements to suppliers • Traceability of recycled material at all stages of the supply chain	• Importance of partnerships for recycling batteries and motors • Foster the relationship with end-of-life service providers • Maintain customer relationship throughout the car's lifecycle • Transparency to involve all the stakeholders in circular transition
AB Volvo	• Share with suppliers the objectives to be achieved • Make sure that requirements are respected along the whole value chain • Forming partnerships to grow together • Choose suppliers who share the same interest in circularity and sustainability	• Customers' feedback and cooperation are important • The value chain of customers must be involved in the cooperation for circularity • Set relationships with regulators to obtain favorable policies and incentives that help circular transition • Collaboration with end-of-life service providers • Create partnership with research institutions to develop tools and indicators for circular transition • Implement research projects about building ecosystems
Volvo Cars	• Ability to manage new relationships with suppliers in a circular perspective • Transparent relationships and collaborations with suppliers • Set specific requirements on suppliers • Impose requirements to ensure sustainability of components and processes • Put in place specific programs to educate suppliers	• Collaboration with end-of-life service providers to have a steady flow of recycled content materials • Close relationships with retailers • Educate retailers for a more sustainable future • Create partnerships with research centers that have specific knowledge • Make consumers aware of the circular initiatives undertaken • Build up dialogue with regulators and public institutions

Table 7 Summary of findings about stakeholder relationship capabilities for circularity implementation

5 - Discussion

In this chapter, the results that emerged from the empirical investigation are analyzed by relating them to each other and to the existing literature. To ensure the best clarity, the structure of the chapter recalls that of the previous one, presenting the analysis following the same categories.

5.1 - Challenges to implement circularity in the business

5.1.1 - Business related challenges

Business related challenges refer to the problems, obstacles and difficulties that companies in the automotive industry face in their daily activities in implementing the circular economy in their business. The challenges identified are cross-cutting, and the analysis showed that they mainly relate to the increasing complexity of the value chain and new production processes.

The main challenge that emerged from the interview with Polestar representatives is the complexity of the supply chain involving many suppliers spread across the globe. Indeed, as pointed out by Kissling et al. (2013) it is complicated to ensure that suppliers' operations are in line with the circularity initiatives carried out by the finished product company. Another difficulty related to geographic dispersion was reported by AB Volvo, which finds it challenging to extend circularity policies in all countries in which the company operates both in terms of production sites and suppliers. This aspect is also reflected in the literature: for Bakker et al. (2014) a supply chain barrier to circularity in the automotive industry is the geographic dispersion of supply chain partners.

Furthermore, in line with findings by Bocken et al. (2015) regarding external barriers to circular business model innovation at the value chain level, Polestar states that it is difficult to ensure that components with recycled content have the same specifications and performance as those made from virgin raw materials. Another challenge is ensuring the availability of recycled-content components that are remanufactured and repaired. Polestar currently uses components with post-industrial recycled content, i.e., materials generated from industrial waste: however, this waste is limited and ensuring

its constant availability is complicated. Therefore, although Polestar is diversifying by also making use of post-consumer waste, in line with what den Hollander et al. (2017) reported, it is important to overcome the uncertainty in recycled material flows. To make up for the shortage of recycled materials, the company argues that there is a need to use components made from zero-emission virgin raw materials.

In terms of reusing, recycling, and disposing of vehicle components at end-of-life, the most challenging aspect for Polestar is to minimize the impact of batteries and electric motors by finding alternative uses in other industries for batteries no longer suitable for vehicle traction. Here, in addition to the operational difficulties of the recovery processes, the company faces national and international regulations that are unfavorable (Rizos, et al., 2016).

Also internally, according to Volvo Cars, the circular transition leads to more complex relationships with business functions as the interdependence between them is greater than in a linear business model. This is partially reflected in the literature as Liu & Bai (2014), regarding organizational barriers to circularity in the automotive industry, identify existing linear operations and current function development targets as a barrier to circular transition.

Finally, both AB Volvo and Volvo Cars emphasized that the implementation of circularity is only one of the challenges facing companies in the automotive industry. In particular, for AB Volvo, the circular transition must be carried out in parallel with technological transformation, while Volvo Cars believes that the difficulty is in meeting the ever-increasing customer demand for customization, with the increased use of materials that goes with it, and at the same time achieving the goals in terms of sustainability and components circularity. To succeed in the transition, in line with what Bocken et al. (2016) reported about organizational enablers for circularity in the automotive industry, all the companies interviewed agreed that circular transition needs to be included as a priority in corporate strategy.

5.1.2 - Cultural related challenges

The business model of automotive companies is traditionally linear, and this is also reflected in values, beliefs, attitudes and behavior of the people who work in the industry. Embarking on such a radical transition involves a transformation of these deeply rooted aspects of corporate culture that cannot be changed overnight.

Among the barriers to circular business model innovation, Mont (2002) states that integrating sustainability issues into the production process increases the time to market of products, while ISPRA (2018) argues that redesigning products and processes from a circular perspective requires large investments. With specific regard to the automotive industry, Gumley (2014) identifies the long payback period of investments in component repair and remanufacturing technologies as the biggest financial barrier to the circular transition. For this reason, AB Volvo argues that the company must look at circularity not only as a value in terms of lower environmental impact but also as a means of creating greater economic value for itself and the entire value chain, avoiding reliance on traditional performance measurement systems but adopting a long-term perspective.

Finally, all the companies surveyed agreed that there is a need for a cultural change and that, in agreement with what Rizos et al. (2016) argued, it is held back by the lack of knowledge about the circular economy and the lack of technical skills that can implement it within the business. Therefore, Volvo Cars believes that for a mindset change within the industry there is a need to rethink staff training paths, including modules on sustainability and circularity to meet the challenge, mentioned by AB Volvo, of mobilizing people to change to a more sustainable business.

5.2 - Organizational capabilities for circularity

5.2.1 - Organizational capabilities related to management and people

This category includes those capabilities that enable management to support the transition to the circular economy by balancing the needs of customers with the need to create sustainable products by changing or modifying current business models. Specifically, the category encompasses the best practices and skills of managers needed

to ensure the involvement of all members of the organization in the circular transition and the capabilities needed to create a sustainable culture at all levels of the company.

Ways to ensure employees' commitment to circularity

All interviewees agree that to ensure the alignment of all people from different business functions in implementing circularity, guidelines and tools need to be formulated to assess and promote the circular transition. However, as pointed out by Polestar, there are no internationally recognized standards and targets: the ISO standards already used for vehicle lifecycle assessment (LCA) are a good starting point but have limitations, mainly due to the lack of an unambiguous calculation methodology. For this reason, as reported in the literature by Rattalino (2018) about organizational capabilities for the circular transition, internally creating ad hoc metrics for measuring sustainability and circularity performance, which also take into account increasing environmental regulation, is of paramount importance. In fact, as stated by Rizos et al. (2016), about internal barriers to circular business model innovation, and Liu & Bai (2014), about organizational barriers to implementing circularity in the automotive industry, the lack of unambiguous standards and tools is a barrier to circular transition.
Furthermore, in addition to the dynamic capability to measure and evaluate sustainability performance, AB Volvo and Volvo Cars point out that in order to gain the commitment of all employees, it is necessary to create customized KPIs for each business function in order to track the actions taken for the circular transition and ensure that aspects related to its implementation are taken into account during the decision-making process.

Finally, to ensure that all employees are aligned on the path the company has taken toward circularity and that best practices in the field are used throughout the organization, both AB Volvo and Volvo Cars emphasize the importance of knowledge sharing. In particular, ensuring optimal participation in the shift to a circular business model is crucial for AB Volvo, and this entails providing both theoretical knowledge regarding the advantages of the circular economy and technical expertise on the tools necessary for its implementation. This aspect is reflected in the literature about absorptive capabilities in relation to knowledge management and the ability to create a corporate culture conducive to learning and collaboration (Zahra & George, 2002). In

addition, AB Volvo stresses the importance of corporate universities to deliver specific circularity training and the need to create ad hoc organizational structures for sharing best practices implemented in circularity pilots carried out by different departments.

Management skills

The literature review found that internal barriers to circular business model innovation include managers' lack of commitment (ISPRA, 2018) and their risk aversion when return on investment occurs over a particularly long-time frame (Lacy & Rutqvist, 2015).

To overcome these obstacles, according to Polestar and AB Volvo, managers need to have a positive attitude and genuine interest in the circular transition, recognizing its benefits and planning the strategy to address the changes. In addition, in order to disseminate strategic priorities to all levels of the organization, managers need to have excellent communication skills and, as highlighted by Volvo Cars, be able to mobilize people to change and know how to manage it. This aspect complements what Khan et al. (2020) stated about the ability of top managers to support the transition to the circular economy by means of redesigning and improving current business models.

Another factor to consider is that the transition to a circular business model requires not only a change in production and design processes, but also a cultural change that occurs over a long period of time. Managers must explain to employees what the company wants to do, how and why. To accomplish this task, AB Volvo argues that managers must reconcile different business priorities, using limited resources and ensuring that all teams involved have the necessary tools and skills. This requires a good level of technical knowledge and strong listening skills to consider all the needs of the functions involved in strategy implementation.

Green culture creation

Rizos et al. (2016), list corporate culture, which has traditionally been influenced by the linear model of production and consumption, as one of the internal company barriers to circular business model innovation.

In this regard, the interviewees state that in order to create a circular business, it is important to incorporate sustainability into the corporate culture, which, in agreement

with Bocken et al. (2016) regarding enablers for circularity in the automotive industry, must be a priority in corporate strategy.

To foster the creation of a green culture, Polestar says it uses knowledge sharing on sustainability and circularity with all workers. The latter also receive specific training on the use of tools to measure sustainability performance in the production processes in which they are involved.

In addition, AB Volvo respondents claim the that zero-emission concept has been well learned by all workers as it is easy for the company to set targets on CO2 emissions and keep track of them. In contrast, the concept of business circularity is not yet well established and understood. In this regard, Volvo Cars considers it crucial not only to attract talent with strong environmental awareness, as stated by Prieto-Sandoval et al. (2019), but also to attract professionals with specific skills in implementing the circular economy.

Management and people practices for circular transition

Based on interviews with representatives from the three companies, it is possible to identify the best practices that employees need to implement to ensure the transition to a circular business model.

Polestar stresses the importance of channeling financial resources for massive investments in new technologies both for study and design, but also for remanufacturing, repair, and reuse of components. These investments, in accordance with AB Volvo and Bocken et al. (2016) statements about organizational enablers for circularity in the automotive industry, must be supported by a coherent, long-term strategy with specific and measurable goals for circularity projects.

All interviewees agreed that specific requirements must be established for each production process. In this regard, managers need to ensure that workers receive the necessary training to deal with new design and production processes. In line with what Prieto-Sandoval (2019) says about the ability to develop new ideas that create value for customers and stakeholders, Volvo Cars highlights the importance of involving workers in the search for innovative and sustainable solutions, including making use of cross functional teams and pilot projects in different business units.

Polestar also mentions best practices for engineers to follow when designing components: the focus is no longer just on the durability of the component but, in accordance with the operational principles of the circular economy reviewed in section 2.1.3, also on the use of materials that make it easily reusable and recyclable.

Finally, in accordance with what Prieto-Sandoval (2019) reported about consumer involvement in the design of circular products, AB Volvo argues that managers and people in the group need to be transparent with consumers about the initiatives undertaken for the circular transition.

5.2.2 - Organizational capabilities related to structure, product and processes

Based on the literature presented in Section 2.4.2, these organizational capabilities are related to eco-design, high-quality production with recycled or remanufactured materials, the establishment of efficient research and development departments, product remanufacturing, and the provision of efficient maintenance services.

Product development and production processes

Den Hollander et al. (2017), regarding product-related barriers to implementing the circular economy in the automotive industry, pointed out the difficulty in ensuring that components with recycled content have the same quality as those made from virgin raw materials. To overcome this problem, all respondents believe it is necessary to pursue research projects both to develop expertise related to materials science and to test new manufacturing technologies that can avoid the loss of performance of recycled materials. In addition, AB Volvo stresses the importance of projects based on the 6R framework, reviewed in section 2.1.2, to develop skills for resource optimization, remanufacturing, and component repair.

In agreement with all respondents, the design phase plays a key role in the development of a new vehicle. Consequently, in order to make the product circular, already at the design stage, cautions must be taken. In particular, in line with the "design out of waste principle" and the strategies of product life extension and material substitution, presented in section 2.1.3, it is necessary to design vehicles and their components in a modular way so that they are easier to repair, refurbish, and remanufacture. In addition, AB Volvo and Volvo Cars stress the importance of paying more attention to the type

of materials used, avoiding those that are scarce and preferring those that are easily recyclable.

Finally, making business circular requires rethinking production processes and adding new ones that were not covered in the traditional linear model of production and consumption. In particular, AB Volvo stresses the importance of developing remanufacturing activities both to extend the life of vehicles and their components and that of the machinery used along the production line.

Best practices to create circular products

The creation of circular products requires a change in materials and design strategies, as well as the modification and renewal of the organizational structure of companies in the automotive industry.

Regarding the latter, Mathews & Tan (2011) identified the creation of the reverse supply chain as an enabler to the implementation of circularity in the automotive industry. AB Volvo, in fact, has long had a reverse logistics program in place, is developing waste sorting and recycling capabilities for end-of-life products, and has created a specific business unit for remanufacturing construction equipment. In parallel, in order to profit from the latter activity, it has activated a certified second-hand program.

Moreover, in addition to having an efficient R&D department, a very important aspect also reported by Prieto-Sandoval et al. (2019) about organizational capabilities for the implementation of circularity, AB Volvo has a purchasing unit specialized in renewable and circular materials, while Volvo Cars carries out pilot projects in various departments, from design to engineering, to study new materials with recycled content. Finally, Polestar considers it of paramount importance to use monomaterial components to facilitate their recycling and to promote synergy between engineering and design so that the best material is chosen according to the design and vice versa.

5.2.3 - Organizational capabilities related to stakeholders relationship

Organizational capabilities related to "relationship with stakeholders" involve identifying environmentally friendly suppliers, implementing sustainable standards across the supply chain, and developing partnerships with suppliers through

information sharing, long-term relationships and incentive programs. They also involve partnering with governments to encourage eco-friendly practices.

Relationship with suppliers

Kissling et al. (2013) list among the value chain-level barriers to circular business model innovation the difficulty in ensuring that suppliers have a circular business. To overcome this obstacle, Bakker et al. (2014) point out that information sharing between supplier and manufacturer for material traceability at each stage of the value chain is critical. In this regard, Polestar believes it is important to establish information systems to track recycled materials throughout the supply chain.

In addition, to facilitate the transition to a circular business model, all interviewees agree that it is necessary to establish partnerships with zero-emission suppliers who have sustainability as a strategic priority, through transparent sharing of material circularity goals. Furthermore, in order to ensure compliance with corporate standards, Volvo Cars actively promotes specific programs for supplier education.

Relationship with other external stakeholders

Regarding the relationship with other external stakeholders, the companies interviewed believe that this should focus on maximum transparency, involving them in the circular transition, making them participants in the goals to be achieved. AB Volvo and Volvo Cars are sponsoring research projects in collaboration with numerous research institutions, in Sweden and abroad, so that they have access to specific technical expertise for materials processing and managerial expertise for developing metrics for evaluating the circular transition.

Also, in line with what Sousa-Zomer et al. (2018) said about partnerships with regulators to encourage eco-friendly practices and considering the institutional barriers examined in section 2.2.4, respondents believe lobbying is necessary for obtaining favorable policies and incentives for circular transition.

Other relationships that need to be carefully managed are those with consumers, retailers, and end-of-life service providers.

For the companies surveyed, it is important to build a strong relationship with their customers from the beginning to monitor the vehicle throughout its life cycle and maximize, in cooperation with retailers, the benefits of end-of-life vehicle take-back services.

Finally, to build an effective reverse logistics network, the three companies interviewed have close partnerships with end-of-life service providers that ensure a steady flow of materials for use in processing parts with recycled content.

6 - Conclusion

This chapter concludes the research and provides the answer to the research questions. In addition, the theoretical and managerial contribution of the study is highlighted. This is followed by limitations and directions for future research.

6.1 - Restatement of the research problem and purpose

The current model of production and consumption is no longer sustainable: there is a need to adopt a new one that values waste as a resource and extends product life cycles in response to increasing resource scarcity and environmental degradation. The automotive sector is highlighted as a pioneer in the circular economy due to the need to reduce its environmental impact: indeed, true carbon neutrality requires a fresh perspective on manufacturing processes that incorporate end-of-life product disposal and recycling. Nevertheless, the path towards circularity is plenty of barriers and new organizational capabilities need to be developed.

The purpose of the study is to contribute to existing research about circularity in the automotive industry, identifying the challenges faced by vehicles manufacturers in transitioning from a linear to a circular business model. In addition, the organizational capabilities utilized to overcome these challenges and facilitate the transition to a circular model were also uncovered. To achieve the research objective, a sample of three automotive companies based in Sweden, well known for their commitment to sustainability, was chosen to gain a better understanding of the challenges they face and the capabilities they employ to implement a circular business model.

6.2 - Addressing the research questions

Combining what emerged from the systematic literature review with the empirical investigation, organizational challenges and capabilities were grouped and categorized. For the former, two categories were identified: *business related* and *cultural related challenges*. For the latter, eight categories were traced and in turn distributed into the three dimensions suggested by Pais Seles et al. (2022). Namely, the eight categories of organizational capabilities identified refer to *ways to ensure employees' commitment to circularity*, *management skills*, *green culture creation*, *management and people practices for circularity*, *product development and production processes*, *best practices*

to create circular products, *relationship with suppliers* and *relationship with other external stakeholders*.

6.2.1 - Answering research question 1

Regarding *business related challenges*, the main challenge identified in the automotive sector for the transition to a circular business model is the complexity of the supply chain, which involves numerous suppliers scattered around the world. Another challenge relates to ensuring that components with recycled content have the same specifications and performance as those made from virgin raw materials. In addition, given the high demand and unfavorable waste legislation, it is complicated to ensure a continuous flow of recycled content to be used for component production. From an organizational point of view, on the other hand, circularity also means more complex internal relationships between business functions. Finally, another challenge is that the implementation of circularity is only one of the priorities facing automotive companies, along with technological transformation and increasing customer demand for customization.

Cultural related challenges are due to the traditional linear production model of automotive companies influencing the values, beliefs, attitudes and behavior of people working in the industry. The transition to circularity represents a radical change and therefore a change in mindset is necessary. Initiatives to make products circular and processes more sustainable should no longer be viewed as aspects that lengthen time to market and cause large investments, but as opportunities for the creation of greater value for the company and its value chain. Mobilizing people to change is therefore a major challenge that can only be met by rethinking training processes to spread a solid understanding of the circular economy.

6.2.2 - Answering research question 2

The companies interviewed also highlighted the organizational capabilities to be leveraged to overcome these challenges and achieve the goal of making business circular.

"Organizational capabilities related to management and people" are grouped into four categories.

In *ways to ensure employees' commitment to circularity* there are guidelines and evaluation tools to ensure alignment of all business functions on circularity initiatives, development of internal metrics that take into account environmental regulations to measure the circular transition, and KPIs that ensure that circularity aspects are taken into account throughout the decision-making process. Finally, this category also includes corporate universities for theoretical, technical training and sharing best practices for circularity.

The *management skills* category includes managers' positive attitude toward circular transition, excellent communication skills to convey strategic priorities to lower levels, and the ability to guide people during change. Finally, the category also encompasses managers' technical skills that enable them to understand what tools and resources each team should possess.

In addition, organizational capabilities for *creating a green culture* refer to the involvement of sustainability among the priorities of corporate strategy, specific training of workers in the use of tools to measure sustainability performance in the processes in which they are involved, and the ability to attract professionals with specific skills in implementing the circular economy.

Finally, the *management and people practices* category refers to the investment of substantial financial resources in new technologies for repairing, reusing, and remanufacturing components. Also included in this category are the adoption of specific standards for each production process, the use of materials that facilitate the reuse and recycling of components, the involvement of consumers in the design of circular products, and the implementation of cross functional teams to search for innovative and sustainable solutions.

Product development and production processes and *best practices to create circular products* are the categories identified for "organizational capabilities related to structure, product and processes".

Included in the first category are research projects to develop new skills related to materials science and to study new manufacturing technologies that avoid the loss of

performance of recycled materials. The use of easily recyclable materials and modular design practices for components so that they are easy to maintain, disassemble, and reuse also fall into this category. Finally, the research included in the category the development of remanufacturing activities to extend the life of vehicles and machinery used in their production.

The category *best practices to create circular products* refers to reverse supply chain development through reverse logistics programs, waste sorting and recycling capabilities of end-of-life products, use of monomaterial components, and implementation of pilot projects to study new materials with recycled content. Also, in the category are the creation of specific business units to remanufacture vehicles, the implementation of certified second-hand programs for their sale, and the use of purchasing units specializing in renewable materials. Finally, best practices also include the promotion of synergy between engineering and design.

To conclude, "organizational capabilities related to stakeholders relationship" were grouped into two categories: *relationship with suppliers* and *relationship with other external stakeholders*.

The first category includes information sharing between supplier and manufacturer through information systems to track recycled materials throughout the value chain, the development of partnerships with zero-emission suppliers, and circular economy education programs targeting them.

The second category, on the other hand, is devoted to capabilities to be leveraged to interface with other external stakeholders such as research institutions, regulators, consumers, retailers, and end-of-life service providers.

Among the organizational capabilities belonging to this category is the promotion of research projects to gain access to specific technical expertise for materials processing and managerial expertise for developing indicators to evaluate actions taken in terms of the circular economy. Lobbying for legislation favorable to the circular transition, building strong relationships with customers and retailers to monitor the vehicle throughout its life cycle, and developing partnerships with end-of-life service providers to have a steady stream of recycled materials also fall into this category.

6.3 - Theoretical and managerial implications

This research has helped identify the challenges that companies in the automotive industry face in making their business model circular. In addition, it helped to outline the organizational capabilities that automotive manufacturers need to leverage for this transition.

Specifically, through empirical investigation, the challenges were divided into business related and cultural related, and the organizational capabilities into eight categories, divided into three dimensions previously emerged in the literature: "management and people", "structure, product, processes", and "relationship with stakeholders".

Accordingly, the theoretical contribution of the thesis consists of a systematic categorization that facilitates the understanding of the challenges and organizational capabilities needed for the transition of automotive companies to a circular model.

From a managerial perspective, the thesis has two main implications.

First, the discussion of the challenges of implementing circularity in business may prove useful to companies in the industry that are in the early stages of the transition to the circular economy. These, in fact, knowing in advance what lies ahead, can prepare themselves by acquiring the skills and resources needed to handle the increased complexities of the circular business model.

In addition, the analysis of organizational capabilities for circularity, on the one hand, allows automotive industry players to identify the competencies they already have and can leverage, and on the other hand, allows them to understand which ones they do not have and need to be developed.

6.4 - Limitations and future research

The study has some of the inherent limitations of qualitative research. The limited number of respondents, due to the time constraint to conduct the research and the difficulty in obtaining the interviews, affects the generalizability of the results. In addition, the analysis of the empirical results may have been affected by the subjectivity of the researcher: in fact, although the interviews were transcribed using AI software, the coding and interpretation of them was done by the thesis author alone.

Moreover, a limitation is the fact that the interviewees, not having signed a non-disclosure agreement with the author, were in some cases reticent to provide the information.
Finally, another limitation is related to the position the interviewees hold within the companies: they almost all have managerial roles and, while they have a very good overview of the actions taken to transition to the circular economy, they may not have an understanding of the challenges faced by more operational roles.

Based on the limitations that emerged, future research could expand the sample of companies and include vehicle manufacturers based in countries other than Sweden.
Moreover, since the empirical investigation shows that the circular transition implies greater supply chain complexity, the research could be expanded by interviewing suppliers of vehicle manufacturers as well.
In addition, the results of this thesis could lay the groundwork for quantitative research to test the results obtained.
Finally, future research could focus on developing unambiguous business metrics to evaluate the transition to the circular economy, considering the current absence of them.

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Appendix - Interview Guide

Introduction

- Introduction of research topic and purpose.
- Ask the permission for recording and citing the respondent's name.

Interview questions

Interviewee overview	1. Can you describe your role within the organization? 2. How is your role related to the implementation of circularity in the business?
Circularity initiatives	3. What are the circularity initiatives implemented by your company? 4. In this regard, what were and are the most difficult challenges?
Management and people	5. Creating a circular business model requires the commitment of the entire organization. How do you ensure that everyone involved is on the same page? Are there tools, guidelines and standards to facilitate this? 6. What is the role of top managers in circularity initiatives? What are the challenges? What skills/capabilities do managers need to have? 7. The transition to circularity requires new capabilities from all workers. How has talent management and training changed? How is the creation of a green culture fostered within your organization? 8. What are the behaviors, processes and routines for circular transition?
Structure, product and processes	9. How does circularity change product development and production processes? 10. What skills are required for the realization of green products and processes? In particular, what are the best practices related to eco-design and the development of material recovery technologies?
Relationship with stakeholders	11. Circularity requires the collaboration of all actors involved in the value chain. In particular, how does the relationship with suppliers change? 12. How are suppliers selected and what requirements do they have to fulfil? 13. Apart from suppliers, which other external stakeholders play a key role for your organization? 14. How do you manage the relationship with them and how do you make sure they are in line with your circular business?

Conclusion

- I don't have any further questions. But if you think that you have to say something important to cover the topic of this interview, please feel free to add whatever you want.
- To make sure I got your words right, can I send you the transcript of the interview so you can validate it?
- If you like, I will send you the final report with the results.

Summary

INTRODUCTION

The circular economy is a topic we have been hearing a lot about in recent years: the scarcity of resources and the degradation of the environment are forcing us to review the traditional linear model of take-make-dispose production and consumption. To transform the economy by eliminating production waste, reusing materials used in production and regenerating the surrounding environment in which the business operates, a decisive step change is needed to put circularity at the heart of business activities (Ahmad, et al., 2023).

By implementing the circular economy, negative externalities on the environment are reduced and sustainable development is promoted. Circular economy represents a new way for companies to create and extract value from their business by exploiting the paradigms of reuse, repair, remanufacturing and recycling (Rodriguez-Gonzalez, et al., 2022).

The automotive sector is among the pioneers of the circular economy, an indispensable strategy to reduce its environmental impact and achieve climate neutrality (World Economic Forum, 2023).
Indeed, together with the importance of powertrain electrification, the automotive sector must address pollutants that are inherent in car materials. Considering the widespread use of electric mobility, lifecycle emissions from vehicles will be increasingly ascribed to the materials from which they are manufactured: for this reason, the time to implement circularity in the automotive industry is now (World Economic Forum, 2023). However, the path towards circularity is plenty of barriers and new organizational capabilities need to be developed.

Given the increasing emphasis on the topic, business research has produced a considerable amount of knowledge on the circular economy and its management. Management scholars have focused on defining the meaning of circular business models, mostly expanding the definition of BM considering the operational principles of the circular economy. Strategies to innovate business models and make them circular were also analyzed: the focus was thus on the creation of circular business models and

their implementation in specific industries. Other scholars have instead focused on enablers and barriers towards the circular transition of business models, providing a categorization based on several levels: from product and process design to value chain management. Additionally, also enablers and barriers at the financial, organizational and market level were analyzed. Nevertheless, few of the existing studies have deepened the role of organizational capabilities for a successful transition to a circular business model and the main challenges to be overcome.

To fill this gap, the author chose to analyze three companies in the automotive sector that have been investing a lot of resources in recent years to make their business circular. The companies examined are Polestar, AB Volvo and Volvo Cars. The targets of these three companies are different segments of the automotive industry. In particular, Polestar deals with the production of full electric vehicles, AB Volvo is the world's largest manufacturer of trucks, buses and construction machinery while Volvo Cars specializes in light vehicles. The choice fell on these three companies to provide a comprehensive view of the challenges they face and the organizational capabilities they deploy for the circular transition.

RESEARCH QUESTIONS AND PURPOSE

The study aims to provide evidence on the challenges that automotive companies are facing for the circular transition and on the new organizational capabilities to be developed in terms of human resource management, product development, processes, and relationships within the value chain. Consequently, the author identified the following research questions:

Research question 1:

"What are the challenges to implement circularity in the business models of automotive manufacturers?"

Research question 2:

"What organizational capabilities are required for this implementation?"

The choice of these research questions is because the author wants to help identify the challenges that companies in the automotive industry face in making their business model circular and outline the organizational capabilities that automotive manufacturers need to leverage for this transition. Moreover, the discussion of the challenges of implementing circularity in business may prove useful to companies in the industry that are in the early stages of the transition to the circular economy: knowing in advance what lies ahead, they can prepare themselves by acquiring the skills and resources needed to handle the increased complexities of the circular business model.

Finally, the analysis of organizational capabilities for circularity allows automotive industry players to identify the competencies they already have and which ones they do not have and need to be developed.

LITERATURE REVIEW

The theoretical foundation for conducting the study consists of a literature review divided into four sections: introduction to circular economy, circular business model, circularity in the automotive industry and organizational capabilities for circularity.

The first section examines the limits of the linear production and consumption model and highlights the need for a circular model. The linear model assumes resources are unlimited, but in reality, losses occur at various points in the value chain, including waste in production, end-of-life waste, energy use, and ecosystem erosion (Ellen MacArthur Foundation, 2013). On the contrary, according to the operating principles of circular economy, the circular model aims to preserve the intrinsic value of materials and keep products and components in cycles as long as possible to reduce waste and minimize the use of virgin raw materials (Ekins, et al., 2019).

Moreover, in this section the 6R framework is presented. This framework, whose acronym means reduce, repair, reuse, recover, remanufacturing, and recycling, provides a course of action that companies must follow to make their business circular and identify potential new sources of value creation (Ghisellini & Ulgiati, 2020).

The following section is devoted to circular business models. A definition is provided and four strategies for their implementation are presented: cycling (the process of

reusing, remanufacturing, refurbishing and recycling materials and energy within a system), extending (product's use phase is extended by using durable and timeless design, marketing that promotes prolonged use phases, maintenance and repair), intensifying (enhance the product's use phase through initiatives like sharing economy and public transport), and dematerializing (the delivery of product utility without hardware, through the use of service and software solutions) (Geissdoerfer, et al., 2020). Finally, barriers to circular business model innovation are examined. These can be categorized into external barriers at the market, institutional, and value chain level, as well as internal barriers at the organizational and employee level (Guldmann & Huulgaard, 2020). Regulatory barriers, such as the legal classification of materials as waste, and the patenting of components by companies, make it difficult to reuse and recycle materials (Rizos, et al., 2016). Difficulties in ensuring circularity throughout the value chain and maintaining product quality are also significant barriers (Bocken, Rana, & Short, 2015). At the organizational level, designing products for circularity (Sundin, Lindahl, & Ijomah, 2009), implementing a cultural paradigm shift (Rizos, et al., 2016), and investing in circularity are major challenges (ISPRA, 2018). Furthermore, incentive systems based on traditional business performance indicators discourage the implementation of circular business models (Mont, 2002). At the employee level, a lack of knowledge and technical capabilities to create a circular business model (Rizos, et al., 2016) and a lack of commitment from top management (ISPRA, 2018) are significant barriers.

The third section focuses on circularity in the automotive industry, with special reference to enablers and barriers.

The enablers and barriers are categorized into four areas: product and process, economic/financial, organizational, and supply chain/customer management (Urbinati, et al., 2021). Product and process-related enablers include technologies and methods that optimize resource use, remanufacturing, and regeneration of by-products, as well as sharing solutions with superior consumer experience and convenience (Bakker, et al., 2014). Economic/financial enablers refer to the scarcity of resources and their increasing price that can stimulate companies to achieve resource efficiency (Ghisellini, Cialani, & Ulgiati, 2016), reducing the costs and the risks of accessing virgin materials,

new revenue streams and new value creation, business growth and increase in margin and profits (Linder & Williander, 2017). Organizational enablers involve prioritizing circularity within the company's strategy, developing internal skills and capabilities, and raising environmental awareness (Bocken, et al., 2016). Supply chain/customer management enablers refer to the availability and proximity of suitable partners and end users, which eases coordination and traceability (Bakker, et al., 2014). Barriers in each area are also identified, such as the quality and quantity of returned products (den Hollander, Bakker, & Hultink, 2017), the high costs of new technologies and uncertainty around returns on investments (Gumley, 2014), conflicts with existing organizational culture (Liu & Bai, 2014), and complexities in logistics management due to geographical dispersion of supply chain partners and end-users (Bakker, et al., 2014).

In the last section, three dimensions of organizational capabilities for making business circular are identified and a categorization is provided.

Sehnem et al. (2022) classify these capabilities into four categories: dynamic, relational, innovation, and absorptive capabilities. Dynamic capabilities are the ability to continuously adapt and innovate in response to changing market conditions and consumer needs (Teece, Pisano, & Shuen, 1997). Relational capabilities are the ability to build and maintain relationships with stakeholders, particularly with customers, suppliers, and partners (Czakon, 2009). Innovation capabilities refer to the ability to generate and implement new ideas that create value for customers and stakeholders (Sehnem, et al., 2022). Absorptive capabilities are the ability to identify, assimilate and apply external knowledge, information, and resources to enhance innovation and performance (Zahra & George, 2002).

In addition, three dimensions of organizational capabilities for circularity are identified (Pais Seles, et al., 2022): "management and people", "structure, product and process", and "relationship with stakeholders". The first dimension includes capabilities such as understanding the regulatory framework (Sousa-Zomer, et al., 2018), involving customers in sustainable product design (Prieto-Sandoval, et al., 2019), and management ability to support the transition to a circular economy (Rattalino, 2018). Included in this dimension the ability to measure and evaluate sustainability performance (Rattalino, 2018), the ability to attract talent with environmental

awareness in order to create a green culture (Prieto-Sandoval, et al., 2019) and the ability to develop training courses on the subject at all levels of the organization (Mura, Longo, & Zanni, 2020). The second dimension focuses on the ability to use innovative technologies for eco-design (Scarpellini, et al., 2020), reconcile high-quality production with recycled or remanufactured materials (Hsieh, et al., 2017), and create processes for remanufacturing and efficient maintenance services (Prieto-Sandoval, et al., 2019). Finally, the third dimension concerns the ability to identify suppliers with low environmental impact (Mura, Longo, & Zanni, 2020), develop sustainable material and component system that ensures compliance with certain sustainable standards, and cooperate with stakeholders through information sharing, long-term relationships, and circularity incentive programs (Sousa-Zomer, et al., 2018).

METHODOLOGY

The researcher aims to discover new concepts and produce generalizable explanations based on empirical observation of a phenomenon (Harley, Bell, & Bryman, 2018). Particularly, organizational capabilities to implement circularity in the automotive industry business models are an unexplored aspect of the current literature. The challenges associated with this implementation also need to be investigated further. For this reason, an inductive approach is the most suitable for this exploratory research.
Considering the use of the inductive strategy to link empirical evidence and theory, the qualitative approach is particularly suitable for answering the research questions. The qualitative approach allows for a more extensive explanation of various aspects of the observed phenomenon according to the issues addressed in the interviews by the different respondents involved in the implementation of CE. Furthermore, considering that the implementation of circularity requires the deployment of new organizational capabilities, from product design and production to stakeholder relations and employees' management, qualitative analysis can highlight practices, procedures and standards used to cascade the circular paradigm within the organization.

To answer the research question, the author considers it appropriate to use a multiple case study: the results are obtained based on a detailed and in-depth analysis of three cases: Polestar, a Swedish company specialized in the production of full electric performance cars, AB Volvo, a company active in the manufacture of trucks, buses and

machinery, and Volvo Cars, producers of light vehicles. These companies were chosen because they are leaders in the circularity of the vehicles they produce. They embarked on a journey to make their vehicles as circular as possible and did so much earlier than their competitors. This implies that they faced and developed the capabilities to overcome the challenges of circularity earlier than others.

Before start collecting the primary data, to understand what is already known about the topic and to provide a theoretical foundation that works as a starting point for the research work, it is necessary to gather what has already been written in literature about circularity transition. To this end, the author performed a systematic literature review. The inclusion and exclusion criteria are shown in the table below.

Inclusion criteria	Exclusion criteria
Papers dealing with: • Circular economy definition • Circularity in the manufacturing industry • Circularity in the automotive industry • Sustainable and circular business model • Organizational capabilities for circularity	Papers that: • Analyze circular economy from a technical perspective • Analyze circularity in industries other than those considered in the inclusion criteria • Are not related to the discipline of business, management and accounting

Table 8 Inclusion and exclusion criteria

In line with the qualitative nature of the research strategy, primary data were collected using semi-structured interviews: the interviewees had the opportunity to express their knowledge in depth as semi-structured interviews guarantee complete freedom of expression.

The sample of interviewees were identified following the purposive sample approach. The interviewees have a good knowledge of the subject matter and, above all, hands-on experience: they have a relevant role within the organizations under analysis and in particular it is related to the implementation of circularity in the business model. The contacts were facilitated by the intermediation of FIRST TO KNOW and, according to the snowball sampling, at the end of the interviews, the interviewees were asked to point out other key respondents. In addition, some interviewees were found by the researcher by entering the word “circularity” followed by the name of the companies being studied in the LinkedIn search bar.

The interview transcripts were analyzed using thematic analysis. The latter is a valuable tool for rigorously analyzing the content of the transcripts and tracing common themes throughout the interviews. Considering the inductive approach and exploratory nature of the research, the freedom with which labels can be attributed facilitates the interpretation of a large amount of text and makes it easier to identify connections between concepts. Such a rigorous approach is therefore very useful for new theory building (Gioia, Corley, & Hamilton, 2013).

FINDINGS AND DISCUSSION

The analysis of the findings led to identify challenges related to the increased complexity of the value chain and to the need for a change in organizational culture. Furthermore, based on the current literature, organizational capabilities are distinguished in relation to three dimensions: "Management and people", "Structure, product and process", and "Relationship with stakeholders". The table below provides an overview of the categories identified with the empirical investigation.

Challenges to implement circularity in the business		Organizational capabilities for circularity		
Business related challenges	**Cultural related challenges**	**Management and people** - Ways to ensure employees' commitment to circularity - Management skills - Green culture creation -Management and people practices	**Structure, product, processes** - Product development and production processes - Best practices to create circular products	**Stakeholders relationship** - Relationships with suppliers - Relationships with other external stakeholders

Table 9 Overview of the categories identified with the empirical investigation

Challenges to implement circularity in the business

Business related challenges

Business related challenges refer to the problems, obstacles and difficulties that companies in the automotive industry face in their daily activities in implementing the circular economy in their business.

The interview with Polestar representatives revealed that a significant challenge is represented by the complexity of the supply chain, which involves numerous suppliers located worldwide. Indeed, according to Kissling et al. (2013), aligning suppliers' operations with the circularity initiatives carried out by the finished product company is a complex task. Moreover, AB Volvo finds challenging to extend circularity policies in all countries in which the company operates both in terms of production sites and suppliers. This aspect is in line with Bakker et al. (2014) who highlight geographic dispersion as a supply chain barrier to achieving circularity in the automotive industry.

Furthermore, Polestar states that it is difficult to ensure the availability of recycled-content components and to ensure that they have the same specifications as those made from virgin raw materials. Polestar currently uses components with post-industrial recycled content: however, this waste is limited and ensuring its constant availability is complicated. Therefore, in line with what den Hollander et al. (2017) reported, to make up for the shortage of recycled materials, the company argues that there is a need to use components made from zero-emission virgin raw materials.

In terms of reusing, recycling, and disposing of vehicle components at end-of-life, the most challenging aspect for Polestar is to minimize the impact of batteries and electric motors by finding alternative uses in other industries for batteries no longer suitable for vehicle traction. Here, in addition to the operational difficulties of the recovery processes, the company faces national and international regulations that are unfavorable (Rizos, et al., 2016).

Moreover, Liu & Bai (2014) identify existing linear operations and current function development targets as a barrier to circular transition. In this regard, Volvo Cars claims that the circular transition leads to more complex relationships with business functions as the interdependence between them is greater than in a linear business model.

Finally, both AB Volvo and Volvo Cars emphasized that the implementation of circularity is only one of the challenges facing companies in the automotive industry. For this reason, in line with what Bocken et al. (2016) reported about organizational enablers for circularity in the automotive industry, all the companies interviewed agreed that circular transition needs to be included as a priority in corporate strategy.

Cultural related challenges

Embarking on the circular transition involves a transformation of deeply rooted aspects of corporate culture such as values, beliefs, attitudes and behavior that cannot be changed overnight.

Among the barriers to circular business model innovation, the longer time to market due to sustainability concerns in the production process (Mont, 2002) and the large investments to redesign products from a circular perspective (ISPRA, 2018). For this reason, AB Volvo argues that the company should avoid relying on the traditional performance measurement systems and adopt a long-term perspective.

Finally, the cultural change needed to succeed in the transition is held back by the lack of knowledge about the circular economy and the lack of technical skills that can implement it within the business. Therefore, Volvo Cars and AB Volvo believe that there is the need to rethink staff training paths, including modules on sustainability and circularity, to mobilize people to change to a more sustainable business.

Organizational capabilities related to management and people

The category encompasses the best practices and skills of managers needed to ensure the involvement of all members of the organization in the circular transition and the capabilities needed to create a sustainable culture at all levels of the company.

Ways to ensure employees' commitment to circularity

All interviewees agree that to ensure the alignment of all people from different business functions in implementing circularity, guidelines and tools need to be formulated to assess and promote the circular transition. However, Polestar claims that there are no internationally recognized standards and targets. For this reason, according to Rattalino (2018), internally creating ad hoc metrics for measuring sustainability and circularity performance, which also take into account increasing environmental regulation, is of paramount importance. In addition, AB Volvo and Volvo Cars point out that to gain the commitment of all employees, it is necessary to create customized KPIs for each business function to track the actions taken for the circular transition.

Finally, to ensure that all employees are aligned on the path the company has taken toward circularity and that best practices in the field are used throughout the organization, both AB Volvo and Volvo Cars emphasize the importance of knowledge sharing through corporate universities and ad hoc organizational structures. Indeed, as pointed out by Zahra & George (2002), knowledge management and the ability to create a culture of learning and collaboration are two important absorptive capabilities.

Management skills

The literature review found that internal barriers to circular business model innovation include managers' lack of commitment (ISPRA, 2018) and their risk aversion when return on investment occurs over a particularly long-time frame (Lacy & Rutqvist, 2015). To overcome these obstacles, according to Polestar and AB Volvo, managers need to have a positive attitude and genuine interest in the circular transition, recognizing its benefits and planning the strategy to address the changes.

In addition, as highlighted by Volvo Cars, to disseminate strategic priorities to all levels of the organization and be able to mobilize people to change, managers need to have excellent communication skills.

Finally, managers must be able to explain to employees what the company wants to do to address the circular transition. To accomplish this task, AB Volvo argues that managers must have a good level of technical knowledge and strong listening skills to consider all the needs of the functions involved in strategy implementation.

Green culture creation

Rizos et al. (2016), list corporate culture, which has traditionally been influenced by the linear model of production and consumption, as one of the internal company barriers to circular business model innovation. To overcome this barrier, all interviewees state that it is important to incorporate sustainability into the corporate culture. In order to foster the creation of a green culture, Polestar says it uses knowledge sharing on sustainability and circularity with all workers.

Moreover, AB Volvo claims that the concept of business circularity is not yet well established and understood. For this reason, Volvo Cars considers it crucial not only to attract talent with strong environmental awareness, as stated by Prieto-Sandoval et al. (2019), but also to attract professionals with specific skills in implementing the circular economy.

Management and people practices for circular transition

Among the best practices that employees need to implement to ensure the transition to a circular business model, Polestar stresses the importance of channeling financial resources for massive investments in new technologies both for study and design, but also for remanufacturing, repair, and reuse of components. These investments, according to AB Volvo and Bocken et al. (2016), must be supported by a coherent, long-term strategy with specific and measurable goals for circularity projects.

Moreover, all interviewees agreed that specific requirements must be established for each production process and managers need to ensure that workers receive the necessary training to deal with new design and production processes. In addition, in line with what Prieto-Sandoval (2019) says about the ability to develop new ideas that create value for customers and stakeholders, Volvo Cars highlights the importance of involving workers in the search for innovative and sustainable solutions, while AB Volvo underlines the importance of involving customers in the design of circular products.

Organizational capabilities related to structure, product and processes

These organizational capabilities are related to eco-design, high-quality production with recycled or remanufactured materials, the establishment of efficient research and development departments, product remanufacturing, and the provision of efficient maintenance services.

Product development and production processes

To overcome the difficulty in ensuring that components with recycled content have the same quality as those made from virgin raw materials, all respondents believe it is necessary to pursue research projects both to develop expertise related to materials

science and to test new manufacturing technologies that can avoid the loss of performance of recycled materials.

Moreover, to make the product circular, already at the design stage, cautions must be taken. In particular, it is necessary to design vehicles and their components in a modular way, paying attention to the type of materials used, so that they are easier to repair, refurbish, and remanufacture.

Finally, making business circular requires rethinking production processes and adding new ones: an example is represented by the remanufacturing activities carried out by AB Volvo to extend the life of vehicles and their components and that of the machinery used along the production line.

Best practices to create circular products

The creation of circular products requires a change in materials and design strategies, as well as the modification and renewal of the organizational structure of automotive companies. Regarding the latter, AB Volvo has long had a reverse logistics program in place, is developing waste sorting and recycling capabilities for end-of-life products and, in addition to having an efficient R&D department, a very important aspect also reported by Prieto-Sandoval et al. (2019), AB Volvo has a purchasing unit specialized in renewable and circular materials. In addition, Volvo Cars carries out pilot projects in various departments, from design to engineering, to study new materials with recycled content.

To conclude, Polestar considers it of paramount importance to use monomaterial components to facilitate their recycling and to promote synergy between engineering and design.

Organizational capabilities related to stakeholders relationship

This category involves identifying environmentally friendly suppliers, implementing sustainable standards across the supply chain, and developing partnerships with suppliers. It also involves partnering with governments to encourage eco-friendly practices.

Relationship with suppliers

According to Kissling et al. (2013), it is difficult to ensure that suppliers have a circular business.

To overcome this problem, Polestar believes it is important to establish information systems to track recycled materials throughout the supply chain.

In addition, all interviewees agree that it is necessary to establish partnerships with zero-emission suppliers while Volvo Cars stresses the need for specific programs for supplier education that guarantee the compliance with corporate standards.

Relationship with other external stakeholders

The companies interviewed believe that the relationship with other external stakeholders should focus on transparency, making them participants in the path towards circularity. AB Volvo and Volvo Cars are sponsoring research projects in collaboration with numerous research institutions to access technical and managerial expertise.

Also, considering the institutional barriers, respondents believe lobbying is necessary for obtaining favorable policies and incentives for circular transition.

Moreover, all the companies agree on the need to build a strong relationship with their customers to monitor the vehicle throughout its life cycle and maximize, in cooperation with retailers, the benefits of end-of-life vehicle take-back services.

Finally, to build an effective reverse logistics network, the three companies have close partnerships with end-of-life service providers that ensure a steady flow of materials for use in processing parts with recycled content.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

Combining what emerged from the systematic literature review with the empirical investigation, organizational challenges and capabilities were grouped and categorized. For the former, two categories were identified: *business related* and *cultural related challenges*. For the latter, eight categories were traced and in turn distributed into the three dimensions suggested by Pais Seles et al. (2022). Namely, the eight categories of

organizational capabilities identified refer to *ways to ensure employees' commitment to circularity, management skills, green culture creation, management and people practices for circularity, product development and production processes, best practices to create circular products, relationship with suppliers* and *relationship with other external stakeholders*.

Future research could expand the geographical scope of the companies and include vehicle manufacturers based in countries other than Sweden.

Moreover, since the empirical investigation shows that the circular transition implies greater supply chain complexity, the research could be expanded by interviewing suppliers of vehicle manufacturers as well.

In addition, the results of this thesis could lay the groundwork for quantitative research to test the results obtained.

Finally, future research could focus on developing unambiguous business metrics to evaluate the transition to the circular economy, considering the current absence of them.