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*The evolution of circular business models in the context of repair*

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## **Statutory Declaration**

I declare that I have written this thesis independently, that I have not used any sources other than those stated, and that I have marked the passages taken from the sources as such, either verbatim or in terms of content. The thesis has not yet been submitted in the same or a similar form to any other domestic or foreign examination authority and has not yet been published. The present version corresponds to the submitted electronic version.

## **Acknowledgement**

At this point, I want to express my appreciation to everyone who encouraged and supported me throughout the process of completing this master's thesis.

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## Abstract

This master's thesis tackles the global issue of resource overuse by examining the repair strategy, an integral component of the circular economy system, which counteracts the linear economy by closing resource cycles. Repair ensures that defective products are returned to their initial function, thus extending their life span. Despite the importance of repair, potential customers often lack confidence in businesses offering repair and face other barriers such as comparatively high repair costs to low replacement costs. In turn, companies within the sector are confronted with several difficulties preventing them from meeting customer requirements, like missing (affordable) spare parts. Therefore, the objective of this study is to generate insights and approaches to strengthen the repair sector by placing the focus of research on the intersection between the potential consumers and the repair providers.

A structured literature review is conducted to obtain a multi-perspective observation, considering repair clients, repair businesses and relevant research and innovation projects, using various data channels, the platforms Scopus, ScienceDirect, proceedings of the PLATE conference, websites of repair businesses/organisations, as well as project databases at EU and national level. After a detailed description of the data gathering process, these documents are analysed using qualitative content analysis according to Mayring.

The findings reveal four categories of customers' repair-decision considerations. Firstly, economic considerations driven by consumers, such as the above-mentioned repair price, are emphasised, but also socio-ecological factors, like previous repair experience. Furthermore, economic considerations of the providers, including spare part availability, are confirmed as decisive factors, as well as repair awareness and skills. In addition, nine business strategy patterns covering a broad range from remote repair diagnosis to design for repairability are recognised. These business concepts are in turn evaluated in a mapping process regarding their potential to fulfil the identified user demands. Thereby, opportunities emerge to increase repair engagement and convenience, alongside promising cooperation approaches in the repair sector.

*Keywords: Circular Economy, Repair, Business models*

## **Zusammenfassung**

Diese Masterarbeit befasst sich mit dem globalen Problem der Ressourcenübernutzung, indem die Reparatur-Strategie beleuchtet wird. Diese ist ein integraler Bestandteil des Konzepts der Kreislaufwirtschaft, welche durch die Schließung von Ressourcenkreisläufen der linearen Wirtschaft entgegensteht. Die Reparatur ermöglicht die Rückführung defekter Produkte in ihre ursprüngliche Funktion und verlängert so ihre Lebensdauer. Trotz der Bedeutung der Reparatur fehlt potenziellen Kunden oft das Vertrauen in Reparaturdienstleistungs-Unternehmen, bzw. stoßen sie auf andere Hindernisse, z. B. hohe Reparaturkosten im Verhältnis zu niedrigen Ersatzkosten. Die Unternehmen des Sektors wiederum sehen sich mit verschiedenen Schwierigkeiten konfrontiert, die sie daran hindern, die Kundenanforderungen zu erfüllen, wie fehlende (erschwingliche) Ersatzteile. Ziel dieser Studie ist es daher, Erkenntnisse und Ansätze zur Stärkung des Reparatursektors zu generieren, indem der Forschungsschwerpunkt auf die Schnittstelle zwischen den potenziellen Konsumenten und den Reparaturanbietern gelegt wird.

Eine strukturierte Literaturrecherche wird durchgeführt, um eine multiperspektivische Betrachtung zu erhalten, die Reparaturkunden, Reparaturunternehmen und relevante Forschungs- und Innovationsprojekte berücksichtigt. Dabei werden verschiedene Datenkanäle genutzt, die Plattformen Scopus, ScienceDirect, Proceedings der PLATE Konferenz, Websites von Reparaturunternehmen/Organisationen, sowie Projektdatenbanken auf EU- und nationaler Ebene. Nach einer detaillierten Beschreibung des Datenerhebungsprozesses werden diese Dokumente mittels qualitativer Inhaltsanalyse nach Mayring analysiert.

Die Ergebnisse lassen vier Kategorien von Erwägungen erkennen, die Kunden bei ihren Reparaturrentscheidungen anwenden. Einerseits werden ökonomische Aspekte seitens der Konsumenten, wie der bereits erwähnte Reparaturpreis, hervorgehoben, aber auch sozio-ökologische Faktoren, wie frühere Reparatur Erfahrungen. Darüber hinaus werden wirtschaftliche Erwägungen auf Seiten der Anbieter, darunter die Ersatzteilverfügbarkeit, als ausschlaggebende Faktoren bestätigt, ebenso wie das Reparaturbewusstsein und die Reparaturfähigkeiten. Diese Geschäftskonzepte werden im Rahmen eines Mapping-Prozesses hinsichtlich ihres Potenzials zur Erfüllung der identifizierten Kundenanforderungen bewertet. Daraus ergeben sich Möglichkeiten, das Reparatur-Engagement und die Nutzerfreundlichkeit zu erhöhen, sowie vielversprechende Kooperationsansätze im Reparatursektor.

*Schlüsselwörter: Kreislaufwirtschaft, Reparatur, Geschäftsmodelle*

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## Abbreviations

ACRP	Austrian Climate Research Programme (Österreichisches Forschungsprogramm zu Klimafolgen)
AI	Artificial intelligence
BMI	Business model innovation
BMK	Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie)
CE	Circular economy
CEAP	New Circular Economy Action Plan
CORDIS	Community Research and Development Information Service
DIY	Do-it-yourself
ESPR	Ecodesign for Sustainable Products Regulation
EU	European Union
FFG	Austrian Research Promotion Agency (Österreichische Forschungsförderungsgesellschaft)
FWF	Austrian Science Fund (Österreichischer Wissenschaftsfonds)
GDP	Gross domestic product
IP	Intellectual property
IR	Independent repairer
IPPC	Intergovernmental Panel on Climate Change
NGO	Non-governmental organization
OEM	Original equipment manufacturer
OeNB	Austrian National Bank (Österreichische Nationalbank)
PLATE	Product Lifetimes and the Environment
R2R	Right to repair

R&D	Research and development
RQ	Research question
SBMI	Sustainable business model innovation
UK	United Kingdom
US	United States
USA	United States of America
VAT	Value-added tax
WTP	Willingness-to-pay

## 1. Introduction

According to the latest observations of the Intergovernmental Panel on Climate Change (IPPC), published in their Climate Change 2023 Synthesis Report, global surface temperature reached 1.1 °C above the 1850-1900 level in the period 2011-2020. This substantial, concerning rise in temperature can clearly be attributed to the increase in emitted greenhouse gases, which are caused by the human use of resources and overproduction and overconsumption (Lee et al., 2023). This trend is also reflected in the development of the Earth Overshoot Day. It marks the date on which the annual human demand on ecological resources and services surpasses the Earth's capacity to regenerate in the given year. Since the 1970s, when the calculated Earth Overshoot Day was still in December or November, this day has moved further and further forward, in 2024 it already coincides with the 1<sup>st</sup> of August (Earth Overshoot Day, 2024).

To counteract these developments, the increasing consumption and wastage of resources, a systematic change in individual lifestyles as well as in business and political structures is required. A suitable framework for this purpose is the circular economy (CE), which opposes the conventional linear economy. This model adopts the "close the loop" approach, in which the cycle of products and materials must be closed, leading to a longer lifespan, greater efficiency and less waste (Ellen MacArthur Foundation, n.d.–b; Stahel, 2019). A more detailed elaboration of the CE framework is presented in the 2<sup>nd</sup> chapter of this thesis.

### 1.1. Problem definition

To facilitate the practical implementation of the CE and thus ensure the transition away from the linear economy, the so-called R-framework, depicted in Figure 1, was developed. These strategies are organised in a hierarchy to achieve resource utilisation and waste management in line with CE (Kirchherr et al., 2017; Manoochehri et al., 2022; Potting et al., 2017).

This thesis places its focus on the strategy of repair, which is an important element of the CE. By implementing this approach, the utilisation intensity of a product is increased, and fewer resources need to be extracted for new production because the device is returned to a functional state, as highlighted in Figure 1. Considering the hierarchical arrangement, it again becomes clear that repair is a significant factor in the desired transformation to a circular economy, as R4 achieves a higher value retention than recycling (R8) for example. This is due to the fact that repair extends the lifetime of the goods and recycling only recovers materials (Lechner et al., 2021; Manoochehri et al., 2022; Monier et al., 2016).

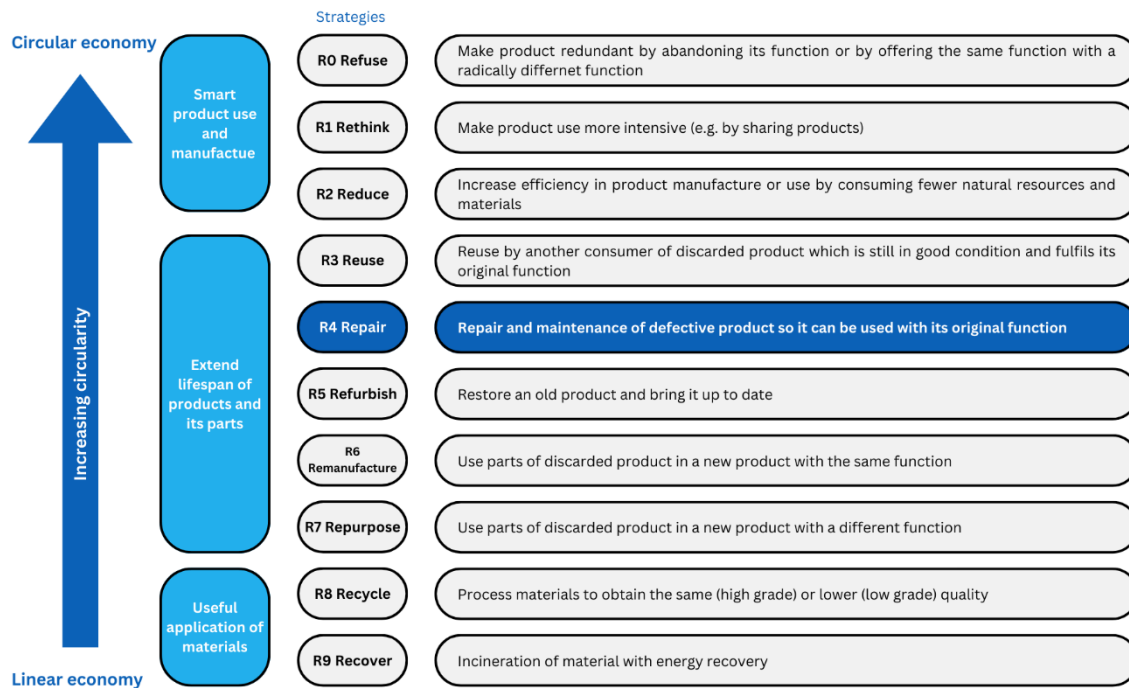


Figure 1: The R-framework (adopted from Kirchherr et al., 2017; Potting et al., 2017, p. 5)

Even at European political level, the great potential of the circular economy and repair has been recognised and actions have been taken to urge and support companies, as well as society in general, to innovate and shift towards circular economy. In 2015, the European Union (EU) adopted the “First Circular Economy Action Plan”, with the declared aims of promoting circularity, fostering job creation, increasing global competitiveness, and promoting sustained economic growth (European Commission, n.d.–e). The subsequent step was the publication of the “European Green Deal” in 2019, which also includes circular economy as a central element (European Commission, 2019a). One foundation of the Green Deal is the “New Circular Economy Action Plan” (CEAP), introduced in 2020 (European Commission, 2020b). A recent development intended to promote the CEAP’s objectives is the “Directive on Common Rules Promoting the Repair of Goods”, designed to make repairs more attractive for customers than replacing products with new ones, which just recently entered into force in July 2024. The Member States therefore are given two years to adopt and realise the measures set out in the Directive, further discussed in Chapter 2.4., at national level (European Commission, n.d.–b). As the previous explanations suggest, developments and also research in the repair sector are highly dynamic and relevant at various levels, posing great potential for the circular economy. Nevertheless, shortcomings or barriers concerning the repair strategy still remain. For instance, clients often consider repair services to be costly, time-demanding and inconvenient (Güsser-Fachbach, Lechner, & Reimann, 2023; Lechner et al., 2021). In addition, many customers are insecure regarding the outcome quality of the repair process. From the repair providers' point

of view, it is in turn challenging to fulfil customer requirements, and some factors are often beyond their control, such as the availability of spare parts (Güsser-Fachbach, Lechner, Ramos, & Reimann, 2023). This master's thesis thus serves to generate insights into the repair sector from multiple perspectives and thus demonstrate paths for increasing the attractiveness of the essential repair strategy.

## 1.2. Objective and research questions

*“The results suggest that consumers’ expectations of convenience do not match what repair companies can actually deliver” (Güsser-Fachbach, Lechner, Ramos, & Reimann, 2023, p. 8).* Therefore, in order to strengthen the repair sector, greater attention needs to be placed on this issue. Looking at further contributions in research and practical implications related to repair, they mostly concentrate on either the viewpoint of the customer or the company. This master's thesis therefore serves to investigate the research gap in terms of insights into the intersection between these perspectives.

To identify potentially beneficial approaches and developments for the repair strategy, firstly the demands placed by customers on repair providers are reviewed. Furthermore, existing implementations for repair business models/strategies in practice are investigated. The overall goal of this study is to derive new approaches from theory and furthermore to develop new ideas for the repair sector. For this purpose, the following research questions were formulated:

- **RQI:** *What are barriers and requirements of customers towards repair businesses?*
- **RQII:** *What is the current state of the art regarding i) implemented repair business models/strategies and ii) topic-related research/innovation projects in an (inter)national context?*

Based on the findings from research questions I and II, conclusions can be drawn to analyse RQIII, which is specified as follows:

- **RQIII:** *Which consumer needs can be met/enhanced by implementing which identified business models/strategies?*

By conducting this master's thesis and answering the corresponding research questions, valuable insights can be gained for the repair sector, business model innovation and circular economy. Thereby, both scientific and social relevance is generated, as the circular economy and conservation of resources contribute to tackling global problems such as waste production, pollution, and the climate crisis.

### **1.3. Structure of the thesis**

This 1<sup>st</sup> chapter of the present master's thesis serves as an introduction to the topic of circular economy and repair and to present its relevance to research and society. Furthermore, the objective and the specific research questions are addressed.

The following 2<sup>nd</sup> chapter provides a theoretical background, by firstly outlining the framework of CE. Furthermore, a brief discussion into the significance of customer awareness and engagement in CE is introduced in 2.2. Also, Chapter 2.3. covers the topic of (sustainable) business model innovation and how circular business models can be established. Since the legal circumstances are crucial for the implementation of CE and the repair strategy, they are presented in 2.4. as the final section of the theoretical context.

The detailed research design of the thesis is presented in Chapter 3. Firstly, a general overview of the research process is given, followed by subchapters on the literature research of the three defined perspectives on the repair sector, namely the perspectives of customers, businesses and the relevant research and innovation projects. Chapters 3.1.1., 3.1.2. and 3.1.3. explain step by step how the literature search/data gathering was carried out for the respective perspectives. How this obtained data was analysed applying a coding procedure using the MAXQDA software (MAXQDA, 1995-2024) is documented in Chapter 3.2.

The findings of the performed analysis are displayed in Chapter 4, whereby the description is again structured according to the three perspectives. 4.1. lists all identified factors affecting customers' repair decisions. Section 4.2. summarises all recognised business models/strategies in the repair sector. The relevant projects are presented in 4.3. In conclusion, a mapping of customer needs and business strategies is undertaken, which can be viewed in section 4.4. From this, insights are gained regarding which customer needs can be fulfilled/improved by which business approaches, visualised and summarised in tool maps and an oversight table.

Following the presentation of the results, they are examined and discussed in Chapter 5. Emphasis is placed on answering the research questions, which structure the discussion accordingly.

The conclusion forms the last and 6<sup>th</sup> chapter of the thesis, in which the findings and output of the study are critically assessed, limitations are pointed out and further research directions are indicated.

## 2. Theoretical background

This chapter presents an overview of the theoretical foundations upon which the subsequent work is founded. Firstly, the concept of the circular economy is explained by means of the butterfly diagram. Followingly definitions and insights are discussed concerning the importance of customers, companies and politics in the implementation and success of CE and repair. Therefore, Section 2.2. deals with consumers' understanding and participation in circular methods, in particular repair. The application of the CE concept towards the realisation of a business model is discussed on the subject of (sustainable) business model innovation in Chapter 2.3. To complete the theoretical background, a compact insight into the political framing conditions of CE and repair is introduced in 2.4. These explanations constitute an introductory guide to the further multi-perspective examination of the repair sector in this study.

### 2.1. Circular economy framework

The circular economy is a highly relevant field that continues to be researched and developed for the purpose of counteracting the throwaway society and thus serves as a complementary approach to the conventional linear economy. However, in current scientific discourse it is recognisable that a multitude of definitions and perceptions of the CE concept exist, as particularly evident from the review by Kirchherr et al. (2017) and its revised version Kirchherr et al. (2023). Thereby, 114 or in the updated report 221 definitions of CE could be evaluated, but no commonly adopted definition was identified, and Kirchherr et al. (2023) doubt that a final definition will ever emerge. However, according to these literature evaluations, and also Geissdoerfer et al. (2017), the Ellen MacArthur Foundation supplies the mostly prominent definition of circular economy, which therefore is also referred to in this thesis and formulated as follows:

*“[CE] is an industrial system that is restorative or regenerative by intention and design. It replaces the ‘end-of-life’ concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models” (Ellen MacArthur Foundation, 2013, p. 7).*



Concludingly, the Ellen MacArthur Foundation (n.d.–b) specifies three core principles underpinning the circular economy, notably:

- **Eliminate waste and pollution:** Waste should be prevented from the outset by designing products for a process of disassembly and reuse (Ellen MacArthur Foundation, n.d.–a).
- **Circulate products and materials (at their highest value):** Products/components/raw materials ought to circulate for as long as possible in the resource cycle in the interests of conservation, whereby hierarchically superior strategies are to be favoured (Ellen MacArthur Foundation, n.d.–a).
- **Regenerate nature:** Emphasis is to be shifted from the extraction of materials to regeneration. This includes, for example, expanding biodiversity and utilising renewable resources (Ellen MacArthur Foundation, n.d.–a).

To conceptualise and visualise CE, the Ellen MacArthur Foundation furthermore elaborated the butterfly diagram displayed in Figure 2. According to the graph, two main cycles emerge, the natural/biological cycle labelled in green to the left, representing the raw materials, and the technological cycle coloured blue to the right, illustrating the materials' processing (Ellen MacArthur Foundation, 2013).

As also apparent from Figure 2, repair, the focus of this master's thesis, is a central element of the circular economy framework, located within the inner loops of the technical cycle, marked as maintain/prolong in the diagram. In this context, it is important to note that the inside circles of the butterfly diagram reflect a greater value for CE compared to the outside circles, which in turn, analogue to the R-framework in Figure 1, highlights the significance and preferability of repair (Ellen MacArthur Foundation, 2013).

Repair, as understood throughout this thesis, commonly refers to the process of restoring a defective device or component to a serviceable condition while preserving the initial product function. As a result, the lifespan of the product is extended, consequently less new items are required and fewer materials are consumed (Rogers et al., 2021). Please be aware that, to present a holistic outlook on the repair sector, this study does not limit repair activities to certain product categories.

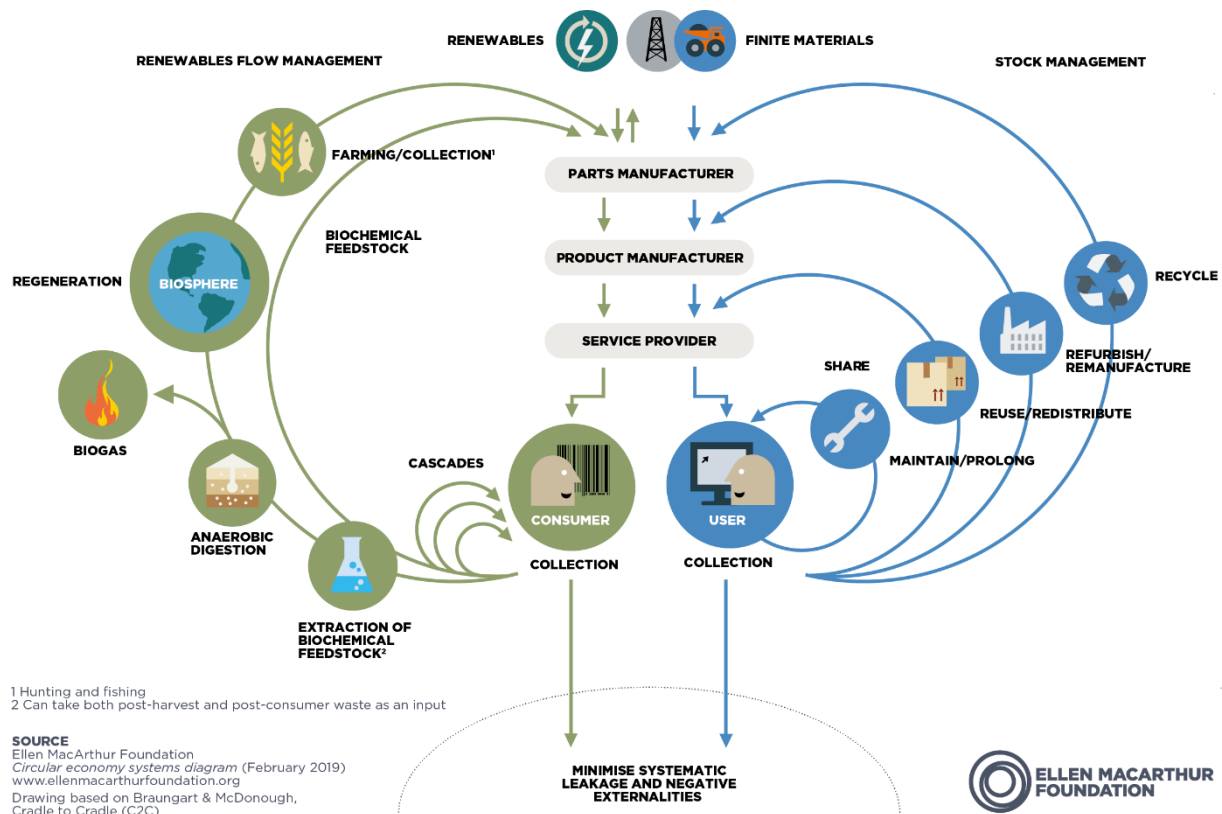


Figure 2: CE butterfly diagram (Ellen MacArthur Foundation, 2019)

## 2.2. Customer perception and engagement in circular economy and repair

An essential pillar of CE and the adoption of circular practices, such as repairs, are the product consumers, their perceptions, awareness and behaviour. Putting CE, as outlined in the previous chapter, into practice involves having empowered, environmentally aware customers whose decisions align with circularity (Parajuly et al., 2024). The Ellen MacArthur Foundation (2013) argues that moving away from a linear economy implies shifting consumption behaviour from ownership to appliance and service use, therefore device utilisation can be maximised through methods such as sharing, renting or leasing. Furthermore, goods generally need to be durable and if sold, they, or their parts or materials, should remain in circulation for the longest possible time (Ellen MacArthur Foundation, 2013). In this regard, the previously discussed butterfly diagram in Figure 2 provides guidance as to how product cycles are closed which optimum value prevention over the greatest possible time period and thus the amount of raw materials usage is reduced (Ellen MacArthur Foundation, 2019).

A study by the European Commission (2018) extensively examined consumer behaviour with regard to circular economy. Thereby, various research methods including a literature review,

customer survey and a behaviour study were applied to determine how customers perceive their circular habits and the extent of their actual engagement (European Commission, 2018). The results reveal that people overall indicate a high level of participation in circular activities, with 93% of surveyed consumers for example agreeing to the claim that they keep their items long-term (European Commission, 2018, p. 55-57). In turn, when talking about taking active steps, the consumer survey and the repair experiment demonstrate lower commitment. 64% of participants in the survey reported always repairing their belongings when damaged (European Commission, 2018, p.55-57), in the repair experiment 82-63% favoured repair, depending on the respective product (European Commission, 2018, p. 95-97). The report hence concludes a gap between the willingness and actual involvement of customers in CE (European Commission, 2018, p. 176). To bridge this difference multiple drivers and barriers must be considered which positively or negatively affect client decisions. Thereby, the study highlights the price as being the most crucial factor as to whether customers practise circularity, ahead of convenience (European Commission, 2018, p. 65-67).

These findings have been confirmed in a multitude of studies focusing specifically on the repair sector, repairs are frequently too expensive for clients and new equipment is very affordable, as can be consulted for example from Dalhammar et al. (2020). According to the evaluations of McCollough (2007), the average amount consumers are willing to spend on the repair of small electronic devices is about 20% of replacement expenses.

Building on these explanations, a broad analysis of the customer requirements faced by repair providers is conducted in the further course of this thesis. Issues such as how can the willingness-to-pay (WTP) of clients be increased, what are demands and motivators enhancing the actual repair engagement and how can the repair convenience be improved are addressed.

### **2.3. Integration of circular economy into business models**

The Ellen MacArthur Foundation (2013) further points out the crucial role of new business models to support clients in taking circular action and facilitate the transition to a circular economy. In this context, companies face a number of challenges, but also opportunities, when adapting their respective business approaches towards sustainable development (Ellen MacArthur Foundation, 2013).

In their review paper, Geissdoerfer, Vladimirova, and Evans (2018) gathered and assessed definitions and characteristics of business models as well as their advancement in an extensive manner. Thereby, by analysing various descriptions, the authors conclusively determine a

business model as “*simplified representations of the value proposition, value creation and delivery, and value capture elements and the interactions between these elements within an organisational unit*” (Geissdoerfer, Vladimirova, & Evans, 2018, p. 402). Furthermore, the study resulted an illustration of the progression from conventional business models to circular business models, which constitute a subcategory of sustainable business models, as depicted in Figure 3 (Geissdoerfer, Vladimirova, & Evans, 2018). Accordingly, alongside the characteristics of sustainable business models, as indicated in Figure 3, circular business models also incorporate the focus of CE, namely the conservation of resources by slowing down, intensifying and closing cycles (Bocken et al., 2016; Geissdoerfer, Morioka, et al., 2018).

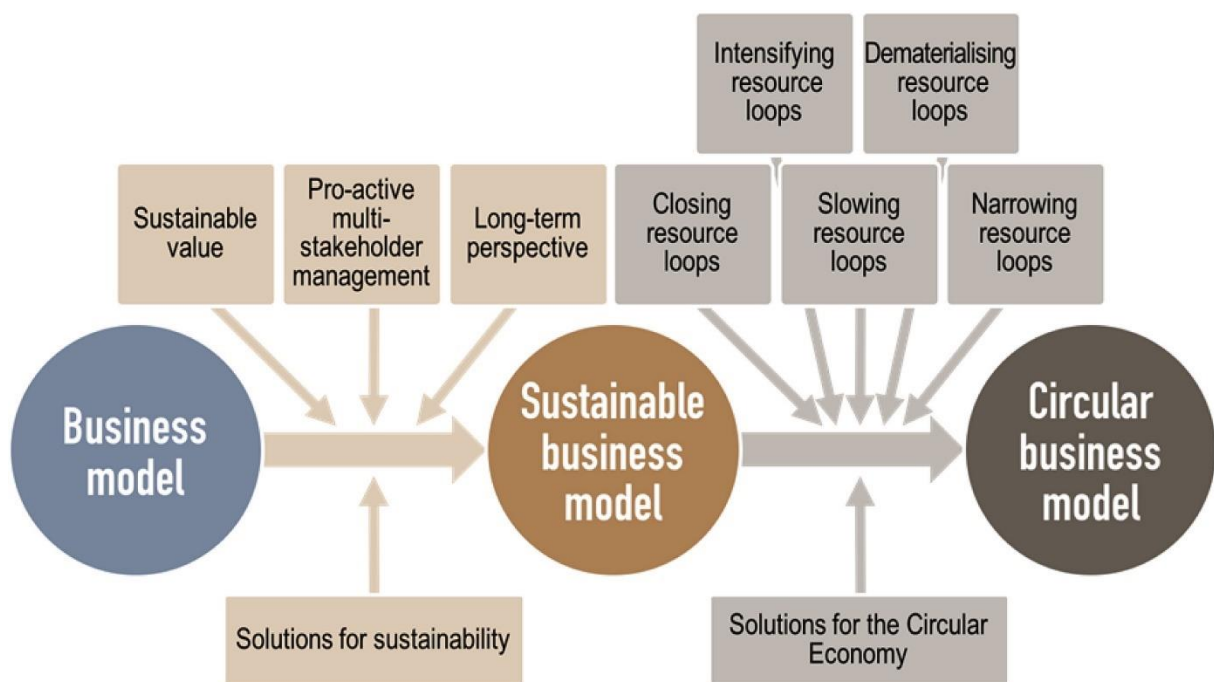


Figure 3: Business model transition towards circularity (Geissdoerfer, Vladimirova, & Evans, 2018)

Insights and assistance on how enterprises can evolve their business models towards circular economy are offered by the concept of business model innovation (BMI), more precisely the sustainable business model innovation (SBMI). Ferlito and Faraci (2022) define SBMI as an application of “*change in how a firm operates to create positive impacts or reduce negative consequences for the environment and society*” (Ferlito & Faraci, 2022, p. 222).

Based on their overview research on (sustainable) business model innovation, Geissdoerfer, Vladimirova, and Evans (2018) also established a categorisation structure to distinguish the innovation of a business operating concept into four groups, illustrated in Figure 4. A differentiation appears whether the corresponding business model has to be established from scratch (start-up), an existing model is fundamentally converted into another (transformation),

a new business model is added to the existing one (diversification), or a further business model is obtained and integrated (acquisition) (Geissdoerfer, Vladimirova, & Evans, 2018).

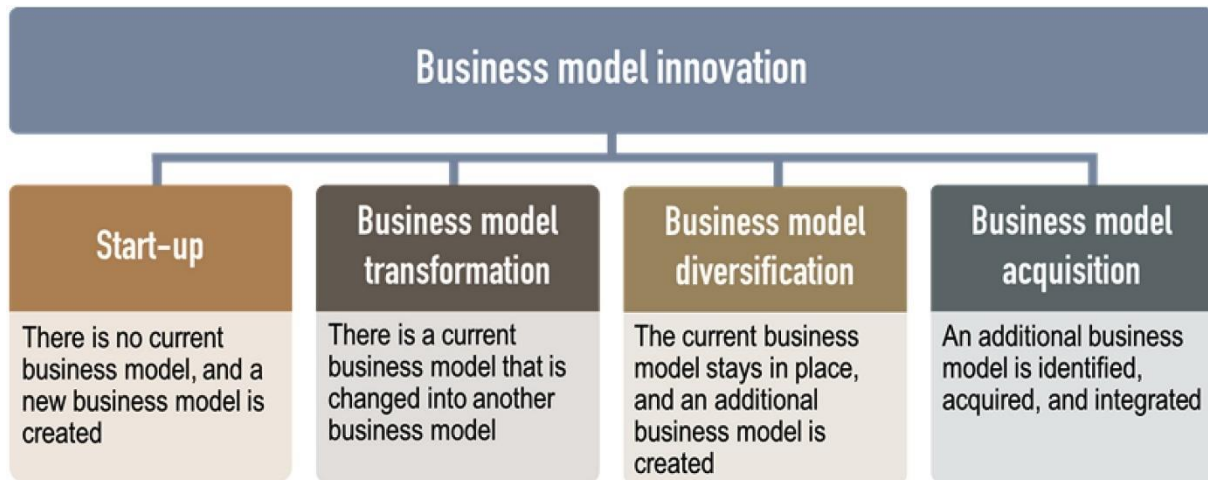


Figure 4: Business model innovation categories (Geissdoerfer, Vladimirova, & Evans, 2018)

Looking at the repair sector, according to Svensson-Hoglund et al. (2021) the involved actors are on the one hand commercial service providers, including original equipment manufacturers (OEMs) and independent repairers (IRs), either authorised by OEMs or operating completely by themselves. Alongside these services, repairs are also frequently performed by the customers directly, as so-called do-it-yourself (DIY) activities. The report by Manoochehri et al. (2022) further emphasises the relevance of volunteers carrying out repairs at repair cafés for example, as repair-facilitating actors. Analogue to the product categories, this master's thesis incorporates all parties influencing repair business models and operations referred just above.

The understanding gained from this section subsequently serves to investigate business cases implementing repair activities and assists in the assessment of possible approaches to further develop these models in an innovative way towards sustainable development in terms of circular economy.

## 2.4. Political framework conditions for circular economy and repair

Achieving the CE transition and ensuring the competitiveness of the above elaborated circular business models with linear models requires wide-ranging political interventions (Milios, 2021). In their review, Svensson-Hoglund et al. (2021) specifically examined the regulatory circumstances concerning product repair. One of the main barriers cited was intellectual property (IP) law, which often prevents alterations such as repairs to a protected object and thus restricts repair activities, in the EU as well as the United States (US). For instance, reparations regarded as reconstruction or modification are treated as patent infringements. Under patent

law, devices can only be repaired lawfully during their “normal life”. Spare parts are also partially subject to patent legislation, i.e. replications of patented spare parts are prohibited. Furthermore, copyright law, restricted to the authorised use of software, frequently hinders repairs since sharing copyrighted repair information such as manuals and instructions constitutes a contravention within the scope of this law (Svensson-Hoglund et al., 2021).

Through all these regulations, OMEs particularly discourage third-party service providers but also individuals from repairing devices, for example by making access to replacement parts difficult or even impossible (Russell et al., 2023). In the event of a warranty claim, manufacturers themselves are faced with the decision whether to repair or replace the appliance for the customer. Due to the current market conditions, product replacement is often preferred, as skilled workers in the repair sector are lacking (European Labour Authority, 2024) and labour costs are rising (European Environmental Bureau & Eunomia, 2017), whereas expenses for new goods are kept low through process optimisation, low resource costs and cheap labour in the production countries (Dalhammar et al., 2020; European Environmental Bureau & Eunomia, 2017). Thereby Svensson-Hoglund et al. (2021) indicate a hindering aspect within consumer law since, even if clients would rather have their faulty appliances under warranty repaired, they may still receive a new substitute device. Concludingly, the current market does not favour repair activities (Svensson-Hoglund et al., 2021).

To overcome the market barriers for repair, regulatory measures reinforcing producer responsibility are often proposed, as by Dalhammar et al. (2020). Such measures include a commitment to improved repairability of products by design, as well as the commercialisation and provision of spare parts and information on the useful life and repairability of appliances. To this end, to extend product lifetimes, Svensson et al. (2021) also recommend a prohibition against planned obsolescence, a strategy applied by manufacturers whereby products are designed/processed with a limited utilisation period (Roskladka et al., 2023; Svensson et al., 2021). As a pioneer, France already implemented such a ban in 2014 (Kaźmierczyk & Gee, 2016, p. 77). France serves as a role model in the repair context in another respect too, namely through the introduction of a repairability index in 2021. This index covers the product categories of mobile phones, laptops, televisions, lawnmowers and washing machines, whereby consumers are instructed about the repairability of the item based on five criteria when purchasing it. These characteristics concern “*documentation, disassembly, availability of spare parts, price of spare parts and product specific aspects*” (Manoochehri et al., 2022, p. 7), which are displayed standardised as shown in Figure 5 (Manoochehri et al., 2022; Right to Repair, 2021).



Figure 5: French repairability index (Auboy, 2022)

Another important regulatory step proposed by Dalhammar et al. (2020) to establish repair as the favourable strategy and to overcome the previously mentioned obstacle in consumer law is the extension of the legal guarantee, accompanied by a transfer of the evidential burden to the enterprises and enabling repair rather than replacement if requested by the consumer (Dalhammar et al., 2020).

Making repair competitive furthermore requires political action to overcome tax barriers (Svensson-Hoglund et al., 2021). Sweden already made efforts in this direction, for instance by reducing the value-added tax (VAT) for smaller repair activities from 25% to 12% (Dalhammar et al., 2020). The authors, nevertheless, point to the need for a further reduction, if not elimination, of VAT for repair. In addition, there should be a general shift in taxes away from labour and towards resources to even out the market imbalance between new goods and repair services (Dalhammar et al., 2020). Further financial incentives for potential repair clients, as suggested by Svensson et al. (2021), are offered through repair funds and vouchers. One practical example already realised is the Austrian repair bonus for electric equipment, whereby 50% of the repair costs are covered by the government after submission of an electronic voucher to the service provider, with a maximum amount of €200 for the subsidy and up to €30 for a cost estimate (BMK, n.d.). An extension of the programme to include bicycle repairs as well as the maintenance and servicing of electric appliances recently became effective on 16 September 2024 (GRAZ repariert, n.d.–b).

As previously indicated in the Introduction, numerous steps are already evident for strengthening CE and repair by the EU or are currently emerging. A cornerstone for the transformation to a sustainable development of economy was established through the **“First Circular Economy Action Plan”**, which was adopted by the EU in December 2015. The ultimate goal of this catalogue of measures is to consider the entire life cycle of products, from manufacturing to usage, repair, waste management and secondary raw materials, and to close this circuits by implementing concrete actions. A total of 54 initiatives were implemented as part of this roadmap by 2019, including the revision of the eco-design regulations introduced in the corresponding **“Ecodesign Directive”** from 2009 (European Parliament & Council of the European Union, 2009), by means of the **“Ecodesign Working Plan 2016-2019”** (European

Commission, 2016), whereby in October 2019 “10 Ecodesign implementing regulations” (European Commission, n.d.–e) were adopted (Circular Futures, n.d.; European Commission, n.d.–e). Modifications and ongoing optimisations in this respect are of major relevance to repair, referring to the above outlined needed manufacturer responsibility regarding simplified product reparability through design as well as the availability of spares, tools and information. The “First Circular Economy Action Plan” therefore paved the way for subsequent legislation on CE and also for more extensive repair-focussed policies.

In December 2019, the EU adopted the “**European Green Deal**” as a following milestone (European Commission, 2019a). This is the extensive policy intervention programme to achieve three defined overall goals. Firstly, greenhouse gas emissions target net zero by 2050, potentially turning the European continent into the world’s foremost climate-neutral one. Furthermore, due to the previously discussed issue of resource overuse, a declared aim is to separate Europe’s economic development and growth from resource consumption. To ensure a fair and inclusive transition to a greener future, the third main objective of the “European Green Deal” is leaving no human being nor region behind (European Commission, n.d.–a, n.d.–d). Achieving these outcomes requires a wide range of policy interventions, involving the revision of over 50 European laws and reshaping public policy covering eight areas of governance, namely sustainable/circular economy, sustainable mobility, clean energy, sustainable food systems/agriculture, eliminating pollution, preventing and resorting biodiversity, sustainable building and renovating and ambitious climate action (Belardo, 2021). These and the EU’s approaches, financing, inclusion and promoting research and innovation, also emerge from the overview roadmap of the “European Green Deal” depicted in Figure 6 (European Commission, 2019b).



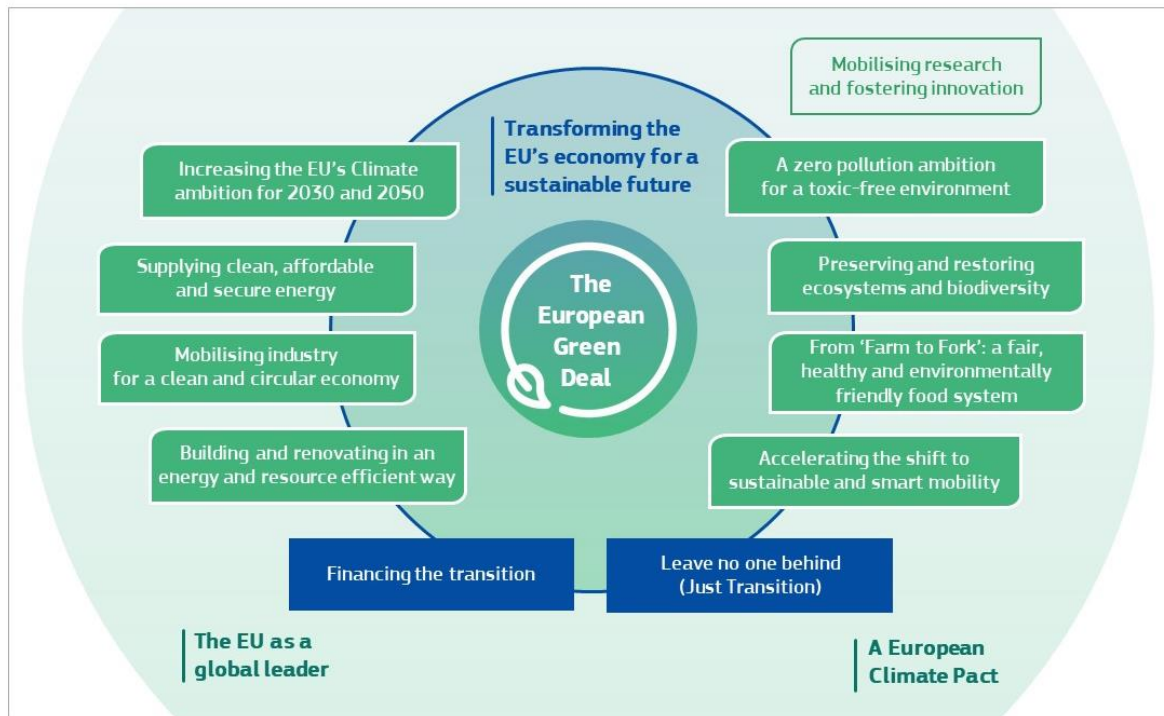


Figure 6: Roadmap of the “European Green Deal” (European Commission, 2019b)

An essential pillar of the previously discussed “European Green Deal” is the “**New Circular Economy Action Plan**” (CEAP), officially published by the EU in March 2020 (European Commission, 2020b). In line with the pathway of the “European Green Deal”, see Figure 6, the CEAP serves to create a more sustainable and competitive continent, in a joint venture involving consumers, citizens, industry actors and organisations of civil society. Thereby, this political intervention targets accelerating the shift to a regenerative model of growth, which reduces resource consumption, while leveraging the CE measures implemented since 2015, by the “First Circular Economy Action Plan” (European Commission, 2020a). According to the European Commission (2020a), transitioning to a CE through the measures introduced by the CEAP could lead to a 0.5% growth in the EU’s gross domestic product (GDP) by the year 2030 and generate 700,000 additional jobs. Furthermore, companies may enhance their profitability through the closed loops approach and less required primary materials and customers will be delivered high quality and durable products which are designed to be reused, repaired and recycled (European Commission, 2020a).

Among the most recent legislative efforts to realise the CEAP is the “**Directive on Common Rules Promoting the Repair of Goods**”, specifically aimed at promoting repair activities in the EU, which was adopted in June 2024 and entered into force in July 2024 (European

Parliament & Council of the European Union, 2024a). The major elements of this directive are defined by the EU as follows:

- **Improved repair access:** Manufacturers are obliged to provide customers with the opportunity to have their defective products repaired within a reasonable period of time at a reasonable charge (European Commission, n.d.–b). The “Right to Repair” initiative, an association of organisations in Europe campaigning for a structural change in the repair sector, acknowledges that with this legislation, the producers’ responsibility to offer affordable repair goes beyond the legal guarantee, which is defined as a minimum of two years in the EU (European Union, 2022), and can last up to ten years depending on the device (Rezende, 2024). However, this requirement initially only applies to appliances already governed by the reparability requirements under EU law, like smartphones or fridges for example (European Commission, n.d.–b), which “Right to Repair” criticise as a limited scope of product categories (Rezende, 2024).

Furthermore, by means of the directive, manufactures must inform customers about their repair services and pricing in an easy-to-access manner and spares need to be supplied, again at reasonable rates, to consumers including independent repairers (European Commission, n.d.–b; Rezende, 2024). “Right to Repair” once again highlights a shortcoming, namely the lack of a precise definition and understanding as to what a “reasonable price” amounts to (Rezende, 2024). Another noteworthy aspect is the prohibition of *„contractual clauses, hardware or software techniques that impede the repair of goods [...] unless justified by legitimate and objective factors”* (European Commission, n.d.–b), representing a further step towards producer responsibility and a ban on planned obsolescence.

- **“European Repair Platform” and “European Repair Information Form”:** To make repair providers even more accessible and visible, an EU-wide repair platform will be set up, with the member states responsible for implementing the registration of their repairers, while the European Commission supplies the necessary IT architecture. The portal is expected to be launched in 2027. In addition, a standardised form is designed to make repair offers more transparent, allowing operators to communicate their repair services to potential clients and making it easier for them to compare them with other options (European Commission, n.d.–b).
- **Guarantee prolongation for repairs:** The Directive grants consumers a 12-month guarantee extension if they opt for repair instead of replacement within the legal coverage period (European Commission, n.d.–b).

- **Nationwide repair incentives:** The EU members must implement a minimum of one initiative in favour of repair, which can be of monetary nature, such as the previously described repair bonus in Austria, but may also be non-monetary, such as citizens awareness raising through education campaigns (European Commission, n.d.–b).

The EU member states are now given two years to incorporate these and all other measures of the “Directive on Common Rules Promoting the Repair of Goods” and implement them in national law, meaning it has to be applied by 31 July 2026 (European Commission, n.d.–b). Associated to this directive, the “**Ecodesign for Sustainable Products Regulation**” (ESPR) was also enacted in July 2024, replacing the previously mentioned “Ecodesign Directive” (European Parliament & Council of the European Union, 2024b). Through this regulation, the durability, sustainability and circularity of goods within the EU market are to be further strengthened by, among other things, enhancing energy performance and expanding the repairability requirements. In terms of realisation, ESPR represents a framework legislation whereby specific requirements for products are gradually defined over time, for individual devices or product groups with common characteristics (European Commission, n.d.–c). “Right to Repair” recognises a major opportunity to broaden the scope of the “Directive on common rules for the repair of goods” at this point, as its coverage will be enlarged following an adoption of new legislative acts determining repairability obligations within 12 months (Rezende, 2024).

Please note, that these explanations serve to clarify the European policy landscape regarding circular economy, in particular repair, which underlies this research and do not claim to be exhaustive. Consequently, conclusions can be drawn in Chapter 6 as to whether these measures align with the explored needs and opportunities of customers and businesses within the repair sector.

### 3. Research design

After giving general theoretical insights, the methodological basis of this master's thesis, for assessing the current state of the repair sector, its potential, and the improvement possibilities, is outlined in this chapter. The chosen approach is a structured literature review, which constitutes a theoretical study, where new insights and approaches are developed from the secondary data collected (Döring & Bortz, 2016, p. 186-187/191-192). The detailed research process is represented in Figure 7, which was developed on the basis of Arlene Fink's 7-step framework for conducting a research literature review (Fink, 2013, p. 3-5).

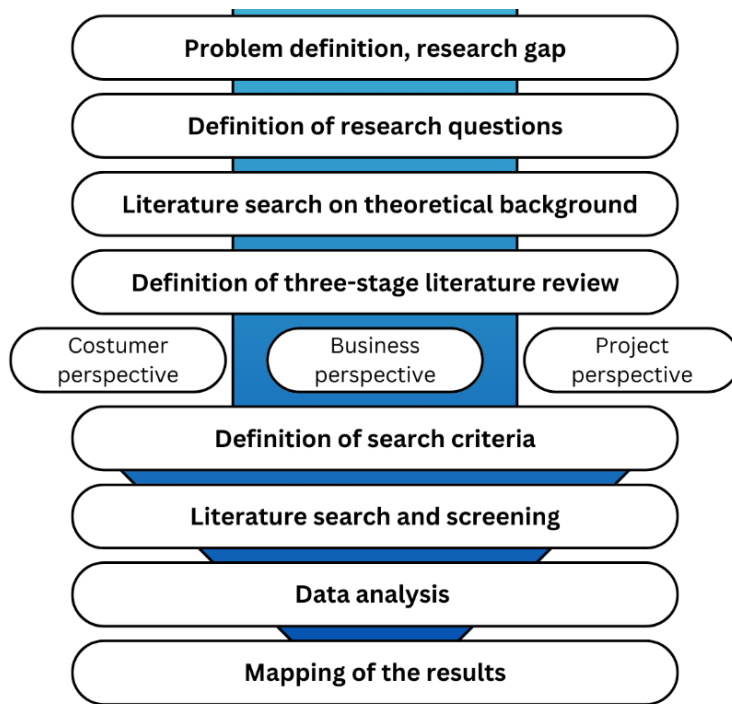


Figure 7: Research design/process (own illustration)

Following Figure 7, the first steps of the research process are the problem definition and the elaboration of a specific objective and research questions, as already discussed in Chapter 1. The subsequent literature search on the theoretical background, which focused on contributions concerning the topics of “circular economy”, “butterfly diagram”, “(sustainable) business model innovation”, “circular business models”, “circular economy policy” and “repair rights”,

served to compile Chapter 2. To create a meta-level overview on research and practical implications in the repair sector, the literature review is followingly categorised into three phases. In the first part publications are selected which deal with the customers' perspective and their requirements concerning repair, corresponding to RQI. During the second research period, RQII will be assessed by highlighting implemented business models/strategies in the repair sector. Finally, relevant research and innovation projects are examined in the third phase, which concludes the literature review. As these steps are established, the respective search criteria are determined. These and the corresponding procedure, screening and analysis are outlined in the following subchapters.

### 3.1. Three-stage literature review

#### 3.1.1. Customer perspective

As illustrated in Figure 8, the online databases Scopus (Elsevier, 2024b) and ScienceDirect (Elsevier, 2024a) were utilised for the literature review focusing on the customer perspective towards the repair sector. Firstly, the following search strings were specified and run in order to obtain all potentially relevant publications (see Figure 8, Step I):

- **Scopus:** *"repair\*" → "customer" OR "consumer" → "demand" OR "need" OR "requirement" OR "decision" OR "perspective"*

Within the Scopus search, all article titles, abstracts, and keywords were first scanned for the search term "repair\*". Arrows appearing in the search string indicate that the "Search within results" function is applied. The wildcard \* allows all variations of the respective search term, e.g. repair, repairs, repairability, etc., to be included (Elsevier, n.d.–c).

- **ScienceDirect:** *"repair" AND ("customer" OR "consumer") AND ("demand" OR "need" OR "requirement" OR "decision" OR "perspective")*

The assigned ScienceDirect search field "Find articles with these terms" identifies results from all parts of the document except the references (Elsevier, n.d.–b). The Boolean operator OR was used in both cases to group the terms, this operator ensures that at least one of the terms linked with OR is included. In the case of the ScienceDirect search, the groups were separated by parentheses and linked with the AND operator, so the resulting publications must contain at least one term from each group (Elsevier, n.d.–a; MIT Libraries, n.d.).

After running these search strings, 7,033 articles resulted on Scopus and 80,061 on ScienceDirect (see Figure 8, Step I). Following, step II refers to establishing and applying search criteria. Therefore, to narrow down the search, only research articles and reviews in English that are available as open access were considered. As the repair sector is very dynamic and to detect current insights, the search was limited to the years 2020-2023. Furthermore, the results were limited to the subject areas of Business, Management and Accounting; Decision Sciences; Environmental Science and Social Sciences. Google and the SCImago Journal Ranking (SCImago, 2007-2024) were used to select the thematically corresponding and scientifically high-quality journals. The criteria are summarised in Table 6 and Table 7 in the Appendix and reduced the number of papers to 174 on Scopus and 678 on ScienceDirect (see Figure 8, Step II).

Figure 8 also illustrates the further steps of the literature search and how many relevant papers were recognised in total after each step. Firstly, a title screening, which in turn reduced the articles to 92 (Scopus) and 169 (ScienceDirect), was carried out (see Figure 8, Step III), followed by an abstract screening, leading to 39 contributions from Scopus and 22 from ScienceDirect (see Figure 8, Step VI). Furthermore, overlaps were eliminated, whereby 42 papers remained (see Figure 8, Step V). Based on the articles received after step V, snowballing was performed (Radboud University, 2024), meaning that the references of these 42 articles were searched for the most cited, relevant papers published before 2020 and/or in other journals using the citation software Citavi (CITAVI, 2024). The 52 papers received in total after the snowballing process (see Figure 8, Step VI) were proceeded to full text analysis (see Chapter 3.2.), resulting in a final set of 39 journal papers relevant to the customer perspective results of this thesis (see Figure 8, Step VII).

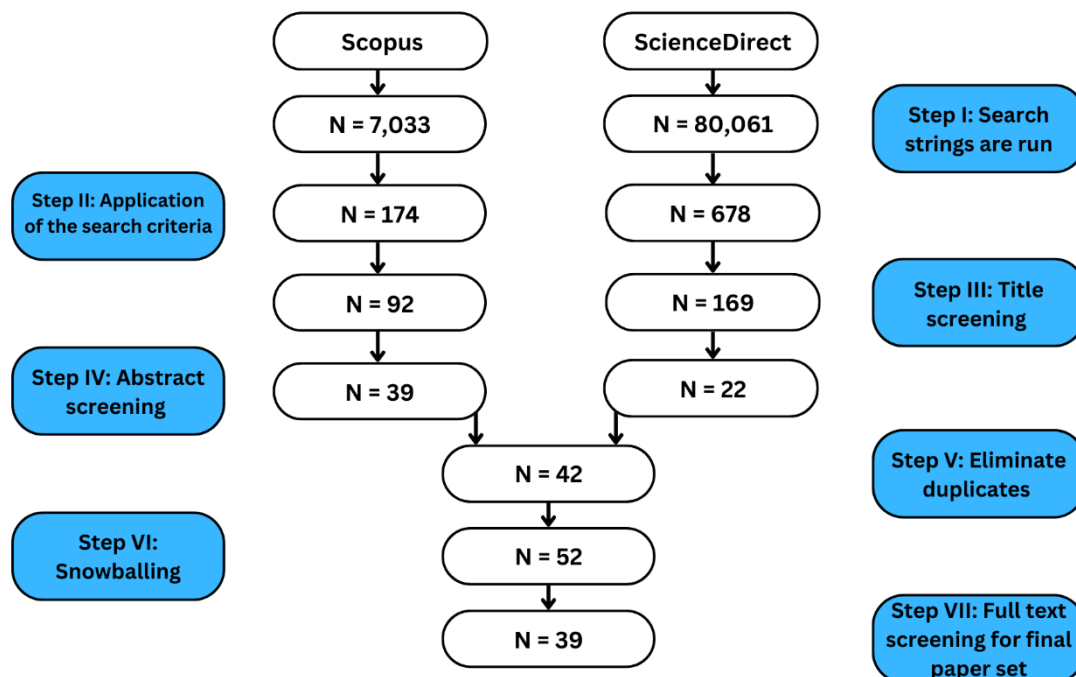


Figure 8: Literature research - customer perspective (own illustration)

### 3.1.2. Business perspective

Analogue to the customer perspective, a suitable search string was initially formulated for the company perspective. The search string ("circ\*" OR "sustain\*") AND ("business" OR "company" OR "organisation") AND ("model" OR "innovat\*") AND ("R-strategy" OR "repair\*") was accessed within the "Article title, Abstract, Keywords" search field in Scopus. The search term "R-strategy" intended to close the possible blind spot of relevant papers that do not mention repair in the title, abstract or keywords. From the initially obtained 858 papers

(see Figure 9, Step I), 81 articles emerged according to the reapplied search criteria (see Figure 9, Step II), which in the first search round correspond to those of the customer perspective and are listed in Table 9 in the Appendix. Again, a title (see Figure 9, Step III) and abstract screening (see Figure 9, Step IV) was performed, after which only 10 relevant journal papers resulted. Therefore, in a second round of literature search, the search criteria were expanded, the limitation of the publication period and the restriction of document types were eliminated, corresponding to Table 9. Even after broadening the criteria, the screening of titles and abstracts resulted in only 14 relevant papers for data analysis (see Figure 9, Step IV), which is why the author decided to enlarge the data collection to other channels, marked as step VI in Figure 9.

Three contributions relating to the perspective of the companies were provided to the author by the supervisor, also indicated in Figure 9, including two conference papers and one report commissioned by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK). To identify further examples of implemented business models/strategies in the repair sector, the proceedings of the Product Lifetimes and the Environment (PLATE) conference were screened. This multi-disciplinary international event was established in 2015 as a biennial conference on issues related to circular economy, the efficient use of resources and the minimisation of waste volumes (PLATE, 2023). As part of the data collection for this master's thesis, all available PLATE proceedings from the years 2015, 2017, 2019, 2021 and 2023 were examined, using a title screening with the search terms *business* and *repair*, followed by an abstract screening and the elimination of duplicates. A total of 29 relevant publications were obtained from the proceedings, the detailed search criteria and results can be found in Table 10 in the Appendix.

As a third form of data generation, a web search was conducted for the business perspective, also depicted in Figure 9, as part of step VI. This procedure allowed the identification of websites of business cases of repair in practice. To be able to narrow down the search for suitable examples, adequate search terms had to be determined initially. This step involved the assistance of artificial intelligence (AI), the two software tools ChatGPT and Microsoft Copilot were questioned as to which business models can be found in the repair sector. Table 13 in the Appendix thus serves as a full transcript documentation of all prompts applied during this AI-supported process (Microsoft, 2024; OpenAI, 2015-2024; see Table 13 for the full transcript).

Please note that the usage of AI is limited to the identification of adequate search terms for the web search, which was individually conducted by the author. The keywords conclusively recognised for the internet search process are again recorded in Table 11. This table also

documents the numbers of the resulting repair providers relevant to this study for the respective search rounds. Finally, the web search resulted in a number of 26 websites of specific repair businesses and initiatives.

After the complete data collection, a total of 74 documents emerges, as indicated in Figure 9 from step IV, which, as outlined above, are journal papers, a report, conference proceedings and websites. In turn, these 74 documents yielded 57 cases relevant to the business perspective findings during the analysis (see Chapter 3.2.).

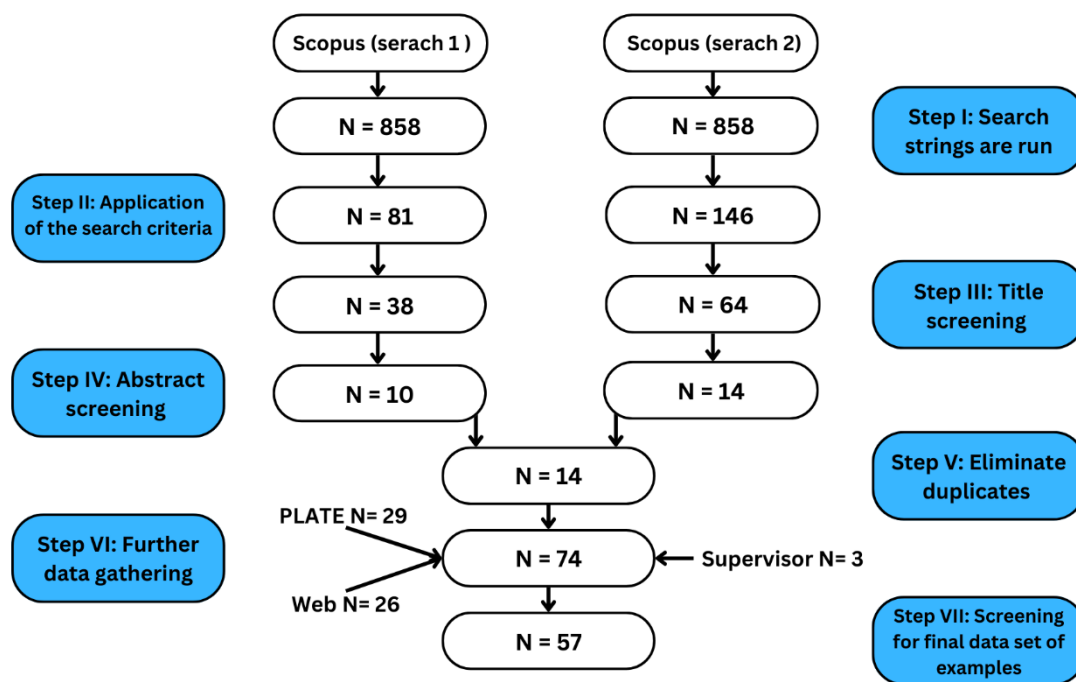


Figure 9: Literature research/data gathering - business perspective (own illustration)

### 3.1.3. Project perspective

For gaining additional understanding of the state of the art of the repair sector and possible developments, a third perspective was evaluated in the course of this master's thesis, namely related research and innovation projects. To identify projects promoted at EU level, the Community Research and Development Information Service (CORDIS) was utilised. This platform of the European Union contains all EU-funded projects in the context of research and development (CORDIS, n.d). Additionally, to ensure that all relevant projects at Austrian national level are covered, the project databases of the Austrian Research Promotion Agency (FFG), the Austrian Science Fund (FWF), the Austrian National Bank (OeNB) and the Austrian Climate Research Programme (ACRP) were screened.

FFG is the Austrian funding organisation dedicated to reinforcing Austria as a location for innovation and research, for example by promoting industry and science through financing



research and development (R&D) projects (FFG, 2005-2022b). Likewise, the FWF funds important and outstanding projects in all areas of basic research and humanities in order to enhance Austria as a centre of research and support solutions for global future challenges (FWF, n.d.–a, n.d.–b). The OeNB operates as Austria's central bank, with its main responsibilities being management of cash, monetary safety and politics, statistics as well as payment traffic (OeNB, 2024a). Furthermore, the OeNB contributes to supporting research, through scholarships, prizes and funding projects within their Jubilee Fund (OeNB, 2024b, 2024d). As part of the Climate and Energy Fund, the ACRP promotes research into climate issues within Austria and it is administered by the FFG. Activities of ACRP concentrate on climate change, climate measures, mitigation, adaptation and their interdependencies (FFG, 2005-2022a; Klima- und Energiefonds, 2024).

Extensive information on the search criteria used for the respective search processes of this perspective is provided in Table 12 in the Appendix. Again, Figure 10 and Figure 11 visualise the search procedures applying the following search terms:

- **Community Research and Development Information Service (CORDIS):** "repair"; ("repair" OR "R-strategy") AND "circular economy" AND "business" AND "model" AND "innovation"
- **Austrian Research Promotion Agency (FFG):** "repair"; "circular economy"; "business" AND "model" AND "innovation"
- **Austrian Science Fund (FWF):** "repair"; "circular economy"; "business" AND "model" AND "innovation"
- **Austrian National Bank (OeNB):** repair (keywords and full text search); circular economy (keywords and full text search); business,model,innovation (keywords and full text search); business (keywords and full text search)
- **Austrian Climate Research Programme (ACRP):** repair; Reparatur; circular economy; Kreislaufwirtschaft; business model; Geschäftsmodell

In total, as can be observed from Figure 10 and Figure 11, 16 research and innovation projects were therefore detected as having a significance for repair, which were then taken into account in the subsequent data analysis.

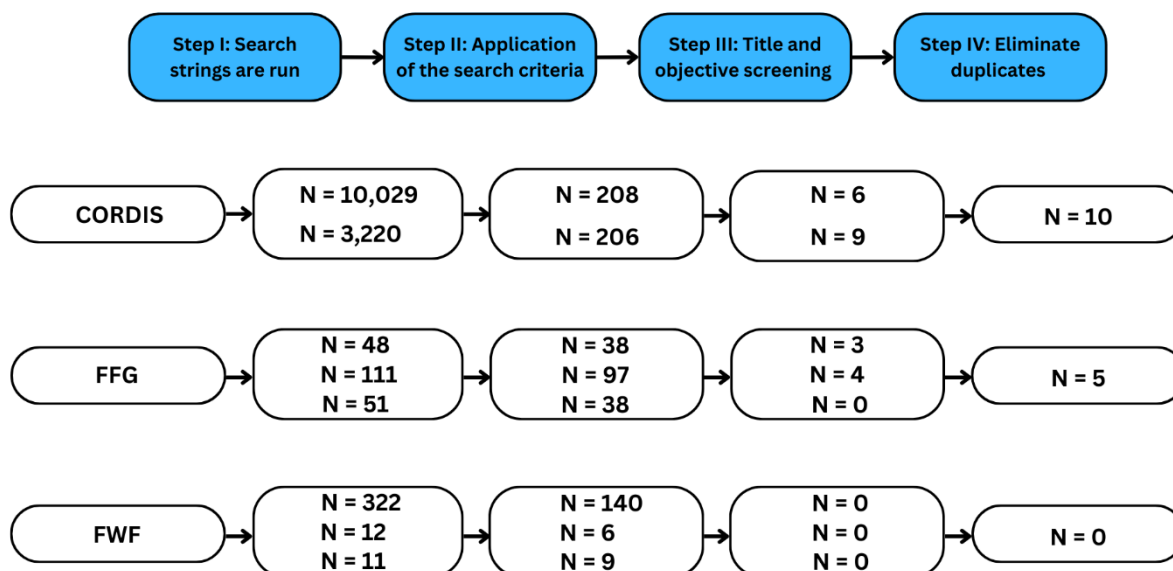


Figure 10: Data gathering - project perspective (1) (own illustration)

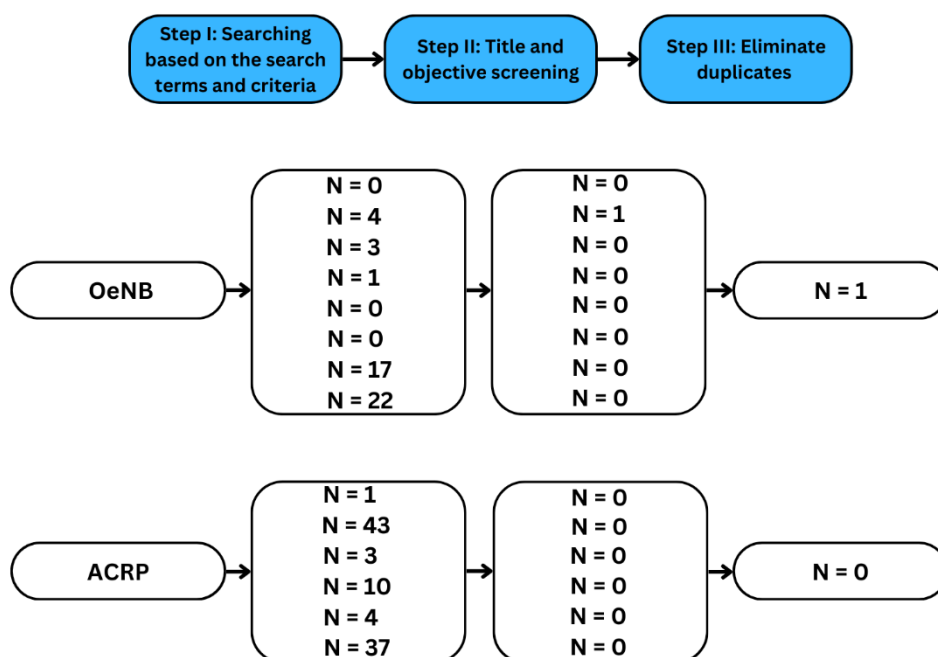


Figure 11: Data gathering - project perspective (2) (own illustration)

### 3.2. Data analysis

The process of literature/data generation as described in the previous subchapters, which was conducted between December 2023 and March 2024, was followed by an analysis of those documents. The analytic approach selected for this thesis is qualitative content analysis based on Mayring (2022), resulting in the analysis procedure visualised in Figure 12.

Following this process adopted from Mayring (2022), in the first step the material definition is performed, as already outlined in Chapter 3.1. according to the three established perspectives. Therefore, 52 journal articles were selected for the customer perspective analysis (see Section 3.1.1.), as well as 74 documents (journal papers, one report, conference contributions and company/organisation websites) for the business cases evaluation (see Section 3.1.2.) and 16 projects by means of project database entries (see Section 3.1.3.). The detailed search criteria and procedures for all these data in written text form are to be obtained from the referenced sections (cf. Mayring, 2022, p. 53-54).

The direction of the analysis, which is specified in the second step, corresponds to the research questions, elaborated in Chapter 1.2. Whereas the content and results of the articles identified in 3.1.1. aim to recognise the decisive factors for customers' repair decisions in order to assess RQI. The documents from 3.1.2. served to identify businesses, organisations and projects shedding light on business strategies in the repair sector for addressing RQII. Again, within the scope of RQII, the project entries from 3.1.3. and their objectives are analysed to determine their relevance for repair (cf. Mayring, 2022, p. 57-59).

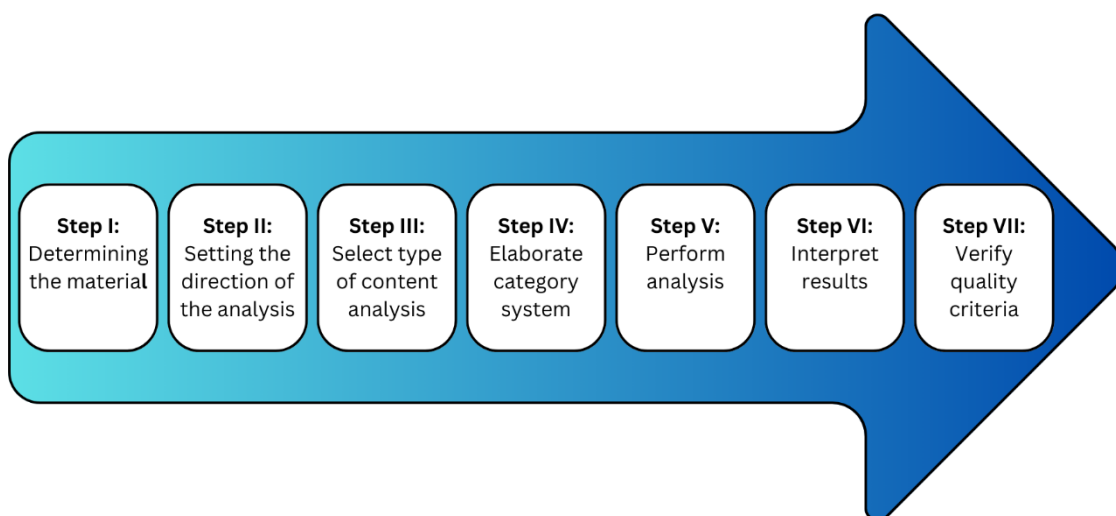


Figure 12: Data analysis procedure (adopted from Mayring, 2022, p. 61)

After the material and the direction have been concretised, the type of content analysis has to be clarified in the third step of the process. Since during full text screening first of all it had to be assessed which of the documents are actually significant for the findings of the thesis, a structuring content analysis was carried out initially (cf. Mayring, 2022, p. 64-68). Thereby, descriptive codes defined prior to the analysis in a deductive manner were applied, corresponding to Figure 13 these are titles, authors/coordinators, years/periods, publication media and objectives for all three perspectives and additionally the research design and main findings for the customer and business viewpoints. The evaluations concluded, as indicated in Figure 8, 39 journal papers for the customer perspective relevant to the findings (see Table 14 in the Appendix). Figure 9, furthermore reveals that 57 businesses, organisations and projects (see Table 4) emerged for the business perspective findings, received from 5 journal papers, one BMK commissioned report, 18 conference contributions (see Table 15 in the Appendix) and 26 websites. No documents were excluded for the project perspective, leaving the total of 16 selected research projects as illustrated in Figure 10 and Figure 11.

The resulting final data sets were furthermore subject to a summarising content analysis (cf. Mayring, 2022, p. 64-68), referring again to step three in Figure 12, whereby an explorative, inductive coding of the content was undertaken for the purpose of providing responses to the research questions. The main codes involved are evident in Figure 13, namely:

- *Factors influencing customer repair decision-making (RQI)*
- *Implemented repair business models/strategies (RQII)*
- *Project relevance for the repair sector (RQII)*

The therefore inductively resulting sub-codes/categories, implying theses are generated on the basis of and in the course of the content analysis dynamically resulting in an individual category system (cf. Mayring, 2022, p. 84-86), for the factors determining repair decisions of consumer are provided in Table 1. Similarly, the outcomes for the assessment of the business cases, i.e. the sub-codes of the implemented repair business models/strategies, are reported in Table 3. For the projects perspective, no additional sub-codes were applied here, the findings regarding the relevance for the repair sector are listed in Table 5.

For the practical realisation of the analysis, the software MAXQDA was utilised (MAXQDA, 1995-2024), a programme specially adapted to the qualitative evaluation of data and provided by the University of Graz. MAXQDA was employed to establish the previously discussed

category system (see Figure 12, Step IV), whose main codes are displayed in Figure 13, and the subsequent performing the analysis (see Figure 12, Step V).

Having completed the coding of all relevant documents with MAXQDA, the results were compiled and are presented in Chapter 4, followed by an interpretation and discussion of the results (see Figure 12, Step VI) according to the research questions, in Chapter 5. Thereby, the insights are examined in detail and critically, whereby the intersubjectivity in accordance with the quality criteria of analysis (see Figure 12, Step VII) is ensured. The transparency of the research (see Figure 12, Step VII), also essential in this context, is guaranteed by the comprehensive presentation of the procedure and the results as well as the provision of additional in-depth information in the Appendix (Kötter & Kohlbrunn, 2021; cf. Mayring, 2022, p. 118-120).

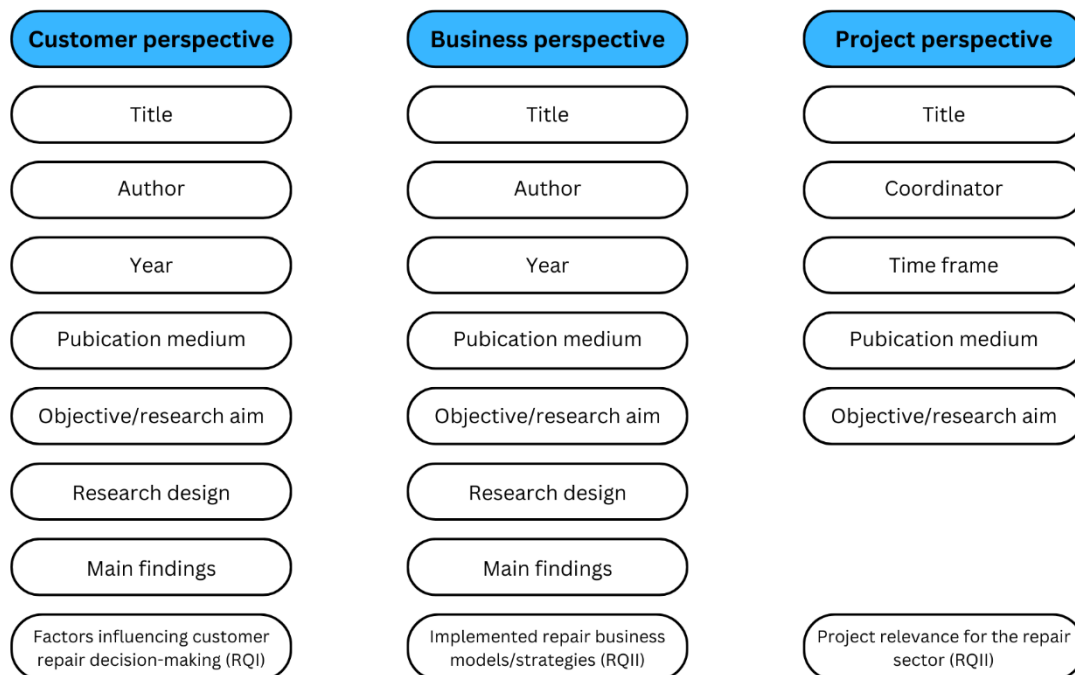


Figure 13: Data analysis - coding structure (own illustration)

## 4. Findings

The main results of this master's thesis, based on the data analysis previously explained, are summarised and illustrated in this chapter. As indicated in the research design and also evident in Figure 7, the literature review was divided into three stages, namely customer, company and project perspectives. The data was analysed according to this division and is accordingly displayed in the following subsections. Initially, the factors influencing customers' repair decisions are outlined in Chapter 4.1., whereby RQI is addressed. Chapters 4.2. and 4.3. in turn tackle RQII, highlighting all identified business strategies in the repair sector and relevant research projects. Concludingly, the mapping of the results to provide insights into the intersection between repair companies and customers, related to RQIII, is demonstrated in Chapter 4.4.

### 4.1. Customer perspective

This subchapter focuses on customers as important actors within the repair sector. As highlighted in Chapter 2.2., there is a clear need to promote actual customer engagement in CE and repair activities. Achieving this goal necessitates a comprehensive understanding of demands placed on repair providers by consumers, the drivers and barriers of their choices, often referred to as factors influencing customers' repair decisions in this study. The entirety of these factors thus serves to reflect the customer perspective on the repair sector.

The results regarding this perspective are based on the papers gathered as described in Chapter 3.1.1., which were analysed as explained in 0. and are also listed in Table 14 in the Appendix. All contributing factors for clients' repair decisions which were recognised by analysing the papers are listed in Table 1. Furthermore, Table 1 serves as a legend for Table 2, which indicates which factors were discovered in which document. As apparent in Table 1 and Table 2, four categories of considerations emerged in the course of the analysis, which are elaborated in the following sections.

#### 4.1.1. Customer-driven economic considerations

Firstly, the "Customer-driven economic considerations", reveal that consumers demand repair companies to minimise effort for them. This can involve effort in the form of costs for the repair process, as significantly demonstrated by total of 32 out of 39 analysed papers indicating the price of the repair service (A2) as a crucial factor for customer decisions. As Güsser-Fachbach, Lechner, Ramos, and Reimann (2023) explored in focus group interviews with Austrian repair clients, these procedural expenses are also related to whether a fee is charged for the

repairability check (A2). These represent a major barrier and, in the case of non-repairability, give customers the impression of having spent money in vain (Güsser-Fachbach, Lechner, Ramos, & Reimann, 2023).

However, effort also refers to parameters such as the time required (A5) or other convenience-defining elements. The relevance of A5 has been confirmed by the study conducted in Styria, Austria, by Güsser-Fachbach, Lechner, and Reimann (2023), wherein a survey allowed to recognise to what extent which factors affect repair choices and resultingly showing how convenience may contribute to the WTP to use repair offers. Following the price and time for repair, the study determined the importance of accessibility (A8) and warranty (A11), in this particular ranking. In addition, according to this investigation, the original purchase costs (A1) of the device also raises the price willing to pay for a repair service (Güsser-Fachbach, Lechner, & Reimann, 2023). The sources in Table 2 for A1 demonstrate that other factors of a defective item also contribute to the decision whether a repair is carried out, namely its quality, brand, age and function.

In the course of the in-depth questioning of customers in the previously mentioned report by Güsser-Fachbach, Lechner, Ramos, and Reimann (2023), these mentioned several further issues arising for them associated with repair services. Thereby clearly emerges a perceived risk with regard to the service quality (A6) and the trustworthiness of the enterprises (A7) (Güsser-Fachbach, Lechner, Ramos, & Reimann, 2023). These two aspects display a logical interaction, as a lack of trust is usually caused by the perceived risk, which in turn can be reduced in the future through reasonable repair quality (Sonego et al., 2022). Moreover, Güsser-Fachbach, Lechner, Ramos, and Reimann (2023)'s research reveals that clients' repair attitudes and experiences can be favourably impacted by service providers through uncomplicated and transparent dialogue and consulting (A10), user-friendly opening hours (A9), the provision of loan devices (A4) and a warranty for the performed repair (A11) (Güsser-Fachbach, Lechner, Ramos, & Reimann, 2023).

Another aspect resulting from the analysis of the repair decision factors is the comparison of the repair costs, if these are more favourable than the purchase of a new appliance, with the expected added years of service life (A12). However, this argument is only specifically stated in the study by Wieser and Tröger (2018).

Some studies, including Roskladka et al. (2023), claim that there are insufficient legal and economic initiatives and incentives (A14), such as tax reductions, for customers to favour repairs. On the other hand, van der Velden et al. (2023), for example, based on their repair shop

inventory and interviews with repairers in Oslo, Norway, pointed out that the main regulatory issues such as guarantee duration and taxation are already considered at their national level and partly at EU level. Concludingly, strengthening knowledge about legal/economic initiatives (A14) furthermore seems to be determining for people to participate in repair activities. Svensson-Hoglund et al. (2021) even pointed out the challenge of insufficient consumer awareness of their rights, given the confusion between legal and commercial guarantees, the former being granted by the legislator and the latter by the product manufacturers/suppliers themselves.

A lack of repair offerings was also indicated as a client barrier, although it does not appear to be a major issue, as only Roskladka et al. (2023) and Rudolf et al. (2022) cite this lack of appealing options (A13). However, it seems to be more a question of accessibility and visibility. As the factors A8, defined before as repair shop accessibility, and D1, referring to the missing customer knowledge on repair offers, imply and Sabbaghi et al. (2017) also state in their study, an approachable repair infrastructure enhances people's willingness to repair.

#### **4.1.2. Socio-ecological considerations**

“Socio-ecological considerations” on the other hand correspond to personal and cultural reasons for individuals favouring or rejecting repairs. Some participants interviewed in the report by Güsser-Fachbach, Lechner, Ramos, and Reimann (2023) for example stated a general attitude of annoyance and scepticism towards repair (B1). This stigmatisation is also reflected in the research conducted by Wieser and Tröger (2018), dealing with the repair and also replacement and reuse of smartphones in Austria. Nevertheless, this scepticism is particularly prevalent among people without repair experience (B2) (Güsser-Fachbach, Lechner, Ramos, & Reimann, 2023; Wieser & Tröger, 2018).

Similarly, a study from Finland by Korsunova et al. (2023), which analysed the views of young adults on the repair strategy by means of collected reflection essays and additional interviews, emphasises the importance of previous experience. The authors moreover derived from the respondents' descriptions how significant product attachment (B3) is for repair attempts. They even emphasised experience and emotions as often being more decisive than costs, especially for personal repair projects (Korsunova et al., 2023).

The evaluation of Marikyan and Papagiannidis (2023)'s survey highlighted that socio-cultural norms and experiences (B5) also shape repair relevance and practices. Specifically, the study arrived at the conclusion that a person's social sphere can act as a stimulus for repair actions, as individuals wish to be perceived as acting in a sustainable manner.



A crucial observed barrier among customers towards repair is the perceived obsolescence (B4), also referred to as psychological obsolescence in some studies (such as Russell et al. (2023) and Svensson-Hoglund et al. (2023)). As verified by Wieser and Tröger (2018), this factor can prevent a repair trial, in this study for smartphones, beforehand. Similarly, Svensson-Hoglund et al. (2023) highlighted that the desire for the latest product potentially leaves the customer with the impression that their goods are becoming obsolete, especially if they are in need of a repair. In addition, environmental awareness (B7) was discussed as an amplifier for repair, implying that people with environmentally conscious values do not want to participate in the throw-away society and tend to repair defective items (Svensson-Hoglund et al., 2023).

Another interesting observation emerging from several of the analysed studies is that socio-demographic factors (B6) also play a role in repair behaviour. In a survey conducted in the area of Graz in Austria, Fachbach et al. (2022) for example uncovered that women are more likely to use professional repair service providers than men. Justifications for this provided the likewise observed greater trust of women in providers and their stronger concern for the environment (Fachbach et al., 2022). In terms of DIY repairs, Fachbach et al. (2022) did not notice a gender-specific difference, whereas Sandez, Pérez-Belis, et al. (2023) did. A survey of Spanish kettles owners showed that men seem to be more willing as women to attempt to repair them themselves. Also, a correlation between an higher level of education and an enhanced openness to repairs could be detected (Sandez, Pérez-Belis, et al., 2023).

#### **4.1.3. Provider-driven economic considerations**

Category “Provider-driven economic considerations” contains customer requirements placed on product producers/providers and followingly also repair services to enable repairs, or also factors hindering them. Based on their study, combining a systematic literature review on repair barriers and subsequent evaluation by a Delphi study, Roskladka et al. (2023) defined three categories, one of them being the “*Technical possibility of repair*”. Several factors are discussed here, such as the complexity of disassembly and reassembly, the material quality and the openability of the product (C1), which can determine the service life and repairability of products already in the design and manufacturing stages. Furthermore Roskladka et al. (2023) and also Svensson-Hoglund et al. (2021) refer to planned obsolescence (C1) in this context, which shortens device lifetime during design and manufacturing as outlined already in Chapter 2.4. (Roskladka et al., 2023; Svensson-Hoglund et al., 2021).

Roskladka et al. (2023) additionally suggest that modular design (C1) acts as a facilitator for repair at the design and technology level. As confirmed by Amend et al. (2022) modular design,

in this study of smartphones, also positively affects the user experience with self-repair. Nevertheless, creating repair options and ensuring these can be realised also requires the availability of affordable spare parts (C3) as well as comprehensible manuals and suitable tools (C4). Even technological advancements (C5) sometimes hinder users from using their items as long as possible and/or to repair them, for example due to a lack of updateability (Roskladka et al., 2023).

Hernandez et al. (2020) indicate, manufacturers in some industries, such as white goods and electronics, do not necessarily have to continue to supply parts or technical details on their devices after the guarantee period (C2). Furthermore, Russell et al. (2023) pointed out a shortcoming in the legal implementation of allowing a warranted item to be repaired by a third-party service provider. These findings correspond with the insights of Korsunova et al. (2023), who only discovered a positive impact of a valid guarantee in connection with authorised repairers. Generally speaking, the sources for C2 in Table 2 suggest that customers are more eager to have their appliances repaired if there is a valid warranty. Hence, the conclusion can be drawn that in order to reinforce repair, providers should (be forced to) offer extended warranties and repair plans.

A further aspect also concerning industry and market-wide competitiveness, which subsequently affects the repair behaviour of customers, is the availability of new low-cost products (C6). According to a survey completed by Rogers et al. (2021) in Kingston upon Hull in England, 55% of participants responded that they do not repair or have products repaired due to cheap replacement prices. Therefore, it is the third most frequently referred barrier, with repair costs (A2) ranking first at 62%. As Sandez, Pérez-Belis, et al. (2023) emphasise, these two criteria A2 and C6 are weighed up against each other by clients. Magnier and Mugge (2022) likewise discovered that goods more expensive to replace, such as a washing machine, are more likely to be repaired.

#### **4.1.4. Considerations on awareness and skills**

The fourth group “Considerations on awareness and skills” shows that customers need to be informed about repair offers and repairability of products in order to strengthen their willingness to undertake repairs. In particular, the customers’ ability to assess faults and the repairability, the knowhow and skills to carry out repairs (D2) were found to be decisive for especially self-repairs. In this regard, Korsunova et al. (2023) emphasised the usefulness of error codes or notifications to provide consumers with easily accessible assistance in diagnosis and repair. Again, the authors’ analysis reveals that confidence to repair lays a foundation for people to

initiate repair attempts, notwithstanding their complexity (Korsunova et al., 2023). Contrary to confidence, complexity or the perceived complexity of the task (D3) may also represent a barrier to the intention to repair (Fachbach et al., 2022).

If customers are unable or unwilling to carry out repairs independently, the obstacle of obtaining a suitable repair provider (D1) remains, stressed by Zhang and Hale (2022) for example. Their survey in the context of clothing repair in the UK indicates that clients often do not know how to mend their clothes or are not aware of such service institutions (Zhang & Hale, 2022).

Table 1: Finding customer perspective - legend

Factors influencing customer repair decision-making (RQ1)		
A1	Price, quality, brand, age and function of the broken product	<b>CATEGORY A - Customer driven economic considerations</b> Price, time, quality and convenience
A2	Price of the repair	
A3	Fee for cost estimate and checking repairability	
A4	Provision of loan devices/costs for substitute option	
A5	Time required for the repair	
A6	Quality of the repair/perceived risk	
A7	Trustworthiness (of the repair service)	
A8	Accessibility (location, arrival costs and time)	
A9	Opening hours of the repair businesses	
A10	Easy and transparent communication and consultation	
A11	Warranty for the repair	
A12	Expected additional years of product lifetime	
A13	(Un)availability of appealing repair services/options	
A14	Lack of (knowledge about) legal/economic incentives	
B1	Personal attitude towards repair	<b>CATEGORY B - Socio-ecological considerations</b> Personal, cultural and environmental aspects
B2	Personal experience with repair	
B3	(Emotional) product attachment/recovery of personal data	
B4	Perceived obsolescence	
B5	Social norms/cultural aspects/trends	

B6	Socio-demographic factors (gender/age/education/income)	
B7	Environmental awareness	
C1	(Design for) reparability of products/planned obsolescence	<b>CATEGORY C – Provider-driven economic considerations</b> Provider decisions, design and technology
C2	Warranty coverage/duration	
C3	Availability and price of spare parts	
C4	Availability of user-friendly repair tools/manuals/information	
C5	Technological advancements	
C6	Availability of new low-cost products/replacement costs	
D1	(Lack of) knowledge about repair offers/options	<b>CATEGORY D - Considerations on awareness and skills</b> Repair knowledge and education
D2	(Lack of) knowledge on reparability/repair skills/confidence	
D3	(Perceived) repair complexity	

Table 2: Findings customer perspective - factors influencing repair decisions (from 39 articles)

Identified factors influencing customers repair decisions (RQ1)																												Authors			
CATEGORY A														CATEGORY B							CATEGORY C						CATEGORY D				
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	C5	C6	D1	D2	D3	
																															Amend et al., 2022
																															Fachbach et al., 2022(Fachbach et al., 2022)
																															Gobert et al., 2021
																															Güsser-Fachbach, Lechner, Ramos, & Reimann, 2023
																															Hielscher & Jaeger-Erben, 2021
																															Islam et al., 2021
																															Korsunova et al., 2023
																															Laitala et al., 2021
																															Lechner et al., 2021
																															Roskladka et al., 2023
																															Svensson-Hoglund et al., 2021
																															Terzioğlu, 2021
																															van der Velden, 2021
																															Hernandez et al., 2020
																															Lehner et al., 2020
																															Moalem & Mosgaard, 2021
																															Rudolf et al., 2022
																															Zhang & Hale, 2022
																															Sandez, Pérez-Belis, et al., 2023

																														Svensson-Hoglund et al., 2023	
																														van der Velden, 2021	
																														Parajuly et al., 2024	
																														Russell et al., 2023	
																														Sandez, Ibáñez-Forés, et al., 2023	
																														van den Berge et al., 2023	
																														Güsser-Fachbach, Lechner, & Reimann, 2023	
																														Magnier & Mugge, 2022	
																														Rogers et al., 2021	
																														Rabiu & Jaeger-Erben, 2022	
																														Marikyan & Papagiannidis, 2023	
																														Ackermann et al., 2018	
																														Jaeger-Erben et al., 2021	
																														Pérez-Belis et al., 2017	
																														Wieser & Tröger, 2018	
																														Sabbaghi et al., 2017	
																														Sabbaghi & Behdad, 2018	
																														Bovea et al., 2017	
																														Diddi & Yan, 2019	
																														Sonego et al., 2022	
Number of papers mentioning the factor	18	32	2	4	21	14	5	10	1	1	3	1	3	6	14	15	15	7	16	7	11	15	8	18	15	8	17	15	31	8	

## 4.2. Business perspective

Within this subchapter, attention is centred on the entrepreneurial and organisational stakeholders operating in the repair sector. Hence due to the significance of business models and their subsequent evolvement, emphasised for example by the Ellen MacArthur Foundation (2013) and further elaborated in Chapter 2.3., implemented business cases associated with repair were compiled.

Please note that at this point, the author does not consider the term business model, as defined in Chapter 2.3., to be exclusively applicable for all identified repair providers, as these are not all solely repair businesses whose value proposition and delivery are based on repair. For this reason, the term business strategy is additionally applied here, which is frequently stated in scientific literature as an overarching goal put into practice through implementation into a business model (Casadesus-Masanell & Ricart, 2010). Repair business strategies as referred to in this thesis are thereby understood as strategies employed in a business model, serving the overall objective of extending product lifetimes through repair. Therefore, a repair business strategy may or may not cover the company's business model conclusively.

Furthermore, the following used term examples relate to the applied or analysed repair business models/strategies within the businesses, organisations and projects forming the final data set of this perspective. These were obtained as initially outlined in Chapter 3.1.2., from all gathered journal papers, conference proceedings, a report and web sites, and analysed as described in Chapter 3.2., whereby nine patterns of strategies emerged, as listed in Table 3. The “elimination of duplicates” mentioned in Table 3 refers to the fact, that for some companies, namely Fast-Fix, Patagonia, Repair Clinic and R.U.S.Z, examples applicable to more than one group of strategies emerged. These categories again reflect the business perspective onto the repair sector, how entrepreneurial and organisational approaches are realised, and which prospects are offered accordingly.

From the findings, it is evident that a large number of the examples can be assigned to the category “Enabling DIY/knowledge spreading/community building”. This includes repair workshops, tutorials and other events and tools that enable customers to expand their repair knowledge and carry out repairs. “Government or nonprofit repair initiatives/networks” as a further heading focuses more on the networking of repairers with each other and with customers, leading to public repair awareness raising.



Groups two and three both attempt to make repair options more accessible to clients. “Location and time-independent repair by dispatch” thereby means defective products are sent to repair providers, whereas “Mobile repair services/repair-to-customer approach” brings the repair directly to the customer using approaches such as repair buses and couriers.

Examples from the category “Centralization of various repair service providers at a single point of contact” support customers access to repair opportunities for various issues by providing a centralised point of information. Companies classified as type “Warranty provisions and repair plans” offer their customers free or low-cost repairs, for example by providing an extensive warranty/insurance. Also, the consideration of repairability during the design process and the use of design approaches to manufacture spare parts contribute to an increase in repairs, category nine contains such businesses and projects.

Only a few cases match the “Remote repair diagnosis”, where repair consulting takes place via digital paths, and “Franchise repair businesses”, companies for repair operating on a franchise scheme, classification.

All examples referred to in Table 3 are also listed in Table 4, which contains a brief description of each company, organisation or project as well as all sources.

Table 3: Findings business perspective - implemented repair business models/strategies

<b>Implemented repair business models/strategies (RQII)</b>	<b>Number of identified examples</b>
1. Remote repair diagnosis	2
2. Location and time-independent repair by dispatch	7
3. Mobile repair services/repair-to-customer approach	4
4. Franchise repair businesses	3
5. Centralization of various repair service providers at a single point of contact	4
6. Enabling DIY/knowledge spreading/community building	24
7. Government or nonprofit repair initiatives/networks	7
8. Warranty provisions and repair plans	4
9. Design for repairability/modular design	6
<b>N = Final data set of businesses/organisations/projects (duplicates eliminated)</b>	<b>57</b>

Table 4: Findings business perspective - examples

1. Remote repair diagnosis		
Business/organisation/project	Description	Source
Pilot project for online repair diagnosis	A remote repair diagnosis project was carried out in which 15-minute timeslots were offered via a video platform. A monetary saving was clearly demonstrated through remote repair diagnosis.	van Moeseke et al., 2022
Repair Clinic	Repair Clinic, based in North America, enables repair expertise to be accessed by phone or live chat.	Repair Clinic, 2024
2. Location and time-independent repair by dispatch		
Business/organisation/project	Description	Source
Computer Expert	Broken notebooks/laptops can be sent directly to the service provider in Vienna, Austria, by post after filling out a repair form.	Computer Expert, n.d.
WIR REPARIEREN ES	This company from Vienna, Austria, offers a mail-in service for smartphone, tablet and computer repairs.	WIR REPARIEREN ES, n.d.
RocketMobile	Fill out a form and send your defective appliance (smartphone, tablet, computer) to this company based in Vienna, Austria.	RocketMobile, 2021
PMS electronics	This company based in Minden, Germany, examines and repairs music devices. The equipment can also be sent together with a completed repair order.	PMS electronics, n.d.
Purajoya Jewelry	The Swiss company repairs, modifies or renews jewellery. A free estimate is provided, and the jewellery can be sent by mail.	Purajoya Jewelry, 2024

My Jewelry Repair	Jewellery repair is offered by this business, based in the USA, in an online step-by-step repair service, including free shipment and free assessment.	My Jewelry Repair, 2024
Fast-Fix	A US-based repair company for jewellery, watches and eyeglass frames offering a mail-in service.	Fast-Fix, 2024b
<b>3. Mobile repair services/repair-to-customer approach</b>		
<b>Business/organisation/project</b>	<b>Description</b>	<b>Source</b>
UpCykla – a rolling repair shop	An initiative by Lund Renhållningsverk, a waste management business from Sweden, also connected to Lund municipality's FixaTill project. A repair bicycle with folding worktables has been developed, equipped with numerous repair utensils such as a stapler, a saw, a hammer as well as a sewing machine.	Moalem & Schmidt, 2023
Sojo	A British alteration and repair tailoring company using an app to connect consumers with local tailors. Sojo collects the clothes and returns them repaired to the customer's home.	Schnitzer et al., 2024
Patagonia	The clothing company toured through Germany with a mobile repair bus as part of the "Patagonia Worn Wear" tour.	Ayerle, 2016
Caritas-Reparaturbus	The so-called "Josefbus" was initiated by Caritas, volunteers support Caritas clients with minor repairs and crafts at their homes.	ORF, 2019
<b>4. Franchise repair businesses</b>		
<b>Business/organisation/project</b>	<b>Description</b>	<b>Source</b>
Repair- and Service-Center (R.U.S.Z)	A repair provider for most electrical appliances of all brands in Vienna, Austria, searching for franchise partners.	R.U.S.Z, n.d.

Fast-Fix	A franchise company for jewellery, watch and eyeglass frame repairs, mainly in the USA, but also looking for franchise partners in Canada and Europe.	Fast-Fix, 2024a
iFixandRepair	A repair service provider dedicated to the repair of mobile phones and other smart products like tablets, computers and drones with over 100 locations across the USA.	iFixandRepair, 2024a, 2024b
<b>5. Centralization of various repair service providers at a single point of contact</b>		
<b>Business/organisation/project</b>	<b>Description</b>	<b>Source</b>
Helferline	A support service connecting people who have a problem with a technical device such as a mobile phone or computer with suitable independent repairers. An app and a hotline can be used to submit repair requests, and if necessary, the repairers will come to the client's home.	Schnitzer et al., 2024
Handled with Care: Developing the paradigm of a culture of repair and share	The objective of this project was to identify the amount and types of repair and sharing services available in a part of Brisbane, Australia, and display them on a map embedded in a digital platform and an app. This should provide residents with easily accessible information about repair and share providers, as well as a forum for sharing experiences and knowledge.	Kalantidou, 2015
IKOS (reuse, repair and recycling ecosystem in Bordeaux)	The project aims to establish the IKOS ecosystem in Bordeaux, France. This network brings together members from different sectors (building, furniture, textiles, books, building) and their business models and activities.	Tyl & Baldacchino, 2021; Tyl et al., 2023
RessourcenZentrum	This organisation offers repair services, coworking spaces and a repair learning facility in Oldenburg, Germany.	RessourcenZentrum, n.d.

6. Enabling DIY/knowledge spreading/community building		
Business/organisation/project	Description	Source
Repair Portal	This tool was developed using the surveys conducted for this study and is primarily designed for repairers. It is therefore not a platform designed to help private individuals carry out DIY repairs, but rather a tool for professional repairers to record their knowledge internally and thereby reduce repair times and costs for customers. Once a product is submitted for repair, all details supplied by the customer, including product specifications and the defect, are entered into the portal. The repair organisation then queries all internal information available in the repair portal for the specific device and problem. If no such internal information is found, the tool searches external sources online.	Rudolf et al., 2022
Clothes Doctor	This UK-based provider delivers garment alterations and repairs, as well as a variety of products and instructions for cleaning, storing and repairing clothes.	Schnitzer et al., 2024
Cyclo	Among other services, this company in Brussels, Belgium, owns a studio where clients can repair their bikes themselves or with some help. Furthermore, they also offer repair classes for beginners and advanced repairers and repair vouchers.	Schnitzer et al., 2024
The Bike Station	A social enterprise located in Edinburgh and Perth, Scotland, offering a variety of bike maintenance and repair services. During the COVID pandemic, the “Fix Your Own Bike” online course was launched, now the company holds a whole range of skills building trainings.	The Bike Station, 2023; Schnitzer et al., 2024

Ethnographic fieldwork with mobile phone repair workers in Dhaka, Bangladesh	The investigation of the mobile phone repair sector in Dhaka, Bangladesh shows how important collaborative learning is in the repair context, especially in developing countries. More specifically, three key forms of knowledge were identified, explicit or conceptual, tacit and social knowledge.	Ahmed et al., 2015
Love Your Clothes (LYC) public engagement events	This study involved holding a series of Love Your Clothes public engagement events in Scotland with the aim of raising public awareness and introducing participants to various mending techniques. For example, a darned heart motif was created especially for these events. Such visible and decorative techniques are intended to overcome stigma linked to repairs.	McLaren & McLauchlan, 2015
Do-Fix Workshops	Four workshops involving fifty-two participants were held, in which different old and new repair techniques such as darning, kintsugi and 3D printing of spares were tested. Learners are inclined to favour repairs with low skill and know-how activities and long-lasting repairs.	Terzioğlu, 2017
Raw Engagement for Electronics Repair (REFER) project	The REFER programme aims to establish an international educational repair-based network. Therefore, the project organises repair cafes/workshops within six different EU countries and creates an accompanying website containing additional support.	M. Johnson et al., 2021
Bike Kitchen, Malmö	A space for DIY bike fixes in Malmö, Sweden, supported by Malmö City Council through the wages of two people working full-time. They offer spare parts and skills sharing at no charge.	Singh et al., 2021
Bagarmossens Cykelköket, Stockholm	An all-volunteer run DIY bike fixing place in Stockholm, Sweden, financing the leased facility through membership contributions.	Singh et al., 2021

Point Vélo, Lausanne	Point Velo in Lausanne, Switzerland, was founded in partnership with the École polytechnique fédérale de Lausanne (EPFL). Its purpose is to provide a DIY bicycle repair facility on the university campus.	Singh et al., 2021
Biciclot, Barcelona	A makerspace in Barcelona, Spain, focussing on bicycle repair, which has been in existence for over 25 years and is operated entirely by volunteers.	Singh et al., 2021
Biciosxs, Barcelona	A bicycle reparation space located in Barcelona, Spain.	Singh et al., 2021
Living Labs	A multi-stage protocol for Living Labs was developed from this study, these are interactive workshops where solutions are developed in a creative and collaborative way. The protocol foresees two main phases of a Living Lab, firstly the individual assessment of broken devices followed by the creation and piloting of solutions to prolong the lifespan of these products. The host and/or experts will illustrate the importance, challenges and innovative approaches in the sector between these two phases of the Living Lab.	Tyl & Allais, 2021
Fashion Fix	The Fashion Fix programme was conducted in Melbourne, Australia, to explore how design and public engagement can support garment repair and their lifespans. Two four-hour mending events were held at RMIT University, where attendees could bring clothing, and choose to repair it personally or have it fixed. The project also included an online exhibition on Instagram with postings about the overlap of fashion, crafts and repairs.	McCorkill, 2021
RepairApp	A tool called RepairApp was developed for this study. This app enables users for example to identify a particular product model through taking a picture of a product label. From	Sterkens et al., 2021



	the identification data, information from a database can be accessed, including information about previous repair attempts, how they were carried out and whether they were successful. Pilot testing was carried out in two washing machine repair facilities, where 97 appliances were listed in the app.	
Hobby repair business	The “Repair as a hobby” business model is based on the notion that individuals might enjoy repairing appliances in their area of interest. The aim of the model is to close the market gap to professional repair providers, which are cost-intensive, while ensuring a consistently high quality. Overall, a starter kit should be established allowing persons an easy and quick access to the repair of equipment. The model was tested in practice with coffee machines in this study, using different sources for devices. Therefore, the feasibility and an approximate turnover of 18€/h was validated, whereby challenges regarding taxes and warranties were also outlined.	Bunodiére & Duflou, 2023
Bio-inspired fixing kit	Based on the design of biomechanical devices as prostheses, a repair package for broken chairs was developed within this study. Each kit is intended for the repair of one leg and contains a “chair prosthesis” and all necessary tools and instructions. Such a kit bears great potential for DIY repairs and could enrich business models.	Domínguez et al., 2023
iFixit	An online repair community also providing spare parts, specialised tools and free repair guides.	iFixit, n.d.
Patagonia	The American clothing manufacturer presents repair videos and DIY guides.	Patagonia, 2024
Repair Clinic	They offer spare parts, technical expertise, repair knowledge and an expansive library of instructions.	Repair Clinic, 2024

Radlobby Wien	The organisation from Vienna, Austria, hosts bike repair workshops for beginners and experienced repairers.	Radlobby Wien, 2024
Werksalon Co-Making Space	Workshops are held to teach various clothing repair techniques in Vienna, Austria.	Werksalon Co-Making Space, 2013-2024
Umweltberatung	“Die Umweltberatung” offers all the necessary information on organising and conducting repair workshops.	Umweltberatung, 2024
<b>7. Government or nonprofit repair initiatives/networks</b>		
<b>Business/organisation/project</b>	<b>Description</b>	<b>Source</b>
FixaTill	A project realised by the municipality of Lund, Sweden, to minimise communal waste by making repair options accessible and straightforward for the public. For example, by offering a store-like facility with tools and competent staff as well as workshops held regularly by external specialists. FixaTill could deliver obvious positive results in terms of attendance numbers and repair attitudes.	Moalem & Schmidt, 2023; Richter & Dalhammar, 2021
Repair Café Malmö	Repair Café Malmö in Sweden is associated with two umbrella programmes, Repair Café International and the Restart Project. It regularly hosts repair events where repairs happen with the audience instead of for them.	Richter & Dalhammar, 2021
GRAZ repariert	A network of repair operations from all sectors initiated by the City of Graz, Austria, in cooperation with an NGO. The institution connects citizens with participating repair businesses, which must fulfil the defined quality standards of Graz repariert, for example via a repair portal.	GRAZ repariert, n.d.–a

Repair Café Graz	An initiative in Graz, Austria, organising events, Repair Cafés. Visitors can bring broken items and together attempts are made to repair them.	Repair Café Graz, n.d.
Re-Use Austria	The association represents the interests of socio-economically orientated re-use businesses as well as repair networks and repair initiatives in Austria. To promote resource protection and efficiency, Re-Use Austria networks and advises various stakeholders from business, politics and NGOs at Austrian and EU level.	Re-Use Austria, 2018
Reparaturnetzwerk Wien	A network in Vienna, Austria, focussing on businesses that repair everyday objects, which have to meet specific quality criteria, coordinated by the environmental advisory service ("Die Umweltberatung"). Its services include a repair hotline.	Reparaturnetzwerk Wien, 2024
ReparaturInitiative	This association is based in Villach, Austria, and one of its aims is to reopen a Repair Café.	ReparaturInitiative, 2024
<b>8. Warranty provisions and repair plans</b>		
<b>Business/organisation/project</b>	<b>Description</b>	<b>Source</b>
GIAB	GIAB is a Swedish company that is characterised by its collaborations and services to develop and implement circular economy practices. One of their main activities is circular insurance, whereby clients, in cooperation with an insurance company, can send in their defective products, usually mobile phones, which are then repaired, refurbished and sold by GIAB. Instead of cash compensation, policyholders mostly receive a repaired phone with the same performance from GIAB.	E. Johnson, 2022; Schnitzer et al., 2024

Houdini	This Swedish sportswear firm does free repairs under warranty or otherwise performs affordable repair services. To ensure the best possible repairability and longest possible lifetime of their garments, repairability is already considered in the design process.	Holtström et al., 2019; Schnitzer et al., 2024
Nudie Jeans	Customers purchasing jeans from this company are guaranteed a permanent free repair, however, their products are rather expensive. Repair shops or partners are available worldwide.	Schnitzer et al., 2024; Stål & Jansson, 2017
Repair- and Service-Center (R.U.S.Z)	A repair provider for most electrical appliances of all brands in Vienna, Austria, also renting out washing machines and dryers for a one-time deposit and a monthly fee. This includes an annual service and, if required, repair within three working days or exchange of the device.	Schnitzer et al., 2024
<b>9. Design for repairability/modular design</b>		
<b>Business/organisation/project</b>	<b>Description</b>	<b>Source</b>
Shapeways	A 3D printing company where users design and upload 3D printable files, these objects are printed by Shapeways.	Park, 2015
Thingiverse	A design collaborative for exploring, creating and distributing 3D printables.	Park, 2015
Sharepair project	Sharepair seeks to strengthen repair communities by indicating repairs using 3D-printed replacement parts. Project research suggests that 7.5% to 29% of non-repaired objects, within the study, could profit from 3D printing.	Samenjo et al., 2021
The Repair Shop 2049	This pilot project focussed on the reparability of Internet of Things devices, such as smartphones or fitness trackers, addressing the limits of the right to repair for such devices. Therefore, new design approaches like co-design and speculative design were	Stead et al., 2023

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	used in workshops to examine how to empower citizens to enhance IoT repair in their communities and what socio-technical ecosystems might be needed to facilitate this.	
Fairphone	A smartphone supplier from Amsterdam, Netherlands, focussing on longevity, easy repair and modular upgrades.	Fairphone, 2024a, 2024b
Framework	This American company produces laptops in a modular design to allow easy repairability and upgrade of parts/devices.	Framework, 2024

### 4.3. Project perspective

As already evident from the explanations on political interventions in Chapter 2.4., especially from the roadmap of the “European Green Deal” in Figure 6, one of the EU’s tactics for paving the way to a greener future and a circular economy is to incentivise pertinent research and innovation (European Commission, 2019b). To this end, multiple endeavours are undertaken at both EU and Austrian level, including the funding of projects that enable companies, universities and other research institutions to work on developing future-oriented solutions.

To generate further insights into the repair sector in this context and to explore emerging prospects for the sector agents, relevant research projects were compiled during the thesis’ data collection. These were obtained from the corresponding platforms of the EU and Austrian organisations as described in Chapter 3.1.3. and followingly coded as specified in 3.2. The outputs of this process are summarised in Table 5, whereby the diverse contributions of the projects towards the repair strategy reveal different paths and chances to foster repair.

Topics explored by projects “sustainablySMART”, “EECONE” and “Circular Design” for example include methods for designing products to be more repair friendly. At this point, a link to the business strategies, namely the “Design for repairability/modular design” approach, becomes apparent.

The integration of digitalisation, data exchange and management, as well as emerging technologies such as AI, also plays a significant role in some projects (“RRREMAKER”, “PROMPT”, “CircThread” and “DaCapo”).

The importance of community building, and knowledge and skill formation has already become evident in analysing business cases, as enabling DIY and also government and non-profit initiatives are of great significance for empowering repair and making it more accessible to customers. The “SCENSUS”, “R&DIY-U”, “Transformer” and “All\*Makers\*” projects are also addressing these aspects.

Furthermore, several of the recognised projects concern the conceptualisation of innovative circular business models or the optimisation of operational business processes, these includes “CIRC4Life”, “C-SERVEES”, “CIRCULAR X” as well as “OPENing Re-Use” and “Towards an integrated model for decision support in closed-loop supply chains”.

All information on the projects’ details such as coordination and timeframe as well as implications for the repair sector and sources are provided in the corresponding Table 5.

Table 5: Findings project perspective - identified topic-related research/innovation projects

Identified topic-related research/innovation projects in an (inter)national context (RQII)	Project coordinator	Timeframe	Programme	Project database /Source	Project relevance for the repair sector (RQII)
RRREMAKER (Reuse Reduce Recycle AI-based platform for automated and scalable Maker culture in Circular economy)	University of Granada - Spain	2021-2024	Horizon 2020	CORDIS, 2024b	Building up a platform for makers operating with the support of AI and enabling various forms of data exchange and networking in order to enable the design and fabrication of customised and refurbished goods in minimum time on the basis of the availability on pre-used products and recyclable materials
CIRC4Life (A circular economy approach for lifecycles of products and services)	Nottingham Trent University - United Kingdom	2018-2021	Horizon 2020	CORDIS, 2023a	Establishing a sustainable economy from scratch, covering all stages of supply and value chains; initiating three innovative business practices for CE, e.g. the model of collaborative reuse/recycling (creating a system whereby actors work together to promote the use/re-use of discarded items and minimise waste, and introducing an environmental credit system)
sustainablySMART (Sustainable Smart Mobile Devices Lifecycles through Advanced Re-design, Reliability, and Re-use and Remanufacturing Technologies)	Fraunhofer Society – Germany	2015-2019	Horizon 2020	CORDIS, 2022a	Working towards novel strategies for product design of computers and smartphones to reinforce the circular economy; enhancing efficiency of resource utilisation via optimised procedures through the product life cycle, e.g. strengthening repair capabilities with re-usable parts/modules
C-SERVEES (Activating Circular Services in the Electric and Electronic Sector)	AIMPLAS – Technological Institute of Plastics - Spain	2018-2022	Horizon 2020	CORDIS, 2023d	Changing the way electrical and electronic products are produced and consumed; increasing resource efficiency in that sector by creating, trialling, and scaling up new business models for CE; creating

					new opportunities for end users and the social economy (e.g. EMAUS, an NGO engaging persons at risk of marginalisation in the repair and refurbishment of products)
PROMPT (PRemature Obsolescence Multi-Stakeholder Product Testing Program)	Fraunhofer Society – Germany	2019-2023	Horizon 2020	CORDIS, 2024d	Reducing the information imbalance among customers and producers by establishing a testing system supporting the durability assessment of electronic goods; focussing on important aspects of defects and obsolescence, such as reparability
CircThread (Building the Digital Thread for Circular Economy Product, Resource & Service Management)	Fundación CARTIF – Spain	2021-2025	Horizon 2020	CORDIS, 2024c	Emphasis on data and information management to support decision making for the circular economy; therefore, setting up cloud platforms for household devices and domestic power installations in certain areas in Spain, Italy and Slovenia to facilitate better defect comprehension and efficient use of replacement parts in favour of the “Right to Repair”
CIRCULAR X (Experimenting with Circular Service Business Models)	Maastricht University - Netherlands	2020-2026	European Research Council	CORDIS, 2024a	Investigating business concepts for circular services, e.g. offering leasing options rather than selling goods and establishing lifetime warranties
SCENSUS (Scaling the Societal Impact of Community Enterprises for Sustainability)	Erasmus University Rotterdam - Netherlands	2023-2028	European Research Council	CORDIS, 2023b	Identifying and understanding the means by which community businesses can increase their societal effects; focusing on examples in the three core areas of repair, energy and carsharing, located in France, the Netherlands, Germany and the United Kingdom
EECONE (European ECOsystem for green Electronics)	Infineon Technologies AG – Germany	2023-2026	Horizon Europe	CORDIS, 2023c	Optimising and implementing eco-design approaches to improve the reliability and repair ratios of electronic devices to extend their life span
DaCapo (Digital assets and tools for Circular value chains and manufacturing products)	AIMEN Technology Centre - Spain	2023-2026	Horizon Europe	CORDIS, 2022b	Realising human-centred smart solutions and services to advance strategies for CE throughout the product value chain and life cycle



R&DIY-U (Repair & Do-It-Yourself Urbanism)	Institute for Advanced Studies (IHS) - Vienna	2017-2020		FFG, 2015-2024d	Strengthening repair and DIY facilities by planning and realising service offerings and infrastructure improvements across targeted city districts of Vienna, Austria
Transformer (Co-Creation Space für hands-on Klimatransformationslösungen rund um Leerstandsgebäuderessourcen)	Vienna University of Technology	2023-2026		FFG, 2015-2024e	Increasing children's and young people's awareness and skills in relation to consumption behaviour and material cycles through dismantling, repairing, and exploring products
All*Makers* (All Kinds of Makers*)	University of Salzburg	2022-2025		FFG, 2015-2024a	Analysing the ecological impact and strategies for sustainable making; dealing with repair, recycling and upcycling as practical examples of making
OPENing Re-Use (Optimale Planungsentscheidungen im Re-Use-Sektor)	University of Graz	2023-2026		FFG, 2015-2024c	Developing a business planning tool to increase the efficiency of re-use processes
Circular Design (Von der Theorie in die Praxis kommen)	ETA Umweltmanagement GmbH	2023-2024		FFG, 2015-2024b	Encouraging the broad application of circular design in Austria through proposals for fields of operation and measures
Towards an integrated model for decision support in closed-loop supply chains	University of Graz	2012-2014		OeNB, 2024c	Developing an integrated view of reverse logistics with interrelated sub-processes; different processes are combined, and complexity is gradually added in the form of additional processes; the findings are largely based on a case study regarding R.U.S.Z. (see examples in section 4.2.)

## 4.4. Mapping

Based on all the results and sources from the previous subchapters, a mapping process is performed, enabling a visualisation of the linkages between customer demands and business strategies. Please note at this point that this process is based on a well-founded analysis of the repair sector from various viewpoints, in order to make a perspective confrontation possible, certain assumptions are necessary, taking into account all the received sources.

The first outcome of the mapping process are tool maps for all of the nine recognised categories of business models/strategies, as depicted in Figure 14 for “Remote repair diagnosis”. This and the following illustrations were developed as follows. Firstly, the factors from 4.1. which encourage or discourage consumers to engage in repairs were illustrated according to the four defined categories. Subsequently, the respective business models/strategies from 4.2. were assessed. Determinant factors that might be fulfilled/improved by the respective business approach were highlighted and others were made transparent.

As indicated above, this process and consequently the tool map for “Remote repair diagnosis” is outlined in Figure 14. The maps covering the other business models/strategies are presented in Figure 15 and Figure 16. Further elaborations on the impact of the business concepts on customer demand, i.e. how these strategies enhance the attractiveness of repair for clients, are provided in Table 6.

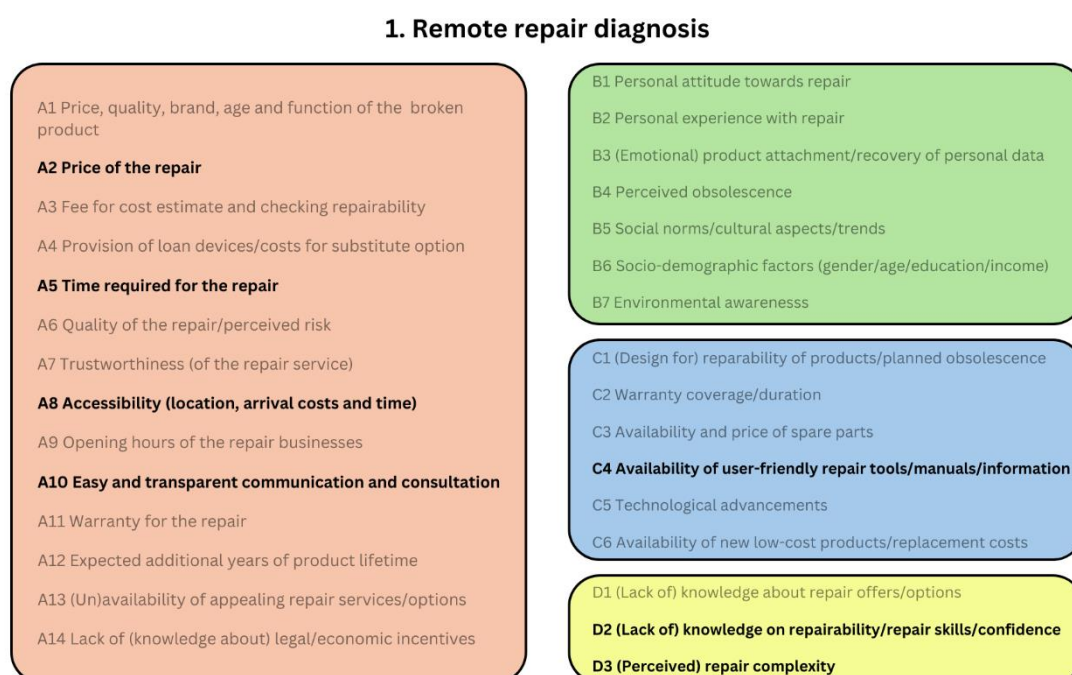


Figure 14: Tool map 1 - Identification of the business strategies' impact (own illustration)

## 2. Location and time-independent repair by dispatch

A1 Price, quality, brand, age and function of the broken product  
 A2 Price of the repair  
 A3 Fee for cost estimate and checking repairability  
 A4 Provision of loan devices/costs for substitute option  
 A5 Time required for the repair  
 A6 Quality of the repair/perceived risk  
 A7 Trustworthiness (of the repair service)  
**A8 Accessibility (location, arrival costs and time)**  
**A9 Opening hours of the repair businesses**  
 A10 Easy and transparent communication and consultation  
 A11 Warranty for the repair  
 A12 Expected additional years of product lifetime  
 A13 (Un)availability of appealing repair services/options  
 A14 Lack of (knowledge about) legal/economic incentives

### B1 Personal attitude towards repair

B2 Personal experience with repair  
 B3 (Emotional) product attachment/recovery of personal data  
 B4 Perceived obsolescence  
 B5 Social norms/cultural aspects/trends  
 B6 Socio-demographic factors (gender/age/education/income)  
 B7 Environmental awareness

### C1 (Design for) reparability of products/planned obsolescence

C2 Warranty coverage/duration  
 C3 Availability and price of spare parts  
 C4 Availability of user-friendly repair tools/manuals/information  
 C5 Technological advancements  
 C6 Availability of new low-cost products/replacement costs

### D1 (Lack of) knowledge about repair offers/options

D2 (Lack of) knowledge on reparability/repair skills/confidence  
 D3 (Perceived) repair complexity

## 3. Mobile repair services/repair-to-customer approach

A1 Price, quality, brand, age and function of the broken product  
 A2 Price of the repair  
 A3 Fee for cost estimate and checking repairability  
 A4 Provision of loan devices/costs for substitute option  
 A5 Time required for the repair  
 A6 Quality of the repair/perceived risk  
 A7 Trustworthiness (of the repair service)  
**A8 Accessibility (location, arrival costs and time)**  
 A9 Opening hours of the repair businesses  
 A10 Easy and transparent communication and consultation  
 A11 Warranty for the repair  
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 C5 Technological advancements  
 C6 Availability of new low-cost products/replacement costs

### D1 (Lack of) knowledge about repair offers/options

D2 (Lack of) knowledge on reparability/repair skills/confidence  
 D3 (Perceived) repair complexity

## 4. Franchise repair businesses

A1 Price, quality, brand, age and function of the broken product  
 A2 Price of the repair  
 A3 Fee for cost estimate and checking repairability  
 A4 Provision of loan devices/costs for substitute option  
 A5 Time required for the repair  
 A6 Quality of the repair/perceived risk  
**A7 Trustworthiness (of the repair service)**  
 A8 Accessibility (location, arrival costs and time)  
 A9 Opening hours of the repair businesses  
 A10 Easy and transparent communication and consultation  
 A11 Warranty for the repair  
 A12 Expected additional years of product lifetime  
**A13 (Un)availability of appealing repair services/options**  
 A14 Lack of (knowledge about) legal/economic incentives

### B1 Personal attitude towards repair

B2 Personal experience with repair  
 B3 (Emotional) product attachment/recovery of personal data  
 B4 Perceived obsolescence  
 B5 Social norms/cultural aspects/trends  
 B6 Socio-demographic factors (gender/age/education/income)  
 B7 Environmental awareness

### C1 (Design for) reparability of products/planned obsolescence

C2 Warranty coverage/duration  
 C3 Availability and price of spare parts  
 C4 Availability of user-friendly repair tools/manuals/information  
 C5 Technological advancements  
 C6 Availability of new low-cost products/replacement costs

### D1 (Lack of) knowledge about repair offers/options

D2 (Lack of) knowledge on reparability/repair skills/confidence  
 D3 (Perceived) repair complexity

## 5. Centralization of various repair service providers at a single point of contact

A1 Price, quality, brand, age and function of the broken product  
 A2 Price of the repair  
 A3 Fee for cost estimate and checking repairability  
 A4 Provision of loan devices/costs for substitute option  
 A5 Time required for the repair  
 A6 Quality of the repair/perceived risk  
 A7 Trustworthiness (of the repair service)  
**A8 Accessibility (location, arrival costs and time)**  
 A9 Opening hours of the repair businesses  
**A10 Easy and transparent communication and consultation**  
 A11 Warranty for the repair  
 A12 Expected additional years of product lifetime  
 A13 (Un)availability of appealing repair services/options  
 A14 Lack of (knowledge about) legal/economic incentives

### B1 Personal attitude towards repair

B2 Personal experience with repair  
 B3 (Emotional) product attachment/recovery of personal data  
 B4 Perceived obsolescence  
 B5 Social norms/cultural aspects/trends  
 B6 Socio-demographic factors (gender/age/education/income)  
 B7 Environmental awareness

### C1 (Design for) reparability of products/planned obsolescence

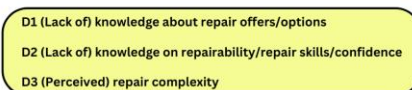
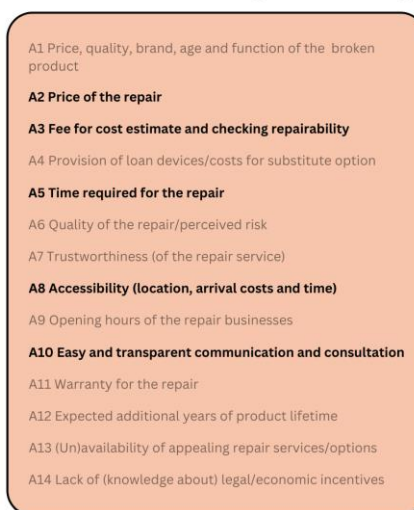
C2 Warranty coverage/duration  
 C3 Availability and price of spare parts  
**C4 Availability of user-friendly repair tools/manuals/information**  
 C5 Technological advancements  
 C6 Availability of new low-cost products/replacement costs

### D1 (Lack of) knowledge about repair offers/options

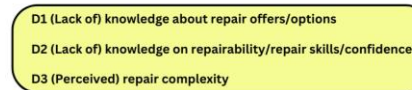
D2 (Lack of) knowledge on reparability/repair skills/confidence  
 D3 (Perceived) repair complexity

Figure 15: Tool maps 2-5 - Identification of the business strategies' impact (own illustration)

## 6. Enabling DIY/knowledge spreading/community building



## 7. Government or nonprofit repair initiatives/networks



## 8. Warranty provisions and repair plans



## 9. Design for reparability/modular design



Figure 16: Tool maps 6-9 - Identification of the business strategies' impact (own illustration)



Table 6: Mapping business strategies impact on customer needs (for specific references see respective sections)

	<b>CATEGORY A Customer driven economic considerations</b>	<b>CATEGORY B Socio-ecological considerations</b>	<b>CATEGORY C Provider-driven economic considerations</b>	<b>CATEGORY D Considerations on awareness and skills</b>
<b>Remote repair diagnosis</b>	Customers receive uncomplicated, location-independent advice. Time and monetary savings can also be achieved for service providers and customers (see 4.1.1. and examples for “Remote repair diagnosis” in 4.2.).		Remote support helps to ensure that customers are provided with straightforward repair information (see 4.1.3. and examples for “Remote repair diagnosis” in 4.2.).	Contributes to clients’ repair knowledge by providing expert advice on repairability and estimated cost, thus potentially minimising the perceived complexity of the repair (see 4.1.4. and examples for “Remote repair diagnosis” in 4.2.).
<b>Location and time-independent repair by dispatch</b>	Due to a mail-in service, customers are not tied to the location and opening hours of a repair business; repair orders and dispatch can take place at any time (see 4.1.1. and examples for “Location and time-independent repair by dispatch” in 4.2.).	Since a negative perception of repair by customers is usually caused by an expected non-repairability and a high effort, a mail-in offer that reduces the effort can create a more favourable attitude (see 4.1.2. and examples for “Location and time-independent repair by dispatch” in 4.2.).		
<b>Mobile repair services/repair-to-customer approach</b>	The accessibility of repair services can be significantly improved through taking the offer to the consumer or by sending carriers to collect			Mobile repair offers, such as repair buses or the repair bike, bring the service directly to the client. Thereby familiarising customers with existing

	the products in need of repair (see 4.1.1. and examples for “Mobile repair services/repair-to-customer approach” in 4.2.).			repair options (see 4.1.4. and examples for “Mobile repair services/repair-to-customer approach” in 4.2.).
<b>Franchise repair businesses</b>	The franchise option creates a larger range of (attractive) repair options for customers. Moreover, an established brand for repairs conveys a certain trustworthiness to users (see 4.1.1. and examples for “Franchise repair businesses” in 4.2.).			As a franchise system increases the amount of offers, it also potentially expands the visibility of these services and thus the customers’ knowledge about the repair options (see 4.1.4. and examples for “Franchise repair businesses” in 4.2.).
<b>Centralization of various repair service providers at a single point of contact</b>	By providing a centrally organised contact point for various repair services, whether through establishing a reuse, repair and recycling ecosystem as in the IKOS project, or the installation of the RessourcenZentrum as a space for various repair activities, the visibility of the offers is increased, and access is facilitated for users. Furthermore, such programmes support clients in obtaining	The possible interaction which is usually associated with the centralisation of repair provides allows the repair attitude of users to be shaped favourably, as experience and know-how about repairs and service providers can be shared effortlessly. Again, positive repair experiences might result, also supported by the simplified identification of suitable repairers (see 4.1.2. and examples for	Solutions like centralised hotlines and apps, such as Helferline, and shared repair coworking spaces and workshops, like the RessourcenZentrum, provide consumers with simplified and comprehensible repair advice and information (see 4.1.3. and examples for “Centralization of various repair service providers at a single point of contact” in 4.2.).	Customer awareness regarding repair offerings can also be enhanced through centralisation, by increased visibility and the ability to identify the offerings through one location, website, platform or app. In turn, these facilities enable the exchange of knowledge and experience, potentially promoting repair skills and confidence among both customers and providers (see 4.1.4. and examples

	straightforward repair advice, for example also through the Helferline app and hotline (see 4.1.1. and examples for “Centralization of various repair service providers at a single point of contact” in 4.2.).	“Centralization of various repair service providers at a single point of contact” in 4.2.).		for “Centralization of various repair service providers at a single point of contact” in 4.2.).
<b>Enabling DIY/knowledge spreading/community building</b>	The provision of DIY instructions, workshops and other repair assistance reduces repair costs and usually also the time required for users. Moreover, these various offers increase the accessibility of repair options and minimise the difficulty of obtaining straightforward advice (see 4.1.1. and examples for “Enabling DIY/knowledge spreading/community building” in 4.2.).	Active participation in repair processes contributes to positive repair experiences, which can also have a positive influence on individual attitudes towards repair. Emotional product attachment favours repairs and repairing a product yourself again encourages attachment. Community building and the dissemination of knowledge through repair events contributes to challenging social norms and raising environmental awareness (see 4.1.2. and examples for “Enabling DIY/knowledge spreading/community building” in 4.2.).	Instructions on how to repair goods and platforms selling spare parts improve clients’ ability to perform DIY repairs (see 4.1.3. and examples for “Enabling DIY/knowledge spreading/community building” in 4.2.).	Through a variety of media such as blogs, tutorials and workshops, the repair confidence and skills of users can be strengthened, which also reduces the perceived complexity of the repair. In addition, such offers lead to community building, which strengthens consumers’ awareness of repair offers (see 4.1.4. and examples for “Enabling DIY/knowledge spreading/community building” in 4.2.).

<b>Government or nonprofit repair initiatives/networks</b>	<p>Organisations such as GRAZ repariert and Reparturnetzwerk Wien contribute to the trustworthiness of repair services through mandatory criteria for participating businesses and in turn reduce the perceived risk for clients. Such repair networks/organisations and interest representatives, such as Reuse Austria, also contribute to creating more attractive repair offers and enhancing legal/economic incentives and public knowledge about them. Repair Café initiatives minimise the monetary effort for participants, also, no fees are charged for checking the repairability (see 4.1.1. and examples for “Government or nonprofit repair initiatives/networks” in 4.2.).</p>	<p>Repair initiatives/networks aim to combat the throwaway society by creating positive repair experiences and attitudes among consumers and, as a result, positively influencing norms and environmental awareness (see 4.1.2. and examples for “Government or nonprofit repair initiatives/networks” in 4.2.).</p>	<p>Repair cafés provide visitors with information on how products can be repaired (see 4.1.3. and examples for “Government or nonprofit repair initiatives/networks” in 4.2.).</p>	<p>At repair cafés, repairs and attempts are carried out with the participants, which can increase their ability to repair, making repairs seem less cumbersome in the future. Repair networks also provide customers with information about suitable repair options, for example via portals and hotlines (see 4.1.4. and examples for “Government or nonprofit repair initiatives/networks” in 4.2.).</p>
<b>Warranty provisions and repair plans</b>	<p>The repairability check is free of charge for customers if an extensive</p>	<p>The attitude of consumers towards repairs can be optimised by the provision</p>	<p>If a device is broken, clients can approach the provider of the</p>	<p>As customers have a direct point of contact to turn to in case of a repair need, the</p>



	warranty/insurance programme is in place. And customers generally do not have to pay anything for repairs, even if the products (like Nudie Jeans) are quite expensive or an insurance fee must be paid (as with GIAB's circular insurance) (see 4.1.1. and examples for "Warranty provisions and repair plans" in 4.2.).	of a guarantee, a valid warranty encourages customers to carry out repairs as their (perceived) effort is reduced (see 4.1.2. and examples for "Warranty provisions and repair plans" in 4.2.).	product/insurance directly, who will offer a repair opportunity (see 4.1.3. and examples for "Warranty provisions and repair plans" in 4.2.).	barrier of lack of knowledge about repair options is no longer an issue (see 4.1.4. and examples for "Warranty provisions and repair plans" in 4.2.).
<b>Design for repairability/modular design</b>	Modular design and techniques like 3D printing of spare parts lower the cost and repair time for clients (see 4.1.1. and examples for "Design for repairability/modular design" in 4.2.).	Facilitating repairability can clearly affect customer attitudes and experience with repair. Furthermore, the users' perceived obsolescence of products is reduced through design for repairability (see 4.1.2. and examples for "Design for repairability/modular design" in 4.2.).	Design methods can improve the repairability of products, thereby simplifying the purchase and replacement of defective parts. Furthermore, a technical upgrade can be carried out without having to buy a new device. Moreover, design approaches such as 3D printing increase spare part availability for customers (see 4.1.3. and examples for "Design for repairability/modular design" in 4.2.).	Modular design reduces the (perceived) complexity of the repair (see 4.1.4. and examples for "Design for repairability/modular design" in 4.2.).

## 5. Discussion

Within this chapter, the insights from Chapter 4 are discussed and thus the research questions are addressed in a chronological manner. In the first step, the expectations customers place upon repair providers are examined. Subsequently, the characteristics and opportunities of the selected business scenarios and projects are analysed. These findings are then aligned on the basis of a critical consideration of the mapping process.

### 5.1. Customer demands on repair businesses

For the purpose of assessing RQI, this master's thesis analysed the factors affecting customer decisions regarding the repair of products, the corresponding results of which are presented in Chapter 4.1. The assessment given in Table 2 reveals that, unsurprisingly, the price of a repair service is critical in determining whether it is purchased by clients. A majority of studies, such as the survey by Güsser-Fachbach, Lechner, and Reimann (2023), identified the repair price as the main deciding criterion. Customers therefore first and foremost demand the lowest possible, reasonable price for the service. As expressed for instance by Pérez-Belis et al. (2017), this major barrier is reinforced by the comparison of the expenses for repair and the acquisition of a new device, especially for low-cost appliances. Moreover, as Güsser-Fachbach, Lechner, Ramos, and Reimann (2023) suggest, fees charged regardless of the repair's success, to assess the repairability of the faulty device and the expected repair monetary expenses, represent a strong obstacle for potential clients.

However, a solely price-based view would be too undifferentiated, as customers impose a variety of other barriers and motivators determining if repair providers are considered. Essential considerations regarding the usage of repair services, and also the amount customers are willing to pay, are the effort required and thus the determinants of the convenience of repair. The evaluation of Güsser-Fachbach, Lechner, and Reimann (2023) demonstrates how crucial the time required for the repair process is to consumers. Generally, that's because users need their devices, or rather their function, and otherwise have to arrange for a substitute device. This expectation is supported by Güsser-Fachbach, Lechner, Ramos, and Reimann (2023), whereby customers emphasise their desire for a loan item provided to them by repairers in case of particularly long service periods.

Furthermore, the accessibility of the repair companies is frequently pointed out during data analysis, whereas poor connectivity by public transport and extensive travelling times and costs lead to less people making use of repair facilities. Korsunova et al. (2023) and Güsser-Fachbach,

Lechner, Ramos, and Reimann (2023) additionally stress the fact that accessibility, especially lengthy commutes, is particularly difficult in rural areas due to limited numbers of repair offers. According to the results of Güsser-Fachbach, Lechner, Ramos, and Reimann (2023), the opening hours of a repair business might additionally have an impact on its utilisation, depending on how customer-friendly these are.

Roskladka et al. (2023), among others, referred to the lack of customer trust in repair providers. Primarily, this is due to the fact of users frequently not being confident of a satisfactory quality outcome of the repair process or concerns of being overcharged. In turn, companies are obliged to demonstrate the quality of their services to their clients to positively shape their repair attitude and experience. The significance of mindset and previous experience gained through repair activities emerged repeatedly throughout the data analysis, and was particularly emphasised by Korsunova et al. (2023). To strengthen people's confidence in repair organisations, attention was drawn to transparent and uncomplicated customer communication and consultation in Güsser-Fachbach, Lechner, Ramos, and Reimann (2023). Enhancing repair offers' visibility through suitable locations and enhanced (online) advertising emerges as another important driver for the success of these repairers, as multiple research papers reviewed, reported in Table 2, demonstrate a continuing absence of information about repair services preventing individuals from undertaking repairs.

Concludingly, consumers require repair services to be affordable, accessible, visible, transparent and of high quality. Hence, the question arises as how repair providers can realise these requirements. The repair effort and outcome are not always within their control. Factors that are decisive for a successful repair process and are therefore also indirectly demanded by customers from repair companies include the reparability of products as well as the availability of spare parts and repair information. These aspects are often within the power and responsibility of the manufacturer and can in turn affect decision-making criteria for the customer, such as repair price and time. These details are primarily derived from the evaluation of category "Provider-driven economic considerations", detailed in Chapter 4.1.3. Customers are also obviously motivated to use a repair service by the existence of a valid warranty, resulting from Russell et al. (2023), for instance. Consequently, the product manufacturers can be again held to account to provide long-term and extensive warranties for their products so as to promote repair activities.

Güsser-Fachbach, Lechner, Ramos, and Reimann (2023) could also recognise a strong customer demand for the provision of a warranty for repairs carried out by the (independent) providers.

Even the request for a guarantee not only for the repaired components but also for the entire appliance was expressed, but this was understandably rejected by the companies as unrealisable, as the associated risk would be too high.

## **5.2. Implemented repair business strategies and relevant research projects**

To investigate the viewpoint of the providers and to enable an assessment of RQII, a state-of-the-art analysis of offers regarding repair was also carried out, which is provided in Table 4. From this inventory it is evident that a broad range of business patterns associated to repair could be detected. As a result, a focus on imparting repair knowledge, skills and tools could be observed. This approach of empowering DIY can be realised on a business level by offering courses and workshops, as Werksalon Co-Making Space (2013-2024) does for example for garments, and through selling spare parts, like iFixit (n.d.). For customers with sufficient repair capabilities, the provision of spaces and equipment is another option, as implemented by Cyclo (Schnitzer et al., 2024), who additionally hold repair classes and sell repair vouchers. Moreover, the paper by Domínguez et al. (2023) presents the option of a customised repair kit for chairs, which has the potential to complement the business model of furniture suppliers, in line with the “business model diversification” depicted in Figure 4, where it is discussed as a category of business model innovation. Another aspect contributing to implementing DIY repairs is the publication of various information sources on how to repair certain items. Again, this represents a business addition, as is the case with Patagonia (2024), where a large number of clothing repair guides and videos are available. Likewise, community engagement events such as Fashion Fix provide valuable DIY input (McCorkill, 2021).

An overarching strategy, which is primarily intended to connect repairers and customers, are repair networks and initiatives. Most of these are not profit-oriented and are organised by the government, NGOs or volunteers. However, networks as GRAZ repariert (n.d.–a) deliver significant added value, especially for independent repair providers, as they become recognisable to potential clients through a repair portal. Repair café initiatives also constitute another worthwhile approach to supporting the repair sector. By attending such events like those from GRAZ repariert (n.d.–a), visitors gain repair expertise and confidence, plus the offer can be utilised to evaluate the reparability of a product and overcome the barrier of fees charged by repair service providers. As Güsser-Fachbach, Lechner, Ramos, and Reimann (2023) already commented, a potential for collaboration between repair cafés and other repair businesses becomes evident at this point, referring to “business model acquisition” (see Figure 4) from the

repair companies point of view. A system in turn interlinking the repair providers is the franchise approach, whereby new businesses can benefit from the existing know-how and brand. As this study revealed, such schemes for jewellery repair (Fast-Fix, 2024a) and electronics (iFixandRepair, 2024b) repair have already been implemented in the USA. With R.U.S.Z (n.d.), a company for electric appliance repair now also intends to set up a franchise model in Austria. The centralisation concept, as in the case of RessourcenZentrum (n.d.), also allows several repair agents and activities to be linked together in one location. Moreover, centralised contact point operators like Helferline (Schnitzer et al., 2024) enable clients to access multiple repair providers, and the operator selects the most suitable service for them.

Mail-in services definitely qualify as a useful extension and diversification (see Figure 4) to a stationary repair shop facility. After specifying details on the product and the defect, users are given the convenient opportunity to send them to the business, which then carries out the repair process. Such offers could previously be identified for mobile phones and smartphones (Computer Expert, n.d.; RocketMobile, 2021; WIR REPARIEREN ES, n.d.), jewellery (Fast-Fix, 2024b; My Jewelry Repair, 2024; Purajoya Jewelry, 2024) and music devices (PMS electronics, n.d.). Another approach intended to loosen the ties to a fixed location is the mobilisation of the repair service. Patagonia, for example, organised a tour with a repair bus (Ayerle, 2016), while Sojo operates a collection service for damaged items (Schnitzer et al., 2024). Moreover, with "UpCykla", a repair bike equipped with all the necessary repair gear was developed (Moalem & Schmidt, 2023). However, at this point the author draws attention to the potentially increased effort for repair providers through mobile offers, the profitability of this approach still needs to be further investigated. Additionally, the research undertaken by van Moeseke et al. (2022) demonstrates the potential of repair diagnosis via online channels. Hence, clients do not require to visit a repair shop to obtain clarification about the repairability of an appliance and the concrete faults, repair options and estimated costs. This study indicates a possible monetary saving, rendering the operation of a repair enterprise more economically feasible, nevertheless, it is worth noting that a suitable technical set-up for remote diagnosis needs to be established. At this point, the author proposes the possibility of a beneficial cooperation between remote repair diagnosis and manufacturers or spare part providers (such as iFixit (n.d.)) whereby customers could receive the necessary spare parts following diagnosis and consultation.

How consumers might profit from the manufacturer's acceptance of responsibility by providing a warranty for a lifetime of free repairs can be observed in the case of Nudie Jeans. The jeans brand operates its own repair shops, but also partners with other repair service providers to

enable customers to claim their warranty (Schnitzer et al., 2024; Stål & Jansson, 2017). Another fruitful collaboration for the provision of a warranty is evident in the form of GIAB, a company that, in partnership with an insurance company, supplies policyholders with equivalent repaired mobile phones in case of a defect. The faulty devices are in turn subjected to a repair attempt and, if possible, resold (E. Johnson, 2022; Schnitzer et al., 2024). Proving a successful example associated with the second circular economy principle “Circulate products and materials (at their highest value)”, introduced in Chapter 2.1., as well as “business model acquisition” (see Figure 4).

Critically, the application of design strategies could also be considered irrelevant for the assessment of repair business models. However, this strategy was considered in this study, firstly to show that CE and the repair strategy must be included in product design and manufacturing, as already justified by the first principle of the CE “Eliminate waste and pollution” (see Chapter 2.1.). Furthermore, simplicity of repair, for example through modular design as in the case of smartphones from Fairphone (2024a) and laptops from Framework (2024), facilitates the repair process for individuals and repair companies.

The evaluation of the project perspective also revealed research activity with regard to the reparability of (electric) devices. Generally, by assessing research and innovation projects on European and Austrian level, a diverse range of projects in the context of the circular economy, indicating a promising future research prospect. Although a broader repair focus is desirable, according to the author, given the broad discussed relevance in this thesis and the extensive search criteria compared to the resulting number of 16 selected relevant projects, given in Table 5.

### **5.3. Business strategies matching consumer requirements**

The process outlined in Section 4.4. and its outcomes, i.e. the tool maps depicted in Figure 14, Figure 15, Figure 16 and the Overview Table 6, serve to examine RQIII, whereby approaches and ideas are to be recognised as to which business strategies can be applied to meet customer requirements. Accordingly, the aim is to identify how business models in the repair sector can be innovated and supplemented in order to enhance consumer willingness to repair.

Once again, it must be pointed out that this evaluation and the creation of the tool maps required adopting certain assumptions about the interactions between the business strategies and customer demands, which are based on the previously conducted and extensively described review of the repair sector. By inspecting the developed tool maps 1-9, conclusions can be

drawn immediately about the potential of the individual business models/strategies and selected “hotspots” of customer requirements. These insights should be of particular interest to repair providers seeking to expand their customer base and engagement by adapting or expanding their model or offering. While the tool maps can initially be used to identify suitable approaches, these can be verified and investigated in more detail using Table 6, wherein also all corresponding sections for deep dives are specified.

For instance, the mapping shows that the repair price, as verified in this study as a significant decisive factor for the use of a repair service, is to a great extent dependent on manufacturer decisions, such as design for repairability (Tool map 9 in Figure 16) and the provision of a warranty (Tool map 8 in Figure 16), but also on the supply and pricing of replacement parts (Tool map 6 in Figure 16). For clients, expenses can be minimised by making use of initiatives such as repair cafés (Tool map 7 in Figure 16), as well as DIY instructions (Tool map 6 in Figure 16). Enterprises, in turn, can address this need for repair expertise in connection with DIY by holding events like repair workshops (Tool map 6 in Figure 16), or by offering a service for remote diagnosis of faulty devices (Tool map 1 in Figure 14).

Furthermore, the mapping results highlight several approaches for improving the accessibility of the repair offer. Examples include solutions facilitating the delivery of the damaged item to the repair facility, such as mail-in services (Tool map 2 in Figure 15), as well as bringing the repair service directly to the users, e.g. via mobile repair services (Tool map 3 in Figure 15). Also, remote diagnosis of repairs (Tool map 1 in Figure 14), a service performed digitally, and centralisation (Tool map 5 in Figure 15), providing a convenient anchor point of support, enhance the accessibility of repair offerings. In this regard, the author emphasises the frequently raised visibility of repair services through improved accessibility.

To counteract the commonly reported lack of trust in repair services, the mapping process especially recognised the established quality standards of the repair networks (Tool map 7 in Figure 16), which are imposed upon the participating repair businesses, giving customers a certain level of assurance in the quality of the work of these companies. Another method of placing a reassurance of trust on repair operations is the franchise system (Tool map 4 in Figure 15), which suggests affiliation to a reputable chain.

Further information and correlations can be obtained from the above referenced Figures and Table 6, which deliver useful resources for insights into the repair sector and business opportunities.

## 6. Conclusion

This research mainly dealt with the R-strategy repair, which constitutes an important building block for the transition to a circular economy. With this approach, faulty appliances' service life is prolonged by performing a repair process to regain their initial functionality. Regardless the necessity of repairs, to realise the strategies' potential and thus increase repair rates and engagement, several challenges need to be considered, both in terms of potential repair service consumers as well as businesses and their operating models. To demonstrate ways for overcoming these difficulties and supporting the repair sector, a structured literature review accompanied by a qualitative content analysis according to Mayring was conducted. Thereby a sectoral examination from diverse perspectives could be realised, shedding light on customer demands as well as implemented business models/strategies and topic relevant research and innovation projects.

The results indicate a broad range of factors affecting customers' repair decision-making, which could be clustered into four groups as listed in Table 1. Overall, the customer perspective examination verifies the significance of the monetary expenses of repair services, frequently hindering users from repair activities, especially if replacement costs for the defective goods are particularly low. Alongside repair services' affordability, further aspects cannot be disregarded, consumers also demand repair providers to be accessible, visible, transparent and of high quality. To identify paths to meet these requirements, the further perspectives of the businesses and projects were assessed. Therefore, as evident in Table 3, nine business strategy patterns were identified, reaching from the "Remote repair diagnosis" approach to "Design for repairability/modular design". Corresponding also to the analysis of research projects, which resulted in 16 relevant projects summarised in Table 5, demonstrating that strategies for repairability during the product design phase are an important research avenue. For the final evaluation and visualisation of the recognised business strategies' potential in terms of fulfilling consumer needs, the tool maps, illustrated in Figure 14, Figure 15 and Figure 16, and the corresponding Overview Table 6, were developed. Thereby, these outcomes indicate whether the repair business strategies are in line with customer requirements, highlighting for example how the demanded accessibility can be enhanced through location independent or mobile repair offerings. Furthermore, the prominent barrier of repair costs is tackled for instance by online consultation offerings, warranty extension and repairability friendly design. Concludingly these insights provide a multitude of possibilities for the innovation of repair business cases and also for promising cooperations within the repair sector, allowing client's needs fulfilment.



This thesis highlights how interconnected the success determinants of the repair sector are. Customer attitudes and awareness influence the repair rate and thus the utilisation of repair services. The repair businesses can in turn increase the repair engagement of potential consumers by adapting, expanding and innovating their business models, whereby their possibilities are often impacted or limited by OEMs, for instance by spare part availability. The overarching significance of political measures preventing or promoting repair activities is also evident, as discussed in Chapter 2.4.

Whether the current political efforts of the EU, namely the recently adopted “Directive on repair of goods” and the “Ecodesign for Sustainable Products Regulation”, are sufficient to effectively reinforce the repair sector and ensure competitiveness is difficult to determine at this stage, as the measures still need to be further defined and transposed at national level over the next two years. For repair providers to be able to propose an affordable price for their services to clients, the obligation imposed on manufacturers to supply spare parts at reasonable costs is promising, but as emphasised by the “Right to Repair” initiative, this definition is not yet sufficiently precise. Visibility and transparency of the repair service offerings, as frequently demanded by users, can be improved through the planned “European Repair Platform” and the “European Repair Information Form”. These measures may certainly be beneficial both for consumers, as they have greater ease in finding suitable options for their repair needs and comparing services, and for companies, as they can reach a wider range of potential customers. However, the author stresses the need of more regulatory intervention making replacement less attractive and profitable than repair, since this study underlines that low replacement costs, as opposed to high repair costs, are a common reason for deciding against repair. As also claimed by Dalhammar et al. (2020), making repairs more economically lucrative calls for a shift in costs from labour to resources, for example through tax reductions or higher raw material prices (Dalhammar et al., 2020). “Right to Repair” further draws attention to the fact that replacement should generally be disfavoured under guarantee, if the fault is repairable, not just if the customer decides against it (Rezende, 2024). In conclusion, the ongoing policy developments present numerous opportunities to fulfil the sector’s requirements on both the client and business side, but still shortcomings and uncertainties concerning concrete applications persist.

## 6.1. Limitations

Through this thesis’ research method by means of a literature review with qualitative content analysis, a large number of repair drivers and barriers could be identified. Nevertheless, this also entails a certain limitation concerning the prioritisation of these parameters. The author

hereby wants to emphasise that the number of papers mentioning the respective aspect in the course of the evaluation, see Table 2, does not automatically indicate a ranking of the importance of these factors. All statements regarding which motivators or obstacles are most decisive for clients in convincing or discouraging them from repairing are based on secondary data from the gathered documents.

In addition, for a sector-wide overview of repair activities and identifying ways of further progress no restrictions for devices were applied in this study. Limitations thereby emerge in making statements as to which customer demands are more crucial for which product (categories), as this was not the focus of this research.

Again, the limitation of certain necessary assumptions, although based on various sources, for the creation of the tool maps must be highlighted. In this context, further concrete investigations of certain repair businesses would be interesting using empirical methods to examine their customer engagement potential.

## **6.2. Future research**

Referring to the limitations and concerning future research opportunities, a general lack of case studies on behalf of repair providers, that take an in-depth look at business strategies and operations, could be observed, which became evident from the data gathering for this study. Such scientific research could contribute to the visibility and dissemination of business innovation approaches in the repair sector and thus enhance repair engagement and repair company upscaling.

Due to the current political progress in connection with repair and the fact that the EU member states now have to prepare and implement new measures, it is necessary to observe these developments and carry out scientific studies on their feasibility and efficiency. Research therefore should take into account the opinions, needs of and effects on both repair customers and repair businesses.

To conclude, comprehensive scientific contributions on repair activities and operations will be of great relevance in the near future to empower actors of the sector and reinforce repair within the transition to a CE.

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## Appendix

Table 7: Search criteria - customer perspective - Scopus

Search criteria	
<b>Database</b>	Scopus
<b>Search string</b>	"repair*" → "customer" OR "consumer" → "demand" OR "need" OR "requirement" OR "decision" OR "perspective"
<b>Date of search</b>	17.01.2024
<b>Field</b>	Article title, Abstract, Keywords
<b>Years</b>	2020-2023
<b>Language</b>	English
<b>Document types</b>	Article, Review
<b>Access type</b>	Open access
<b>Subject areas</b>	Business, Management and Accounting; Decision Sciences; Environmental Science; Social Sciences
<b>Journals</b>	Annals Of Operations Research; Business Strategy And The Environment; Circular Economy And Sustainability; Cleaner And Responsible Consumption; Entrepreneurship Theory And Practice; Environmental And Sustainability Indicators; Environment Development And Sustainability; Environment International; Environmental Research Letters; European Journal Of Operational Research; Frontiers In Sustainability; International Journal Of Consumer Studies; International Journal Of Production Economics; Journal Of Business Ethics; Journal Of Business Research; Journal Of Cleaner Production; Journal Of Industrial Ecology; Operations Research; Operations Research Perspectives; Resources Conservation And Recycling; Sustainable Production And Consumption; Sustainability (Switzerland)
<b>Search query</b>	( TITLE-ABS-KEY ( "repair*" ) ) AND ( "customer" OR "consumer" ) AND ( "demand" OR "need" OR "requirement" OR "decision" OR "perspective" ) AND ( LIMIT-TO ( PUBYEAR , 2020 ) OR LIMIT-TO ( PUBYEAR , 2021 ) OR LIMIT-TO ( PUBYEAR , 2022 ) OR LIMIT-TO ( PUBYEAR , 2023 ) ) AND ( LIMIT-TO ( SUBJAREA , "BUSI" ) OR LIMIT-TO ( SUBJAREA , "SOCI" ) OR LIMIT-TO ( SUBJAREA , "ENVI" ) OR LIMIT-TO ( SUBJAREA , "DECI" ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) OR LIMIT-TO ( DOCTYPE , "re" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( LIMIT-TO ( OA , "all" ) ) AND ( LIMIT-TO ( EXACTSRCTITLE , "Sustainability Switzerland" ) OR LIMIT-TO ( EXACTSRCTITLE , "Journal Of Cleaner Production" ) OR LIMIT-TO ( EXACTSRCTITLE , "Journal Of Industrial Ecology" ) OR LIMIT-TO ( EXACTSRCTITLE , "Circular Economy And Sustainability" ) OR LIMIT-TO ( EXACTSRCTITLE , "Resources Conservation And Recycling" ) OR LIMIT-TO ( EXACTSRCTITLE , "Sustainable Production And Consumption" ) OR LIMIT-TO ( EXACTSRCTITLE , "Frontiers In Sustainability" ) OR LIMIT-TO ( EXACTSRCTITLE , "European Journal Of Operational Research" ) OR LIMIT-TO ( EXACTSRCTITLE , "International Journal Of Production Economics" ) OR LIMIT-TO ( EXACTSRCTITLE , "Cleaner And Responsible Consumption" ) OR LIMIT-TO ( EXACTSRCTITLE , "Journal Of Business Research" ) OR LIMIT-TO ( EXACTSRCTITLE ,

	"Business Strategy And The Environment" ) OR LIMIT-TO ( EXACTSRCTITLE , "Environment Development And Sustainability" ) OR LIMIT-TO ( EXACTSRCTITLE , "Environmental Research Letters" ) OR LIMIT-TO ( EXACTSRCTITLE , "Journal Of Business Ethics" ) OR LIMIT-TO ( EXACTSRCTITLE , "Operations Research" ) OR LIMIT-TO ( EXACTSRCTITLE , "Operations Research Perspectives" ) OR LIMIT-TO ( EXACTSRCTITLE , "Annals Of Operations Research" ) OR LIMIT-TO ( EXACTSRCTITLE , "Entrepreneurship Theory And Practice" ) OR LIMIT-TO ( EXACTSRCTITLE , "Environment International" ) OR LIMIT-TO ( EXACTSRCTITLE , "Environmental And Sustainability Indicators" ) OR LIMIT-TO ( EXACTSRCTITLE , "International Journal Of Consumer Studies" ) )
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Table 8: Search criteria - customer perspective - ScienceDirect

Search criteria	
<b>Database</b>	ScienceDirect
<b>Search string</b>	"repair" AND ("customer" OR "consumer") AND ("demand" OR "need" OR "requirement" OR "decision" OR "perspective")
<b>Date of search</b>	22.01.2024
<b>Field</b>	Find articles with these terms (all parts of the document, except the references, are searched)
<b>Years</b>	2020-2023
<b>Language</b>	English
<b>Document types</b>	Research articles, Review articles
<b>Access type</b>	Open access & Open archive
<b>Subject areas</b>	Business, Management and Accounting; Decision Sciences; Environmental Science; Social Sciences
<b>Journals</b>	Cleaner And Responsible Consumption; Cleaner Logistics And Supply Chain; Ecological Economics; Environmental Innovation And Societal Transitions; Environment International; European Journal Of Operational Research; International Journal Of Production Economics; Journal Of Business Research; Journal Of Cleaner Production; Resources, Conservation And Recycling; Resources, Conservation & Recycling Advances; Sustainable Production And Consumption

Table 9: Search criteria - business perspective - Scopus

Search criteria	
<b>Database</b>	Scopus
<b>Search string</b>	("circ*" OR "sustain*") AND ("business" OR "company" OR "organisation") AND ("model" OR "innovat*") AND ("R-strategy" OR "repair*")
<b>Date of search 1</b>	01.02.2024
<b>Date of search 2</b>	03.02.2024
<b>Field</b>	Article title, Abstract, Keywords
<b>Years (search 1)</b>	2020-2023
<b>Years (search 2)</b>	2009-2024 (No filter applied)

<b>Language</b>	English
<b>Document types (search 1)</b>	Article, Review
<b>Document types (search 2)</b>	No filter applied
<b>Access type</b>	Open access
<b>Subject areas</b>	Business, Management and Accounting; Decision Sciences; Environmental Science; Social Sciences
<b>Journals</b>	No filter applied
<b>Search query (search 1)</b>	TITLE-ABS-KEY ( ( "circ*" OR "sustain*" ) AND ( "business" OR "company" OR "organisation" ) AND ( "model" OR "innovat*" ) AND ( "R-strategy" OR "repair*" ) ) AND ( LIMIT-TO ( PUBYEAR , 2020 ) OR LIMIT-TO ( PUBYEAR , 2021 ) OR LIMIT-TO ( PUBYEAR , 2022 ) OR LIMIT-TO ( PUBYEAR , 2023 ) ) AND ( LIMIT-TO ( SUBJAREA , "SOCI" ) OR LIMIT-TO ( SUBJAREA , "ENVI" ) OR LIMIT-TO ( SUBJAREA , "BUSI" ) OR LIMIT-TO ( SUBJAREA , "DECI" ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) OR LIMIT-TO ( DOCTYPE , "re" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( LIMIT-TO ( OA , "all" ) )
<b>Search query (search 2)</b>	TITLE-ABS-KEY ( ( "circ*" OR "sustain*" ) AND ( "business" OR "company" OR "organisation" ) AND ( "model" OR "innovat*" ) AND ( "R-strategy" OR "repair*" ) ) AND ( LIMIT-TO ( SUBJAREA , "ENVI" ) OR LIMIT-TO ( SUBJAREA , "SOCI" ) OR LIMIT-TO ( SUBJAREA , "BUSI" ) OR LIMIT-TO ( SUBJAREA , "DECI" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( LIMIT-TO ( OA , "all" ) )

Table 10: Search criteria - business perspective - PLATE

<b>Proceedings</b>	<b>Search term</b>	<b>Date of search</b>	<b>N= Papers after title screening</b>	<b>N= Papers after abstract screening</b>	<b>N= Papers after eliminating duplicates</b>
1st PLATE Conference, Nottingham, England, 17-19 June 2015	business	01.03. 2024	2	0	
1st PLATE Conference, Nottingham, England, 17-19 June 2015	repair	01.03. 2024	4	3	
1st PLATE Conference, Nottingham, England, 17-19 June 2015					3
2nd PLATE Conference, Delft, Netherlands, 8-10 November 2017	business	01.03. 2024	9	0	
2nd PLATE Conference, Delft, Netherlands, 8-10 November 2017	repair	01.03. 2024	4	1	

2nd PLATE Conference, Delft, Netherlands, 8-10 November 2017					1
PLATE - Proceedings 2019	business	09.02.2024	12	2	
PLATE - Proceedings 2019	repair	09.02.2024	21	7	
PLATE - Proceedings 2019					7
PLATE - Proceedings 2021	PLATE		39	8	
PLATE - Proceedings 2021					8
PLATE - Proceedings 2023	business	12.02.2024	16	2	
PLATE - Proceedings 2023	repair	12.02.2024	16	10	
PLATE - Proceedings 2023					10

Table 11: Search criteria - business perspective - web search

Search term	Date of search	N = Practical repair provider examples
Mail-in Reparatur Österreich; Mail-in Reparatur Österreich Computer; mail-in repair electronics europe; mail-in repair jewelry europe	01.03.2024	7
Reparaturbus; mobiles Reparatur-Angebot; mobile repair services	01.03.2024	2
Reparatur Franchise Österreich; repair franchise	01.03.2024	3
RessourcenZentrum (suggestion from supervisor)	02.03.2024	1
DIY repair; Reparatur Workshop; repair workshops	02.03.2024	6
Reparatur Initiativen; Reparatur Netzwerk	02.03.2024	5
modular design smartphones; modular design laptops	02.03.2024	2

Table 12: Search criteria - project perspective

Project platform/ Funder	Search term	Date of search	Topic/ Research field	Language	Years	Search field
CORDIS/ EU	"repair"	22.02. 2024	earth and related environmental sciences; social sciences	English		
CORDIS/ EU	("repair" OR "R-strategy") AND "circular economy" AND "business" AND "model" AND "innovation"	22.02. 2024	earth and related environmental sciences; social sciences	English		
FFG	"repair"	24.02. 2024	Energie/Um-welt; Life Sciences; Produktion; Sonstige	German/ English		
FFG	"circular economy"	26.02. 2024	Energie/Um-welt; Life Sciences; Produktion; Sonstige	German/ English		
FFG	"business" AND "model" AND "innovation"	24.02. 2024	Energie/Um-welt; Life Sciences; Produktion; Sonstige	German/ English		
FWF	"repair"	26.02. 2024	natural sciences; social sciences	German/ English		
FWF	"circular economy"	26.02. 2024	natural sciences; social sciences	German/ English		
FWF	"business" AND "model" AND "innovation"	26.02. 2024	natural sciences; social sciences	German/ English		
OeNB	repair	26.02. 2024		German/ English		Key-words
OeNB	repair	26.02. 2024		German/ English		Full text
OeNB	circular economy	26.02. 2024		German/ English		Key-words
	circular economy	26.02. 2024		German/ English		Full text
OeNB	business,model, innovation	26.02. 2024		German/ English		Key-words

OeNB	business,model, innovation	26.02. 2024		German/ English		Full text
OeNB	business	27.02. 2024		German/ English		Key- words
OeNB	business	27.02. 2024		German/ English		Full text
ACRP	repair	29.02. 2024		German/ English	2007- 2023	
ACRP	Reparatur	29.02. 2024		German/ English	2007- 2023	
ACRP	circular economy	29.02. 2024		German/ English	2007- 2023	
ACRP	Kreislauf- wirtschaft	29.02. 2024		German/ English	2007- 2023	
ACRP	business model	29.02. 2024		German/ English	2007- 2023	
ACRP	Geschäftsmodell	29.02. 2024		German/ English	2007- 2023	



Table 13: AI-transcript - identifying keywords to use in the web search for the business perspective

AI	Date of usage	Prompt	Result
ChatGPT	29.01. 2024	What is the state of the art in business model innovation in the repair sector?	<p>As of my last knowledge update in January 2022, I don't have specific details on the very latest developments in business model innovation in the repair sector. However, I can share some general trends and strategies that were gaining attention up to that point. For the most recent and detailed information, I recommend checking the latest industry reports, articles, and publications.</p> <ol style="list-style-type: none"> <li>1. Circular Economy and Sustainable Practices: Embracing a circular economy model, where products are designed for longevity and ease of repair, has become a focal point. Some companies are adopting sustainable practices by reusing materials and components from old products in the repair process.</li> <li>2. Digital Platforms and Marketplaces: Digital platforms and online marketplaces dedicated to repair services have been emerging. These platforms connect customers with repair professionals and make the process more accessible. Some platforms also offer diagnostics and troubleshooting tools online.</li> <li>3. Subscription-Based Repair Services: Subscription models for repair services have been explored, where customers pay a regular fee for access to repair services, maintenance, and even upgrades. This approach can provide predictable revenue for repair businesses and create long-term relationships with customers.</li> <li>4. Mobile Repair Services: Mobile repair services have gained popularity, offering on-site repairs at the customer's location. This is particularly convenient for customers who may not have the time or means to transport their products to a repair center.</li> <li>5. Collaborations and Partnerships: Collaborations between manufacturers, retailers, and repair services have been growing. Some manufacturers are partnering with repair services to offer official repair solutions, and retailers are integrating repair services as part of their customer offerings.</li> <li>6. Emphasis on Customer Education: Businesses in the repair sector are investing in customer education. Providing resources and information about the importance of repair, maintenance tips, and DIY solutions can empower customers and encourage them to choose repair over replacement.</li> <li>7. Blockchain for Supply Chain Transparency: Blockchain technology is being explored to enhance transparency in the supply chain of replacement parts. This helps in ensuring the authenticity of parts and building trust with customers.</li> <li>8. E-commerce Integration: Integration with e-commerce platforms allows customers to easily schedule repairs, order replacement parts, and access services online. This digital integration streamlines the customer experience.</li> </ol>

			<p>9. Extended Warranty Programs: Some businesses are offering extended warranty programs for repaired products, providing additional peace of mind to customers and encouraging them to opt for repairs.</p> <p>10. Diversification of Services: Repair businesses are diversifying their services beyond traditional repairs. This includes offering preventive maintenance, upgrade options, and other value-added services.</p> <p>11. Focus on Data and Analytics: Data analytics is being used to predict potential issues in products, allowing for proactive maintenance and reducing the likelihood of major repairs.</p> <p>12. Government and Regulatory Initiatives: Some regions are implementing regulations or incentives to promote repairability, influencing business models in the repair sector.</p> <p>These trends showcase the dynamic nature of the repair sector as it adapts to technological advancements, environmental concerns, and changing consumer preferences. Businesses that can effectively integrate sustainability, technology, and customer-centric approaches are likely to stand out in the evolving landscape of repair services.</p>
ChatGPT	29.01. 2024	Which business models are found in the repair sector?	<p>Various business models exist in the repair sector, including:</p> <ol style="list-style-type: none"> <li>1. Independent Repair Shops: Local businesses specializing in specific repairs.</li> <li>2. Manufacturer-Authorized Service Centers: Authorized by manufacturers for repairing their products.</li> <li>3. Franchise Repair Businesses: Operating under a franchise model for brand support.</li> <li>4. Mobile Repair Services: On-site repair services, common in electronics repair.</li> <li>5. Subscription-Based Repair Services: Regular fee for access to repair and maintenance services.</li> <li>6. DIY Repair Platforms: Online resources and communities for self-repair.</li> <li>7. Warranty Extension and Repair Plans: Additional purchase for extended warranty or repair coverage.</li> <li>8. Environmental and Circular Economy Models: Focus on sustainability and reducing electronic waste.</li> <li>9. Collaborative Repair Platforms: Online platforms connecting customers with repair professionals.</li> <li>10. Retailer Repair Services: In-house or partnered repair services by larger retailers.</li> <li>11. Government or Nonprofit Repair Initiatives: Programs promoting repairability and sustainability.</li> </ol> <p>Businesses choose models based on their goals, target audience, and the products or services they specialize in.</p>
ChatGPT	29.01. 2024	What are examples of business models in the repair sector in practice?	<p>Examples of business models in the repair sector include:</p> <ol style="list-style-type: none"> <li>1. Independent Repair Shops: Example: "Smith Electronics Repair" - Local shop for electronic devices.</li> <li>2. Manufacturer-Authorized Service Centers: Example: "ABC Automotive Service Center" - Authorized car service center.</li> </ol>

			<p>3. Franchise Repair Businesses: Example: "TechFix Franchise" - Chain of franchise repair businesses.</p> <p>4. Mobile Repair Services: Example: "QuickFix Mobile Repairs" - On-site technicians for electronic devices.</p> <p>5. Subscription-Based Repair Services: Example: "Home Appliance Care Subscription" - Monthly coverage for appliance repairs.</p> <p>6. DIY Repair Platforms: Example: "iFixit" - Online platform for DIY electronic repairs.</p> <p>7. Warranty Extension and Repair Plans: Example: "GadgetGuard Extended Warranty" - Extended warranty and repair plans.</p> <p>8. Environmental and Circular Economy Models: Example: "ReTech Solutions" - Refurbishing and reselling used electronic devices.</p> <p>9. Collaborative Repair Platforms: Example: "RepairMatch" - Online platform connecting customers with local repair professionals.</p> <p>10. Retailer Repair Services: Example: "ElectroFix Service Center at MegaMart" - In-house repair services at an electronics retailer.</p> <p>11. Government or Nonprofit Repair Initiatives: Example: "City Repair Café" - Community-driven initiative for free local repairs.</p> <p>These examples showcase the variety of business models in the repair sector, addressing diverse customer needs.</p>
Microsoft Copilot	29.01. 2024	What is the state of the art in business model innovation in the repair sector?	<p>The state of the art in business model innovation, particularly in the repair sector, is a topic of ongoing research. Here are some key findings:</p> <p>1. Sustainable Innovation: The aim of sustainable innovation is to combine a value proposition with the organization of the upstream [1]. This approach is increasingly being adopted in various sectors, including the repair sector.</p> <p>2. Maintenance, Repair, and Overhaul (MRO) Firms: There has been specific research on business model innovation in the aerospace industry, particularly focusing on Maintenance, Repair, and Overhaul (MRO) firms [2]. This could potentially provide insights applicable to the repair sector more broadly.</p> <p>3. Nature-Based Solutions (NBS): Some research has addressed the NBS business models knowledge gap from different angles, providing an overview of findings and tools that have produced a solid knowledge baseline on business models for NBS and their enabling conditions [3].</p> <p>Please note that while these findings provide a general overview, the specifics can vary greatly depending on the context, including the type of repair sector (e.g., electronics, automotive, aerospace), the geographical location, and the particular business model innovations being considered. For more detailed</p>

			<p>information, you may want to consider reviewing the full text of the referenced articles or consulting with a business strategy expert.</p> <p>[1]<a href="https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2103495">https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2103495</a>  [2]<a href="https://kups.ub.uni-koeln.de/10100/7/PHD_OW_FINAL_wo_CV_incl_date.pdf">https://kups.ub.uni-koeln.de/10100/7/PHD_OW_FINAL_wo_CV_incl_date.pdf</a>  [3]<a href="https://www.mdpi.com/2071-1050/13/13/7413">https://www.mdpi.com/2071-1050/13/13/7413</a></p>
Microsoft Copilot	29.01. 2024	Which business models are found in the repair sector?	<p>There are several innovative business models that have emerged in the repair sector:</p> <ol style="list-style-type: none"> <li>1. Centralization of Repair Services: This model involves the centralization of various repair service providers at a single point of contact [1]. This approach can make it easier for customers to access repair services and can increase efficiency.</li> <li>2. Repair by Mail: Some businesses offer repair services by mail [1]. Customers can send their items to be repaired through the mail, and the repaired items are then sent back to the customers. This model can be convenient for customers and can expand the geographical reach of the repair business.</li> <li>3. Repair-to-Customer Approaches: In this model, repair services are brought directly to the customer [1]. This can include services like mobile repair units that travel to the customer's location to perform repairs. This model can offer added convenience for customers.</li> <li>4. Circular Business Models: These models focus on extending the life of a product through repair, which is more environmentally beneficial than buying new products [1]. This approach aligns with the principles of the circular economy and can create local added value [1].</li> <li>5. Service Centers: In sectors like the Medium–Heavy Commercial Vehicle industry, service centers have been successful with business models that are consistent with their strategy and positively impact the firm's performance [2].</li> </ol> <p>Please note that the effectiveness of these business models can depend on various factors, including the specific type of repair sector and the geographical location. For more detailed information, it would be best to refer to recent publications or consult with industry experts.</p> <p>[1]<a href="https://static.uni-graz.at/fileadmin/ files/ urbi_sites/ ess/2_Dokumente_ab_2023_ESS_Seite/MA_Thesis_Evolution_Repair_Business_Models_09.2023.pdf">https://static.uni-graz.at/fileadmin/ files/ urbi_sites/ ess/2_Dokumente_ab_2023_ESS_Seite/MA_Thesis_Evolution_Repair_Business_Models_09.2023.pdf</a>  [2]<a href="https://www.emerald.com/insight/content/doi/10.1108/IJPPM-05-2019-0230/full/html">https://www.emerald.com/insight/content/doi/10.1108/IJPPM-05-2019-0230/full/html</a></p>
Microsoft Copilot	29.01. 2024	What are examples of	<p>Here are some examples of business models in the repair sector in practice:</p>

		business models in the repair sector in practice?	<p>1. Circular Business Models in Fashion: The Ellen MacArthur Foundation’s study on the fashion industry identified sectors such as rental, resale, repair, and remaking, which represent a USD 73 billion market [1].</p> <p>2. Service Centers in the Medium–Heavy Commercial Vehicle Industry: A study analyzed the fit between the strategy of service centers and their business model (BM) in the Medium–Heavy Commercial Vehicle sector. It found that top-performing companies have BM components that are consistent with each other and with the adopted strategy, positively impacting the firm’s performance [2].</p> <p>3. Circular Economy in Europe: The European Environment Agency has presented an analytical framework for enabling circular business models in Europe. It identifies actions to implement circular business models effectively and ideas for upscaling them as part of a shift to a circular economy in Europe [3].</p> <p>These examples illustrate how innovative business models in the repair sector are being implemented in practice. They highlight the importance of aligning business strategies with business models and the potential for repair services to contribute to a more sustainable and circular economy. Please note that the specifics can vary based on the type of repair sector and the geographical location. For more detailed information, it would be best to refer to recent publications or consult with industry experts.</p> <p>[1]<a href="https://www.ellenmacarthurfoundation.org/news/circular-business-models-in-the-fashion-industry">https://www.ellenmacarthurfoundation.org/news/circular-business-models-in-the-fashion-industry</a>  [2]<a href="https://www.emerald.com/insight/content/doi/10.1108/IJPPM-05-2019-0230/full/html">https://www.emerald.com/insight/content/doi/10.1108/IJPPM-05-2019-0230/full/html</a>  [3]<a href="https://www.eea.europa.eu/publications/a-framework-for-enabling-circular">https://www.eea.europa.eu/publications/a-framework-for-enabling-circular</a></p>
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Table 14: Data analysis - included papers in the sample - customer perspective

Title	Authors	Journal	Year	Method for data collection
The potential of modular product design on repair behavior and user experience – Evidence from the smartphone industry	Amend et al.	Journal of Cleaner Production	2022	Online survey
Drivers of the consumers' intention to use repair services, repair networks and to self-repair	Fachbach et al.	Journal of Cleaner Production	2022	Online survey
Repair and reuse: Misalignments between stakeholders and possible users	Gobert et al.	Journal of Cleaner Production	2021	Two case studies
Repair service convenience in a circular economy: The perspective of customers and repair companies	Güsser-Fachbach et al.	Journal of Cleaner Production	2023	Focus group interviews, interactive workshops
From quick fixes to repair projects: Insights from a citizen science project	Hielscher, S. & Jaeger-Erben, M.	Journal of Cleaner Production	2021	Citizen science research (cultural probes, workshops, in-depth interviews)
A global review of consumer behavior towards e-waste and implications for the circular economy	Islam et al.	Journal of Cleaner Production	2021	Four-steps systematic literature review
Consumer decision-making on repair in a circular economy: A process model based on experiences among young adults and stakeholders in Finland	Korsunova et al.	Journal of Cleaner Production	2023	Reflection essays, interviews
Increasing repair of household appliances, mobile phones and clothing: Experiences from consumers and the repair industry	Laitala et al.	Journal of Cleaner Production	2021	Web-based consumer survey, semi-structured interviews
Exploring a regional repair network with a public funding scheme for customer repairs: The 'GRAZ repariert'-case	Lechner et al.	Journal of Cleaner Production	2021	Exploratory, longitudinal single case study

From “right to repair” to “willingness to repair”: Exploring consumer's perspective to product lifecycle extension	Roskladka et al.	Journal of Cleaner Production	2023	Literature review (using delphi-method to structure group opinion)
Barriers, enablers and market governance: A review of the policy landscape for repair of consumer electronics in the EU and the U.S.	Svensson-Hoglund et al.	Journal of Cleaner Production	2021	Literature review (academic and gray literature)
Repair motivation and barriers model: Investigating user perspectives related to product repair towards a circular economy	Terzioğlu, N.	Journal of Cleaner Production	2021	Cultural probes kit, research through design and four repair workshops
‘Fixing the World One Thing at a Time’: Community repair and a sustainable circular economy	van der Velden, M.	Journal of Cleaner Production	2021	Mixed-method approach (combining a descriptive quantitative analysis of repair data with ethnographic repair research)
Empowering sustainable consumption by giving back to consumers the 'right to repair'	Hernandez et al.	Sustainability (Switzerland)	2020	Literature review (reviewing academic articles from different fields of study)
Circular economy in home textiles: Motivations of IKEA consumers in Sweden	Lehner et al.	Sustainability (Switzerland)	2020	Mixed-method approach (applying quantitative (a survey) and qualitative methods (interviews))
A critical review of the role of repair cafés in a sustainable circular transition	Moalem, R. M. & Mosgaard, M. A.	Sustainability (Switzerland)	2021	Literature review (undertaken in four academic search engines)
Extending the Life Cycle of EEE—Findings from a Repair Study in Germany: Repair Challenges and Recommendations for Action	Rudolf et al.	Sustainability (Switzerland)	2022	Mixed methods approach (repair study, accompanying quantitative and qualitative surveys)
Extending the Lifetime of Clothing through Repair and Repurpose: An Investigation of Barriers and Enablers in UK Citizens	Zhang, L. & Hale, J.	Sustainability (Switzerland)	2022	Online survey (reviewing previous research on influences on the target behaviour beforehand)
Do users have the ability to self-repair non-complex electrical appliances? Design and development of a self-guided workshop with repair documentation in different formats	Sandez et al.	Sustainable Production and Consumption	2023	Three-stage self-guided workshop (introduction and initial interview, fault diagnosis and kettle repair, and final interview)
A Process Approach to Product Repair from the Perspective of the Individual	Svensson-Hoglund et al.	Circular Economy and Sustainability	2023	Literature review (“rapid review” methodology)

The Role of Independent Repair in a Circular and Regenerative Economy	van der Velden et al.	Circular Economy and Sustainability	2023	Mixed-method approach (repair shop inventory, semi-structured interviews)
Product repair in a circular economy: Exploring public repair behavior from a systems perspective	Parajuly et al.	Journal of Industrial Ecology	2024	Framework conception, questionnaire survey
A matter of timing: System requirements for repair and their temporal dimensions	Russel et al.	Journal of Industrial Ecology	2023	Literature review (Google Scholar and Scopus)
Consumer practices regarding the purchase, use, willingness to repair, and disposal of small electric and electronic equipment: A Spanish survey on kettles	Sandez et al.	Journal of Industrial Ecology	2023	Online survey
Until death do us part? In-depth insights into Dutch consumers' considerations about product lifetimes and lifetime extension	van den Berge et al.	Journal of Industrial Ecology	2023	In-depth face-to-face semi-structured interviews
The impact of convenience attributes on the willingness-to-pay for repair services	Güsser-Fachbach et al.	Resources, Conservation and Recycling	2023	Choice-based conjoint analysis (utilising nine qualitative focus groups and three workshops)
Replaced too soon? An exploration of Western European consumers' replacement of electronic products	Magnier, L. & Mugge, R.	Resources, Conservation and Recycling	2022	Online survey
Repairing the circular economy: Public perception and participant profile of the repair economy in Hull, UK	Rogers et al.	Resources, Conservation and Recycling	2021	Intensive case study approach (including a survey)
Appropriation and routinisation of circular consumer practices: A review of current knowledge in the circular economy literature	Rabiu, M. K. & Jaeger-Erben, M.	Cleaner and Responsible Consumption	2022	Literature review (Web of Science and ScienceDirect)
Exercising the "Right to Repair": A Customer's Perspective	Marikyan, D. & Papagiannidis, S.	Journal of Business Ethics	2023	Customer survey



Title (received from snowballing)				
Consumers' perspective on product care: An exploratory study of motivators, ability factors, and triggers	Ackermann et al.	Journal of Cleaner Production	2018	In-depth semi-structured, face-to-face interviews
Why do users (not) repair their devices? A study of the predictors of repair practices	Jaeger-Erben et al.	Journal of Cleaner Production	2021	Interview (1.000 participants in face-to-face setting)
Consumer attitude towards the repair and the second-hand purchase of small household electrical and electronic equipment. A Spanish case study	Pérez-Belis et al.	Journal of Cleaner Production	2017	Survey (based on the information obtained from a literature review)
Exploring the inner loops of the circular economy: Replacement, repair, and reuse of mobile phones in Austria	Wieser H. & Tröger N.	Journal of Cleaner Production	2018	Mixed-method approach (online survey and semi-structured interviews)
The current status of the consumer electronics repair industry in the U.S.: A survey-based study	Sabbaghi et al.	Resources, Conservation and Recycling	2017	Based on a survey conducted n repair technicians by iFixit.com
Consumer decisions to repair mobile phones and manufacturer pricing policies: The concept of value leakage	Sabbaghi M. & Behdad S.	Resources, Conservation and Recycling	2018	Online survey, collecting data on repair service fees and applying statistical techniques to derive the analytical expression for the value leakage
Attitude of the stakeholders involved in the repair and second-hand sale of small household electrical and electronic equipment: Case study in Spain	Bovea et al.	Journal of Environmental Management	2017	Survey (including repair companies, second-hand shops and consumers)
Consumer Perceptions Related to Clothing Repair and Community Mending Events: A Circular Economy Perspective	Diddi, S. & Yan, R.-N.	Sustainability (Switzerland)	2019	Intercept survey approach
Repair of electronic products: Consumer practices and institutional initiatives	Sonego et al.	Sustainable Production and Consumption	2022	Systematic literature review on ScienceDirect

Table 15: Data analysis - included papers in the sample - business perspective

Title	Authors	Journal/Report/Conference	Year
Extending the Life Cycle of EEE—Findings from a Repair Study in Germany: Repair Challenges and Recommendations for Action	Rudolf et al.	Sustainability (Switzerland)	2022
Closing competency gaps for circularity: Exploring partner dynamics for circular-oriented innovation	Johnson, E.	Sustainable Production and Consumption	2022
Municipal solid waste management in the interface between commercial and non-commercial repair: Lessons from Denmark and Sweden	Moalem, R. M. & Schmidt, K.	Cleaner Waste Systems	2023
Business model development for sustainable apparel consumption: The case of Houdini Sportswear	Holtström et al.	Journal of Strategy and Management	2019
Sustainable Consumption and Value Propositions: Exploring Product–Service System Practices Among Swedish Fashion Firms	Stål, H. I. & Jansson, J.	Sustainable Development	2017
Reparaturinitiativen in Europa: Innovationen, Geschäftsmodelle, Empfehlungen. Erfahrungen vom Netzwerk PREPARE	Schnitzer et al.	Report commissioned by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)	2024
Learning to fix: knowledge, collaboration and mobile phone repair in Dhaka, Bangladesh	Ahmed et al.	7th International Conference on Information and Communication Technologies and Development (ICTD), Singapore, 15-18 May 2015	2015
Remote diagnosis for large household appliances: A case study into repair facilitating strategies	Van Moeseke et al.	29th CIRP Conference on Life Cycle Engineering, Leuven, Belgium, 4-6 April 2022	2022
Handled with care: repair and share as waste management strategies and community sustaining practices	Kalantidou, E.	1st PLATE Conference, Nottingham, England, 17-19 June 2015	2015
Crafting sustainable repairs: practice-based approaches to extending the life of clothes	McLaren, A. & McLauchlan, S.	1st PLATE Conference, Nottingham, England, 17-19 June 2015	2015
Print to repair: opportunities and constraints of 3D printing replacement parts	Park, M.	1st PLATE Conference, Nottingham, England, 17-19 June 2015	2015
Do-Fix workshops: understanding users' product repair experience	Terzioğlu, N.	2nd PLATE Conference, Delft, Netherlands, 8-10 November 2017	2017

Engaging with the general public on critical raw materials through the medium of electronics repair workshops	Johnson et al.	3rd PLATE Conference, Berlin, Germany, 18-20 September 2019	2021
Stakeholders, drivers and barriers for local electronics repair: a case study of southern Sweden	Richter, J. L. & Dalhammar, C.	3rd PLATE Conference, Berlin, Germany, 18-20 September 2019	2021
Exploring social, economic and environmental consequences of collaborative production: the case of bike repair maker spaces in three European countries	Singh et al.	3rd PLATE Conference, Berlin, Germany, 18-20 September 2019	2021
Living labs to develop reuse and repair workshops in territories	Tyl, B. & Allais, R.	3rd PLATE Conference, Berlin, Germany, 18-20 September 2019	2021
Developing hybrid business models in the reuse and repair sector: a case study	Tyl, B. & Baldacchino, C.	3rd PLATE Conference, Berlin, Germany, 18-20 September 2019	2021
Fashion Fix: Exploring Garment Repair from a Critical Fashion Practice Perspective	McCorkill, G.	4th PLATE Conference, Online event hosted by University of Limerick, 26-28 May 2021	2021
Opportunities For 3D-printable Spare Parts: Estimations From Historical Data	Samenjo et al.	4th PLATE Conference, Online event hosted by University of Limerick, 26-28 May 2021	2021
Fostering Collaboration between Reuse, Repair and Recycling Centers for Electric and Electronic Equipment	Sterkens et al.	4th PLATE Conference, Online event hosted by University of Limerick, 26-28 May 2021	2021
Design and implementation of an innovative business model based on repair as a hobby	Bunodiére, A. & Duflou, J.	5th PLATE Conference, Espoo, Finland, 31 May-2 June 2023	2023
Repairing reality: from artificial biomechanics devices to bioinspired fixing kit for existing conventional products	Domínguez et al.	5th PLATE Conference, Espoo, Finland, 31 May-2 June 2023	2023
The Repair Shop 2049: Co-Designing Sustainable and Equitable Transitions for Smart Device Repair with and for Local Communities	Stead et al.	5th PLATE Conference, Espoo, Finland, 31 May-2 June 2023	2023
Reuse and repair ecosystems: analysis of the emergence of the tensions between the stakeholders	Tyl et al.	5th PLATE Conference, Espoo, Finland, 31 May-2 June 2023	2023