Toward a Sustainable Business Model

Ecosystem approach to innovation from the Finland Batteries/EV Sector

Xiao'ai WEN

Master's thesis
May 2023
School of Business
Master's Degree Programme in International Business Management

Jyväskylän ammattikorkeakoulu
University of Applied Sciences

Xiao'ai WEN

Toward a sustainable business model: Ecosystem approach to Innovation of Finland Batteries/EV sector.

Jyväskylä: JAMK University of Applied Sciences, May 2023, 97 Pages

Master's degree programme in International Business Management. Master's thesis

Permission for web publication: yes

Language of publication: English

To achieve long term vision of sustainable development of EVB industry, BMs notion offers holistic view that CE incorporate wider scope sustainability for sustainable development. Thus, CEBM implementation in this field is key to reach out EU CE action plans, tackle other suppressing issues e.g., natural resource depletion and unsustainable supply chain while keep economy growing. To scale up the circular impact, SBM innovation offer a unique opportunity that BMI effectively and efficiently practice CE principles at system level. In this research, the BMs' lens is instrumental to look at the CBMs ecosystem from Finland EVB sector to identify the success factors of how focal firms innovate in and overhaul their mechanism of aggregating value.

To elevate the complexity, give clarity to the Ecosystem research, and better understand how to innovate an incumbent business model with CE principles adhered to, in this research, explorative case studies have been conducted from Finland institutions and big firms with semi-structured interviews from EVB sector. To enhance further understanding of how to innovate such a prospective sustainable and circular BM, experts' views are considered, and BMI framework is developed to include SDGs, basing on current trends, gaps and for future assessment of CE performance for broader sustainability. This research dedicates in the emerging field of EVB sector sustainable development with CE perspective: ecosystem approach to innovation in the circular value chain; business models lens to look at the circular ecosystem toward circularity and gaining sustainability.

For BMs can be framework and conceptualizing tool that SBM innovation could conceptualize and implement SBMs (CBMS)at organizational level: multi-stakeholder BMI with CE principles adhered to; CBM advocate various loops to 'slow, close, narrow, intensify, dematerialize 'the resource loops, and eventually contribute to system and environmental sustainability. By addressing the research gap from existing literature review, the ecosystem theory may help to explain business models change for the system level sustainability; CE BM implementation enable more businesses B2B, B2C take up CE principles 'sense, seize, and transform' to CE paradigm. Dynamic capability of BMs changes creating new or innovative BM is essential, in this way that organization and firms renew their competitive edge, incorporate circularity elements, structures the usefulness to evaluate, align organization architecture, calibrate CE activities, and interact with the ecosystem players in the circular value chain development for CE model.

Keywords/tags (subjects)

Circular economy, Sustainable development, Circular economy principles, EV battery, Reuse, Recycle, circular economy business models, Ecosystem, Business models innovation, Circular business models.

.

Contents

Figures

Tables

Abbreviations

EVB Batteries for Electronic Vehinicles

BMI Business Model Innovation

SBM Sustainable Business Model

CEBM Circular Economy business model

LCA Life Cycle Assessment

BMfs Business model for sustainability

CE Circular Economy

SDGs Sustainable Develpment Goals

EC Europe Commission

1. Introduction

Batteries/EV (EVB) sector Circular economy (CE) sustainable development is a modern complex phenomenon as climate change and limited resources are becoming pressing. CE is considered as sustainable solution for keeping economic growth while decoupling natural resource consumption, and renewable energy is increasingly used for sustainable development. The Business models (BMs) concept is proposed earlier for such sustainable innovation; however, in the past ten years this field development stagnated without an innovative BM. To advance the pace of this field, firms need to change their ways of doing business to circular; and business model innovation (BMI) at the organisational level. (Boon et al., 2013; Silva, 2020; Diepenmaat et al., 2020)

Sustainable development requires both systemic and radical innovation. CEBM offer unique value propositions and solutions for system-level long-term sustainability which require firms to take up CEBM (CBMs) and BMI for CE/sustainability (Pieroni et al., 2019; Bocken, 2021). Especially for the EVB sector, EVB is a product and technology that are advancing; however, BMI yields more (Chesbrough, 2010). BMs ecosystem concept as such innovation provides a holistic framework for firms and researchers to study, envision, and implement at the system level. In addition, the BMs concept provides an analytical tool that shed light on the interplay between various parts that firms could combine to generate sustainable value; BMs link individual firm to larger production and consumption system where it operates (Boons, et al, 2013), consequentially BMI has foundation for more businesses advocate CE principles for system level change with circular ecosystems considered as helix (Carayannis et al., 2017) that is vital toward circularity gaining sustainability.

Reflecting this potential, CE research has widely adopted BMs concept(Ferasso et al., 2020; Lüdeke-Freund et al., 2019); and BMs underpin CE principle holds the potential to bring promising sustainable benefits, and they are considered as key enablers to facilitating the transition from linear to a circular economy (Henry et al., 2020; Bocken et al., 2016; EC, 2019; Lewandowski, 2016; Ellen MacArthur Foundation, 2015). In this research the CEBM(CBMs) applications are investigated for circular value chain development from Finland EVB sector. The notion of CEBM offers a unique value proposition to promote sustainability toward circularity with BMs following up CE principles, and recapture the remained value of EVB when it reaches the End of life (EoL) while managing complex issues i.e., recycle or reuse of the EVB or materials, avoid the landfill, and maximize the value over time for EVB industry sustainable development (Wrålsen et al., 2021).

1.1 Motivation and Gaps

EV business booms so do the EV battery sector in the future, especially LIB based battery sector. EVB plays significant role in advancing E-mobility (Hill et al., 2019), achieving the UN SDGs, and transitioning to a carbon-neutral society of ‘2050 the Paris Climate Green Deal’. However, the EU EVB raw material sustainable supply is at a crossroads. EVB plays a key role in the transportation and renewable energy sector to electrification transition. The demands for EVB and materials have been increasingly driven by the EV market rocket rising as well, there is a huge demand for EVB raw materials. The retired EVB requires a more sustainable solution to recapture and maximize the remained value when they reach the EoL. Electronic Vehicle Batteries (EVB) can be reused as re-newable energy storage after the first life when the battery cell capacity reached 70-80%, the re-tired batteries is either recycled or reused depending on final responsible owners’ decisions on the specific battery (Saxena et al., 2015), and that could constitute Circular Economy.

The EU commission recognize investment and innovation must be set up with the sterned policies stance to build an integrated sustainable competitive batteries value chain(The EU commission, 2019), While the global battery/EV supply chain is still emerging, the Finland EVB sector strives to promote all European EVB sector and secure a position to make Europe a global leader in sustaina-ble EVB production base with CE approach (Battery supply chain-Alkio et al., 2019). For the CEBM implementation in this field, new jobs are created (European Commission, 2018). Finland's EVB business ecosystem adds the value that the BMs ecosystem approach to the circular value chain development safeguards the industry sustainability, observes human rights, guarantee the critical raw materials sustainable supply and a balanced and smooth renewable energy transition, and supports economic growth. Below presents a vision of the sustainable battery value chain.

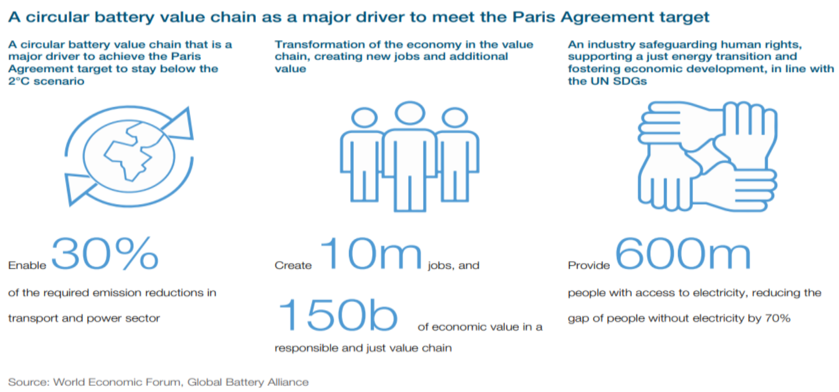


Figure 1. A vision of a sustainable battery value chain (World Economic Forum, Global Battery Alliance, 2019)

According to the EU CE perspective on the management of batteries used in EV reports (Hill et al., 2019), some stages are not directly addressed: the production side, raw and processed materials, and the application side: vehicle use. While CE is considered as a viable solution in this field and achieve the UN sustainable goals (UN SDGs) (United Nations, 2015), the organisational level BMI is required for CE incorporate a wider scope of sustainability, to leverage modern technology gaining sustainability; with the resources optimized with system level sustainability. Accordingly, new and innovative business models are needed for this field sustainable development, and the circular view of EU batteries/EV value chain is presented below.

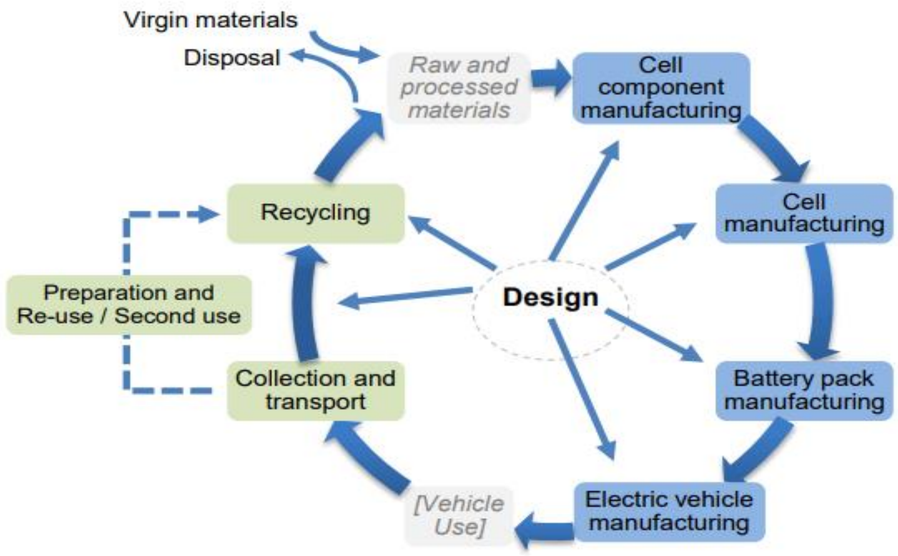


Figure 2. The circular view of the EU EVB value chain (Hill et al., 2019)

CE realizes through suitable BMs with a well-designed product, services, or process exercising CE principles (circular elements) in the circular value chain development. These principles are CBMs enablers to slow, close, narrow, intensify, and dematerialize the resources loops, which rely on CE strategies '10 Rs'. Besides design sitting at the core of CE (Silva, 2020), CE is a contested concept (Korhonen, 2018). CE performance needs evaluation in a specific context e.g., the rebound effect of CE**,** and the attention to internal and external readiness assessments, and it is an iterative journey for sustainable development. Therefore, with CE perspective, as a particular type of SBM for the long-term sustainability, the CEBM issues transcend the value chain relationships and highlight ecosystem stakeholders BMI to align interests and incentives to facilitate the system-level change with CE principles adhered to (Parida et al., 2015; Guldmann, 2019; Diepenmann et al., 2020). As for long-term sustainability, BMI yields more than only product or technology innovation, and businesses need to trial multiple CBMs to remain competitive.

In practice, the CEBM implementation for system level sustainability requires organisational level BMI with CE principles adhered to (Pieroni et al., 2019; Diepenmaat et al., 2020). CEBM research were focused on the supply chain and at firm level how focal firms BMI follow the CE principles (Lüdeke et al.,2018; Geissdoerfer et al.,2018a) which are business fundamentals: value creation, and value capture, appear to be core elements in most of business model research, and that are commonly accepted among S(C)BM scholar research. With the modern technology detecting the demand side of supply, business models can be seen as dynamic capabilities (Juntunen, 2017; Teece, 2018). The researcher argues BM research should draw back to its original networked concept, and BMs ecosystem addresses new market need further research, to drive toward circularity, and gaining sustainability (cf. Gomes, et al, 2018). As for individual businesses has difficulties to connect to system level change, BMI yields more than only product or technology innovation for EVB is evolving, and for long-term sustainability, businesses need to trial multiple BMs to remain competitive. To innovate such prospective BM on a system level for sustainability, an empirical study is beneficial and called for especially relating to novel business opportunities (Antikainen &Valkokairi, 2016) of the EVB sector.

To deliver such prospective BM for the sustainable value generation, a holistic, dynamic view of CEBM and BMI for CE/sustainability (Pieroni et al., 2019*;* Centobelli et al., 2020) is needed for CE to incorporate wider scope of sustainability. As Bocken (2021) renounces BMI is a strategic task though this field of research came late, as usually BMI is perceived as uncertain and difficult, especially for established businesses. In addition, Firms normally focus on technology or product innovation and have many processes, however, they lack a shared sense of how to innovate BMs; for system-level sustainability, the BMI process at an organizational level is necessary that is rarely researched and especially for EVB sector it is not sufficiently researched.

Sustainability has advanced CEBM application, however, without an innovative BM, CE contribute to sustainability is in question. For CE is considered as viable solution for EVB sector sustainable development (Silva, 2020), further research is necessary to bridge the knowledge gaps on BMs which can be innovation vehicle for the significant challenges of SDGs, 'Ethical procurement', and especially for CEBM implementation in this field to reduce GHG for 'a greener industry' that the innovative BMs are needed that BMI with CE principles to gain sustainability toward circularity (Lüdeke-Freund &Dembek, 2017; Nußholz, 2017). Wrålsen, et al. (2021) argue CE is a viable solution to achieve the UN SDGs (United Nations, 2015), and CBM innovation usually includes several CE strategies, the experts identified that CBMs are the potential to bridge the gaps, further emphasizing the most prospecting sustainable CBM usually encompassing several CE principles (Wrålsen et al., 2021). For the CEBM research related to EVB filed, a holistic view that designs BMfS and CEBM implementation at the systems level is necessary for the systemic adoption of CE concept for EVB production side for long-term sustainability, and this concept poses a large business opportunity (Ranta et al., 2021). Most research are mainly on the application side from EV OEM (Albertsen 2020; Albertsen et al., 2021), battery second life (Jiao, N., 2017; Olsson et al., 2018; Reinhardt et al., 2020), and decommission: reverse logistics (Prevolnik & Ziemba, 2019; Alamerew, 2020), reuse or recycling (Kotak, Y., et al., 2021; Hallingstad &GrØnningen AA, 2021). There is little research on the production side.

In addition, to implement the CEBM at a system level (Boons et al., 2013; Linder & Williander, 2017) the existing BMs framework does not sufficiently provide a holistic view and there is lack of understanding of these concepts and the unified perspective of them that hinders the majority take up CE principle. There is extant literature on BMI for CE and sustainability: CBM and CBMI; SBM and SBM innovation; BMfs, CEBM, offer framework, and analytical tool which entails a holistic view of implementation; most concepts are 'siloed' both in conventional positioning and to each other, and thus, are pursued in a 'siloed' way *(*Osterwalder &Pigneur, 2010) or barriers are considered from focal firm level(Guldmann et al, 2020), as a result, BMI for CE/sustainability mostly remain conceptual or lack of evidence.

Historically, CBM draws attention to the lack of a common perspective that the diverse definitions of modes for a circular economy concept demonstrate wide description (Fontell & Heikkilä, 2017; Bocken et al., 2016; SITRA and Circle Economy, 2015; Accenture, 2014; Catherine Weetman, 2017). As a result, CBMs are a nascent field, while the SBM view needs alignment, BMI at the system level needs further study (Dienenmaat et al., 2020; Awan &Sroufe, 2022) That the demanding innovation process remains under-researched, consequentially it is challenging (Geissdoerfeer et al., 2020), and others describe the development of CEBM design process often entails significant uncertainties and complexities (Linder & Williander 2017; Guldmann & Huulgaard, 2020).

Circularity concept was proposed with industrial ecosystem (Lüdeke et al., 2018) earlier, as well as the ecosystem view (Antikainen &Valkokari, 2016; Zucchella et al., 2018; Geissdoerfer, 2020), however, they are 'static'; and Guldmann (2018) conducted research on CBMs innovation on firms level, there is a gap for holistic view of SBMs innovation at organisational level for circularity and gaining sustainability that CE construct wider space of sustainability with the ecological benefit considered and evaluated, which is reflected in SBM innovation academic discussions for so far (Pieroni et al., 2019; Diepenmaat et al., 2020) as shown in the overlapped area in fig.3.

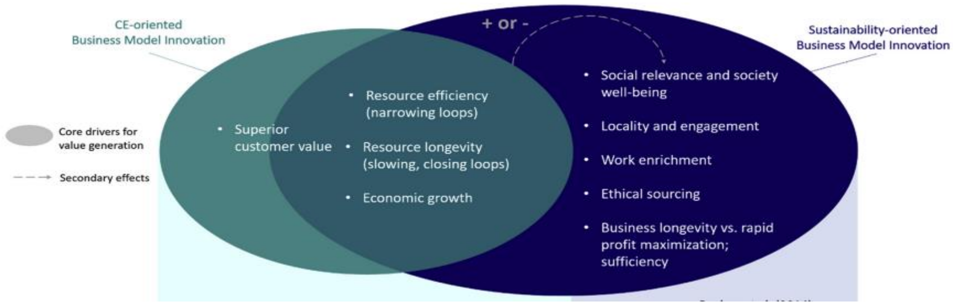


Figure 3. The synergy of BMI for CE/Sustainability (Pironi et.al, 2019)

For system level sustainability to reconsider CE strategy, dynamic view of BMI at an organizational level is required in this field of BMI for CE and Sustainability. The research on CE and sustainable development have been on the divergent way, the clarity is lacking on ecosystem concept of CEBM (Geissdoerfer et al., 2020), Only 40% research took dynamic view of CEBM (Pieroni et al., 2019), and the conceptual tool for practitioners and researchers to envision various BM elements of distinct interplay is missing.

1.2 Research objective and Question

To close the knowledge gap on BMI for CE/sustainability and better understand how business models can be instrumental as dynamic capability to generate sustainable value in the circular ecosystem development context: how business modes is used as lens to look at ecosystem that facilitate more businesses to resume CE principles; how a focal firm can innovate in with the ambient ecosystem, partner's BMs considered to 'slow, narrow, and close the loops', and the research questions:

RQ1: How to innovate a business model with CE principles for sustainable development?

RQ2: What are the success factors to innovate such a prospective business model?

This study explores Finland's EVB Sector organizations and firms meaningfully pursue such a prospective CEBM and gain insight into how the incumbent business models can be innovated with CE principles adhered to. In this research, the BMs lens is used to look at a circular ecosystem with a multistakeholder view of how the ecosystem approach to innovation in the circular value chain development driving for circularity and specifically the multistakeholder within their business models change at the system level for sustainability, thereby enabling more business to take up CE principles for the sustainable development of EVB industry for a circular and climate neutral economy.

1.3 Structure

There are 6 chapters in this thesis, starting from the introduction of the main theme of research context, motivation, purposes, and objective listed at the end of the chapter detailed listed the related concept and demonstrating the foundational theories of the area with the infusion of the existing literature and the empirical findings on CE research: Sustainable development, BM and BMI, accordingly, CBM and CBMI, and the theoretical driver for the synergy of CE/Sustainability BMI and current BM trends in Digitalisation, and a framework was created as result. The framework filled with the gap of current knowledge on the EVB sector Circular economy sustainable development on business model innovation perspective.

Chapter 1 Research context, research motivation, and current knowledge gap to apply with relevant theories, the research objectives, and structure.

Chapter 2 Theoretical perspective of the research of the knowledge gap about CE sustainable development, EVB circular value chain development, business models for a circular economy, and their innovation to embrace a unified perspective for modern innovation and innovate a sustainable and circular business model with ambient ecosystem considered for sustainable development.

Chapter 3 Methodology presents the methodologies applied to conduct the research, a detailed method and provided including the sampling and data analytics and the validity reliability of the research.

Chapter 4 the research findings of the real-world EVB business trends and EU circular economy actions and regulations and challenges for sustainable value chain development under current circumstances. Empirical case findings from Literature and experts are illustrated with the project stakeholders, and the primary data is analysed in a structured manner with the framework with multiple case studies assisting, firstly an analysis of the case-by-case of the CBMI is then a cross-case study of BMI with CE principles followed to find out the common pattern and strategic development direction of the CBMI for sustainable development from Finland EVB sector.

Chapter 5 presents discussions and conclusions author’s reflection on the new findings presented and the case study findings synthesized. Furthermore, implications for managerial practice are also addressed.

Chapter 6 Future research recommendations and the limitation of the research and discussions on these topics are instantiated.

2.Literature Review

2.1Circular Economy and Sustainability

CE (Circular economy) and sustainable development are related concepts, CE replaces 'take, make dispose of' with 'reduce, reuse, recycle' which could be utilized by society for sustainable development, especially for resources-consuming manufacturers. CE model focuses on the sustainable balance of production and consumption while inspiring renewable sources. As an industrial economic system, CE decouples economic growth from the resource's decay, maximizes the usage of the existing resources, and reconfigures new ways of resources looping in the value chain with 'circularity'. For firms to become circular, they need to implement circular rationale, circular business model (CBM) in their business (Linder & Williander, 2015; Silva, 2020). Ellen MacArthur Foundation (2013) defines CE that is restorative or regenerative by intention and design as the loops drawing inspiration from biological cycles and others for 'technical' materials, both cases aim to limit the leakage from the resources as much as possible. Figure 4 is the Well-known "butterfly model", a compelling rationale that an organization aligns the structures to revolve the economic growth and resolve the finite resources consumption (Stahel ,2010).

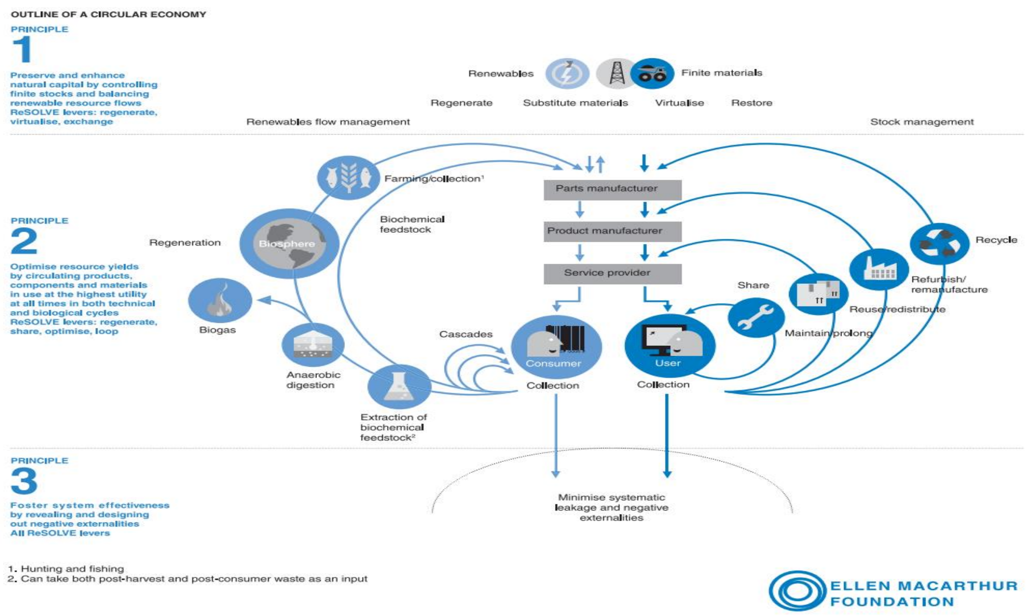


Figure 4: A circular economy characterization (Ellen MacArthur Foundation, 2015)

With the modern technology advent, the notion of circularity with industrial Ecosystem regains the attention for both BMs for CE and Sustainability (Ludeke-Freund et al., 2018; Geissdoerfer et al., 2018a) that CEBM is increasingly acknowledged by firms, research institutions, environmental, and social concern organizations to achieve UN goals. Pavel (2018) highlight that CE is nothing but circularity with CE principles implementation in the circular value chain to generate chances, overcome obstacles, and practice CE activities in production and consumption which are benefited from economic value proposition benefits. Further, the research (Pavel, 2018) proposed the concept of circularity, which is based on CE principles, especially with digital solutions which further strengthens the performance of the sustainability of CE.

CE is based on a few simple principles: first, at its core, a circular economy aims to design out waste. Waste does not exist - products designed and optimized for a cycle of disassembly and reuse (Silva, 2020). CE is defined by the cycles of these tight components and products, which differentiate it from the disposal and even recycling which incurs a loss of the large amounts of energy and labor embedded in it. Then, the technical cycle is mainly constituted of the components that are consumable and durable in design which is introduced with circularity (Silva, 2020). The Biocycle of CE is enormously constituted with biological components that are largely non-toxic with the advantage that they can safely resume in the biosphere, which is distinguished from the existent consumables, with either direct or a cascade of continued usages *(*Silva, 2020*)*. Technical components such as computers or engines, are durables that are usually made of metals and most plastics, and they are unfit for the biosphere, which is subject to rapid technological change, they should be designed as upgradeable. Lastly, renewable energy should fuel this cycle with increasing systems resilience, again, should diminish resource dependence (Silva, 2020)

While design dominates CE with principles to refuse, rethink, and reduce the waste, pollution, and GHG (greenhouse gas emissions) (Kirchherr, et al., 2017; Bocken et al., 2020 a) from the usage of finite resources, maximize the value of the used product, and recapture the value after the first life, and thereafter CE concept replaces the EoL(End of the life) concept by redesigning products or services, and/or processes(Bocken, et al., 2014), so that waste is minimized through the products design phase to have the value over more than one round of life, with continuous improvement for disassembly and reuse to maximize the value of the entire cycle. Therefore, while the economy grows, resource consumption is minimized, and with the continuous innovation of CE, GHG emissions, waste, and pollution are significantly reduced, and CE encourages using more renewable energies. Some research set specific goals and distinguish CE as a target to diminish waste with the optimum design from products, and business models, and some describe CE as the regenerative model that needs a system shift (Diepenmaat et al., 2020) just like the natural ecosystem does, and this can be obtained by design for the endurable, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling(Bocken et al., 2014; Mont et al., 2017). In the research on CE and sustainability and CE for sustainable development, CE principles 10 ‘Rs’ adapt to circularity which relies on CBMs or CEBM implementation into a circular value chain to close, slow, narrow material and energy loops for the long-term sustainability (Geissdoerfer et al., 2017; (Pavel,2018; Geissdoerfer et al., 2018a)

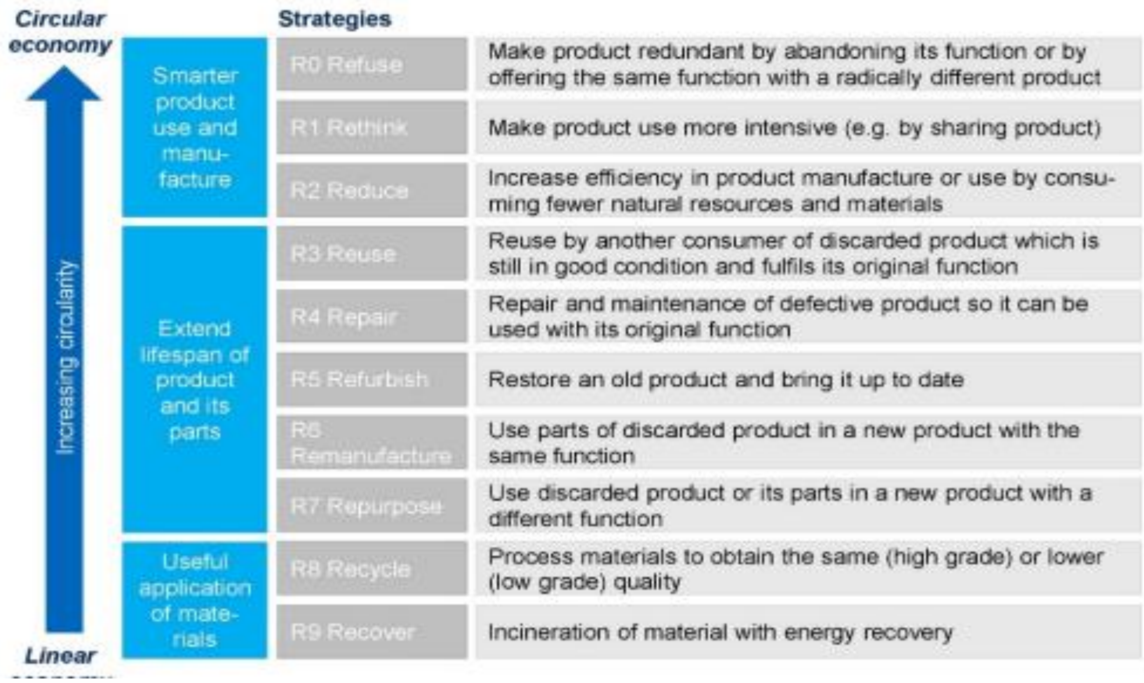
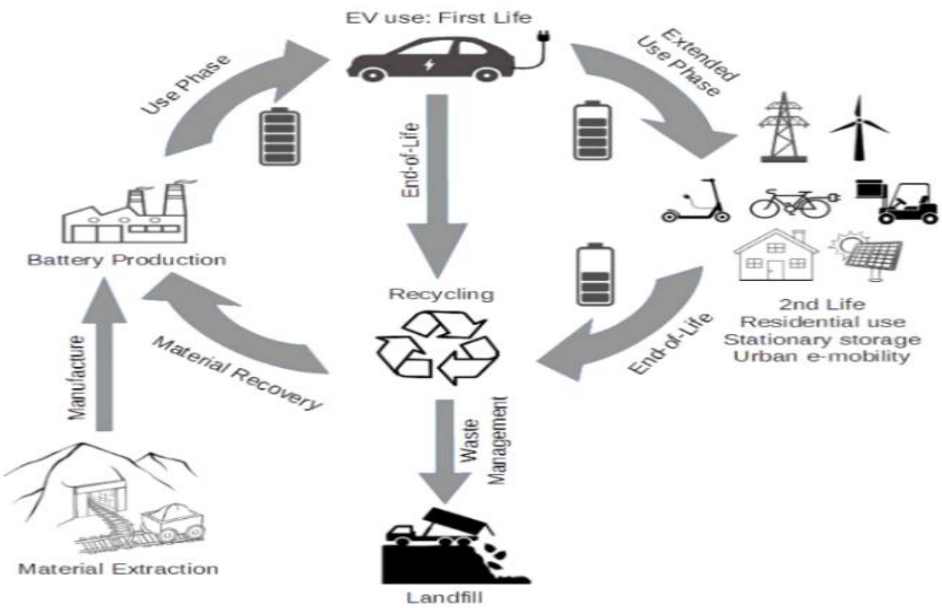


Fig 5. CE ‘10 Rs’ Framework (Kitcher et al., 2017; Pavel, 2018)

CE tackles resource scarcity and climate change however CE is an essentially contested concept (Kirchherr et al., 2018). In practice, CE success relies on the alignment of all players’ CE activity to create sustainable value, as even one unsustainable could downgrade the entire cycle (Ellen MacArthur Foundation, 2015). Typically, CE transformation occurs in the stages: circular company, circular business, and circular ecosystem (Accenture, 2020)**,** two approaches to implement: top-down through policies and legislation or bottom-up through firm competitiveness and profitability (Lieder &Rashid, 2016). To promote sustainable development, firms are compelled to incorporate CE principles and sustainability in a systemic approach and leverage modern technologies with a sustainable business model that creates a competitive edge and sustainable value for stakeholders. Further circular value chain development is different from the linear one, except for the supporting activities among which need practicing circularity. BMs provide a framework and analytical tool for system-level change and sustainability and offer conceptual linkage with various CE activities: design, production, supply chain partnerships, and channel distribution wherefore innovative BM is called for (Silva, 2020) to facilitate more businesses to resume CE principles to BMI, especially for the EVB sector sustainable development with CE perspective.

2.2 EVB Circular Economy Development

EVB business is booming driven by the Electric vehicle booms, especially LIB-based battery sector development is unprecedently accelerating. While the amount of EVB produced is increasing, it turned out to be critical to recapturing the substantial economic value as the used EVB accumulated and poised potential environmental harm with landfill, instead they can be recycled, and materials can be recovered. To address these sustainable matters 'social, economic, and environmental' EU targets to build its own EV batteries and materials value chain that makes all batteries placed on the EU market more sustainable, circular, and safe (EU commission, 2022), accordingly the entire lifecycle management of EVB (Wrålsen et al., 2021) is compelling for the sustainable development of this field. Below is the figure. 6 presents the EVB sector in a CE process with an entire lifecycle.



.

Figure 6. Battery life in a circular economy perspective (Kotak, et al., 2021)

According to recent research (Silva,2020) on EVB sector development with a CE perspective, while the E-mobility sector is still at its application stage, there is a significant chance to architecture EVB sector for the EOL alternatives depending on SoH (state of health) and SoC (state of charge) according to Wang, et al. (2020) states, when the cell capacity is between 60%-80%, EVB could be repurposed or recycled that envisions the remaining energy and residual valuable components materials in the retired EVB can be regained with the remained capacity after its first use (Olsson et al., 2018). To maximumly use the remained value of EVB of its component and materials before landfill that the useful materials are recovered from recycling of the retired EVBs that constitute a circular economy.

In the research (Silva, 2020), transportation electrification tends to decrease GHG emissions. With EV's dominant role in the car fleet eventually, the LIB demand is increasing, and the market is growing exponentially as the costs are dropping substantially. Due to the expected growth in the coming decade, the annual production of LIB (traction) batteries will increase significantly, with the volume sold by five-fold before 2025 to nearly 5 million tons. This accelerating market would multiply the annual battery key raw material demand, i.e., cobalt, Lithium, and Nickel, and it is necessary to make it socially and environmentally acceptable, for product complexity and lengthy supply chain made the exponential challenges to close the materials loops and regenerate natural asset. By 2030, it is forecasted over 11 million tons of spent EV LIB to be disposed of, which poise challenges but considerable opportunities for the drastic increasing demand for raw materials such as 11 times the rise in Cobalt and lithium. It will be critical for recycling to collect the increased batteries after refurbishing and repurposing which are imperative when a battery reached the fi life of automotive, as with all components, and devices in electronics before recycling, it is important to ensure the key raw materials are recovered by the top-notch recycler and discarded properly. By maximizing the value in use and harvesting the remained value from batteries at the end of life, the batteries' footprint improved from both economic and environmental aspects by transforming from a linear to a circular value chain. (Silva, 2020)

· Resilience in over 60% source 90% produced from massive scale and mechanized mine operations, 10% assessed from small scale mining, which is frequently involved with an unsafe working environment.

· Waste management matters, which only escalate with the increasing demand for commodities like rare earth, and it turned out to be gradually obvious that existing approaches to collect and store the waste from mines, and there are negative effects involved with the waste from mines and the tailing dams which are unsuitable for the long-term sustainability, instead, they are possibly at any time disruptive to economy and environment.

· The resource scarcity, that most industries found is another depressing issue. The source used to be easy to get from the primary resources and it was cheap to discard at their end of first life and reuse the materials not favoured 1850-2000. However, commodity prices rise over the last two decades as the price volatility levels for metals. Further, current recycling levels are pressured by finite resources. (Silva, 2020)

· The considerable amount of energy consumed during the recycling process, collection, and transport, which may also produce toxic emissions, pollute the water, and other undesired results, thus have a significant environmental impact, and the principles should not be greater than that of the mining, refining, and material transport.

· The market changes: Nickel and Cobalt make sense of recycling, but in the future, the market might change.

Accenture (2021) also proposed 'circularity' are essential for achieving a sustainable EVB circular value chain, and pathways mapped out as well as a series of strategies for achieving circularity**,** which advocate organization focus on them including Lifecycle Sustainability Assessment. In addition, they address that to realize the circularity**,** this round of sustainable development must be powered by renewable energy i.e., phases of both production and consumption and implementation of these strategies requires alignment throughout the whole value chain (Accenture, 2021). The potential transformation consists of multiple intertwined circular business model change with CE principles, which is not worthwhile to embrace individual business solutions or models. A holistic view of CE with a set of business solutions and models paves the way to sustain the competitive advantage. The orchestrators can be critical stakeholders interested in making a 'fully' circular economy value chain.

Later research (Silva, 2020) highlights Design sits at the CE center and in the EVB value chain, and product design is important in developing systems convenient to repurpose and recycle as part of it to minimize landfill. Recovering the material is an essential link and enhances CE exercises transferring the value chain from linear to circular (Frankenberger et al., 2021). As there is more need for producing lithium batteries in a more sustainable way, i.e., renewable electricity, which is more pressing the demand for recycled content illustrated by this response, which is in line with ecological benefit and climate environmental benefits to implement closed-loop recycling and that is favored for technology development. Though various designs and material compositions are decided for EV models or ESS (Energy storage system). The design become necessary and eventually could turn out to be an advantage.

Design for reuse: as it intends to repurpose as a second-life battery as EV and Battery technologies are still evolving, the repurposed battery will have to compete with the new batteries of improved technologies and cost factors. There are risks of uses cases for potential second life batteries.

Design for maintenance: The concept of a consumer or user largely is replaced with that of an end user in the circular economy and this calls for a new relationship based on product performance between the customers and the business. Products are rather leasing, renting, or sharing wherever possible than linear ways of buying and consuming in today's economy, for example, car-sharing, and fleet management of vehicles. Doing so could have a positive impact on both life cycle design and vehicle design and in turn, this could help incentivize, repurpose, and disassemble.

Design for refurbishment/design for remanufacturing: Life extension of battery in use. Reduction of the usage and demand for new capability and improve the cost factor over a lifetime by leveraging the end-of life-batteries as for all circular economy levers. EVB design for disassembly and lifetime extension is a high priority for the industry, supporting repair and refurbishment.

Design for recycling: Due to the EV battery of the hazard and toxic properties of materials regards of transportation and landfill, there is a need for high safety precautions for handling the recollection and logistics, and the recycling processes are currently expensive. Limit access to the feedstock of the End-of-life battery and the recovery rate is limited in most current processes, other than the most valuable ones like cobalt, copper, or nickel this has hindered economic recycling practices, and the improved recycling technologies would be key to recover more materials at a higher quality. (Silva, 2020)

Systems thinking is one design approach which CE thinking draws from. Unlike the two-sided platform Uber and Air BNB alone, CE Design starts with the issue instead of starting from a specific user's needs; CE design systematically analyses the root cause, decomposes, and patterns changes, components, and dependencies and after all creates a new system with the advanced technologies, regulation, standardization, disassembly, remanufacturing advancement (Carraresi & Bröring, 2021). New business models are needed for the sustainable development of the EVB sector, BMI is crucial for main streaming business for more and more businesses B2B and B2C to take up the CE principles, access to products and components and materials during and within the post-usage loops, and configure who are available in the system, and which can support the solutions that are feasible in the near, intermediate, and long term, in terms of the solutions are not possible at the current moment. (Silva, 2020)

2.3 Business Models concept for CE and Sustainabilty

BMs (Business models) concept increasingly catch attention for its innovative revenue mechanism, since 1990's dot.com boom. BM defines the logic of doing business to create, capture economic value, and grow illustrated conglomerates with returns from technology decreased. To bring the sustainable innovation to the market, a BM perspective has advanced research that firms adopt and organize preliminary 'boundary conditions' for SBM, which has been proposed to create the shared value that support the sustainable innovation (Boons & Ludeke-Freund, 2013; Bocken et al., 2015). For system level sustainability both radical and systematic innovation are needed that BMs are central to system level innovation for sustainability, which offers a framework to envision and implement the sustainable innovations, provides analytical tools, and offers conceptual link-age to various activities: design, production, supply chains, partnerships, and distribution channels (Boons et al., 2013; Bocken et al., 2015). With the advent of modern digital technology, the SBM capability is swiftly transferred to introducing innovative BMs due to their nature of 'boundary spanning' that BMs ecosystem are increasingly seen as the unit of analysis of organisational change, especially for system-level sustainability, the networked BMs aggregate the services from different parts of ecosystem to address new markets (Gomes et al., 2018, Geissdoerfer et al., 2020; Diepenmaat et al., 2020). Geissdoerfer, et al., (2018b) implied BMs for CE and Sustainability is BMs that sustainable business practices SBMs operations, accordingly CEBM a.k.a., CBMs are BMs for sustainability (BMfS), and they are SBM, further BMs could be seen as the framework for sustainable business, as below figure 7 presents the linkage between BMs, SBM, and CBM.

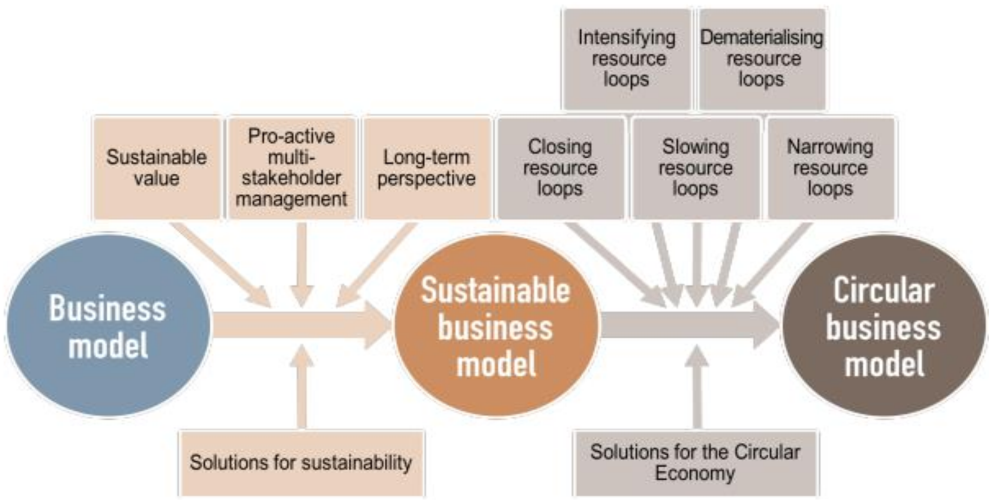


Figure 7. Comparison of traditional, sustainable, and circular business models (Geissdoerfer et al., 2018)

In the literature on SBM, value capture is expanded to accommodate the benefits of social and environmental besides economic value. CBMs are the subcategory of SBM that mostly relies on firms to reengineer, innovate to adapt, connect to the system level, and involve concerns with several stakeholders (Bocken et al., 2015). Accordingly, SBM is an essential component to transferring organization to circular, and they need to re-engineer or readapt their CBMs, CBMs are a networked concept individual firms cannot close the loop, but the system does, they would rather with other BMs together to close a loop, so to be so-called circular (Mont et al., 2017). The success factors of sustainable business are related to value creation and capture which depend on designing such a prospective SBM that bring the sustainable value of 'economic, environmental, and social (Schaltegger et al., 2012; Bocken et al., 2014)

CBM Definitions are based on the conventional BM definition which originates from EMF (2013) and its focus is on closing the materials loops, but it does not fundamentally aim for sustainability (Mentink, 2014).There are various CBM definitions, most focusing on value creation that can be traced to two definitions, roughly they follow either the value logic framework(Richardson, 2008) that depicts BM as a value proposition, value creation and delivery, and value capture (e.g. Linder& Williander 2015; Nußholz 2017); or CBM base on the logic (Osterwalder & Pigneur, 2010) that defines how an organization creates, delivers, and capture value. The Most popular one is CBM defined by Mentink (2014) as BMs that serve the function of closing the material loops with CE principles adhered to and from an industrial ecology perspective. Nußholz (2017) propose the notion of CBM for sustainability that CBMs create production systems and aim to keep the resources at the maximum utility for as long as possible, while material loops at the end-of-life are closed and thus to be considered as BMfS or SBM.

Geissdoerfer, et al. (2018) discuss CBMs about the long-term sustainability with multistakeholder dedicated to a viable economy, beneficial to the environment, and preparing for challenges to be addressed by forming a value network. Finally, CBM and the related system need to value capture both the short and long-term economy to be SBM, preserve natural resources, and for society's benefit. Later, an ecosystem view of CBMs is proposed and shown that how each element affects the value proposition, creation and delivery system, and value capture (Geissdoerfer et al., 2020). For value proposition, the offerings (products and services) need to be reflected and covered by the revenue, and design, and they suggest CBMs tend to diminish the resource investment, waste, and emission leakage from an organizational system view through BMs 'cycling, extend, intensify, and/or dematerialize' the material and energy loops, including cycling, measures of recycling;

extending, the extension of use phase; intensifying, a more intensive use phase; dematerializing, service, and software as solutions to substitute products, while narrowing the resource loops.

CEBM are CBMs, known as BMs for circularity. CEBM is based on the BM definition which is the rationale of value creation, delivery, and the mechanisms used to capture that share of value from customers, aims to create, deliver, and capture value. CEBM advocates different loops to close, slow, intensify, narrow, and dematerialize for system-level sustainability including sustainability metrics, and such a prospective BM that creates value from waste is recognized as an SBM archetype that internalizes concerns of sustainability aspects (Bocken et al., 2016; Geissdoerfer et al., 2017). While many sustainability researchers and practitioners have reached a consensus that sustainable development at the societal level requires an organization-system-level sustainability, and BM is a key initiative component of corporate sustainability, however, with its evolution has moved to sustainability management research, and innovative BMs are needed that either radical or incremental change are needed to help develop sustainable solutions (Schaltergger et al., 2016a, Diepenmaat, et al., 2020). Schaltegger (2016) further states the usual approaches are not sufficient to create a radical transformation for sustainable development, i.e., philanthropy corporate social responsibility, technological process, and product innovation. Bocken. (2021) redefined the concept of BMs for sustainability (BMfs) or SBMs e.g., Product service systems (PSS); Green business models; Social business models; Circular business models; Sharing business models.

In this research, BMfs is the notion that BMs incorporate sustainability principles e.g., CE principles into the core logic of business with pro-active management and create sustainable value for a wider scope of stakeholders, and they are required to rethink mechanisms of BMI for maximizing the sustainable value with a long-term perspective (Bocken, et al., 2015; Geissdoerfer et al, 2018). In searching such innovative ways, BMs can be viewed as a vehicle for innovation, bringing the market outcomes of different types of innovation in products and services, processes, and/or in different organizational settings (Zott and Amit 2008, Teece 2010); innovation source in themselves, bring the market existing products and services in novel ways (Chesbrough 2010; Afuah 2014; Massa &Tucci 2013). Originally**,** the BM concept is to nest between a network that approaches distinguished them from the conventional view from the disseminated BM Canvas, and they describe a firm's position classified on their core value creation activities within its value network, and this is no different than a multistakeholder view (Hedman &Kalling, 2003; Geissdoerfer et al., 2020).

2.4 Sustainable and Circular Busienss model innovation Approaches

For transforming to CE/Sustainability, BMI is an essential tool and component of societal transitions to structure, plan, communicate the increasing complexity of an organization, configure activities, and integrate these changes into organizations for sustainability (Schaltegger et al., 2016a; Doleski, 2015; Pieronie et al, 2019). Earlier, Bocken et al, (2014) described the concept of SBM innovation as a subset of sustainable business thinking that creates profit while taking society and the environment as important stakeholders. This SBM innovation is based on Boons and Lüdeke-Freund (2013) described innovation approaches for a competitive edge through generating superior customer value, and contributing positively to the company, society, and environment while minimizing harm. To clarify BMs as the framework for SBM innovation and take society and environment as stakeholders in this BMI process, which is expected to be beneficial to both SBM innovation and CE to construct wider scope of sustainability (Bocken, et al., 2014).

In this research SBM innovation or BMI for sustainability tend to conceptualize and operationalize SBMs as a dynamic capability (Juntunen, 2017; Teece, 2018; Daou et al., 2020). As CBM is a subcategory of SBM, CBM innovation for sustainability is the same way as SBM innovation for sustainable business innovation, and in an analogous way, as to integrate sustainability into CBM, or CBMs for CE or sustainability (Geissdoerfer et al., 2020). To integrate sustainability into CBM, BMI drives innovative, commercial, and various performances which assist firms in seizing new business opportunities. In addition, SBM innovation involves more stakeholders, BMI, and BMs during the course, the focus needs to shift away from traditional linear counterparts (Roome and Louche, 2015) to a multistakeholder view of CBM innovation for sustainability.

- more heterogeneous and relying on multiple theories.
- The cooperation of BMI in long-term needs for sustainability and CE principles, investigate**,** and succeed.
- Leadership needs to bridge the gap and implement the design on stages of BMI.

To facilitate these consistent agreements and confidence, Kok, et al. (2013) suggest CBM can integrate service elements into three main interlinked dimensions of sustainability 'economic, social, and environmental' and with supplier, partners, and consumer, with close cooperation with supplier, partners, and consumer, and ultimately, then the BM will be different (Linder & Williander, 2015). Antikainen& Valkokari (2016) proposed a framework of a sustainable and circular BMI with the ecosystem considered; understanding partners and stakeholders; evaluating sustainability and circularity. They suggest the role of systemic innovation of BMs is emerging for a sustainable and circular BM that originates the idea from examples like Airbnb and Uber, and disruptive business models from newcomers and redesign the value chains beyond existing business ecosystem and model are suggested, however, CBMI is challenging for established companies, and imply BMI for CE/sustainability is a continuous process for the resource to be optimized, and a multidisciplinary perspective as a central. (Antikainen &Valkokari, 2016).

Bocken et al, (2016) suggest such practices might revolve around various CE perspectives: slow the resource loops, design durable products to extend the lifecycle, narrow the loops, and recycle to close the loop. They view the ideal business models for CE are ways that circulate the continuous loops of the materials and resource, which archetypes are based on product design with rental or sharing model to slow the loop with models of access and performance, extending product value, classic long life, sufficiency incentives, extending resource value, industrial symbiosis, and they revolve around the topics regarding consumption of how customer use products or services, to exploit the residual value of the products, return it to the manufacture with a life long durable design of high quality, reduce consumption by the incentives offers for sufficiency, generate value from waste with recycling to recapture the residual value from the resources. Feed residual output from one to another process. Furthermore, they state, CBM**s** incorporate the environment and society as stakeholders with an equal interest of others. The design offer to change the cost structure, for example, the cost could deduce if the residual value can resume as a source of reuse. In turn, the cost decreased because of fewer materials/components consumed, and these require redesign for the capability of repair, endure, and upgrade, however, might increase the initial cost of the product/service.

To optimize, in practice CBMs include various CE strategies which relations can approach from close, slow, and narrow loops of resources and energies. Design either of the loops with strategies and BMs approach which depends on the firms: BMs to slow the loops, centered on long-life product approach by resource repurposing or reuse; Close the loop, recycling to generate value from the waste and by-products with the business model as usual; narrow the loop, aim to reduce resources use while minimizing waste produced as a result of products and services created (Bocken et al., 2016). The figure8. below further state, CBMs incorporate the environment and society as stakeholders with the equal interest of others.**,** and these three approaches illustrated help identify the different BM strategies into single categories later.

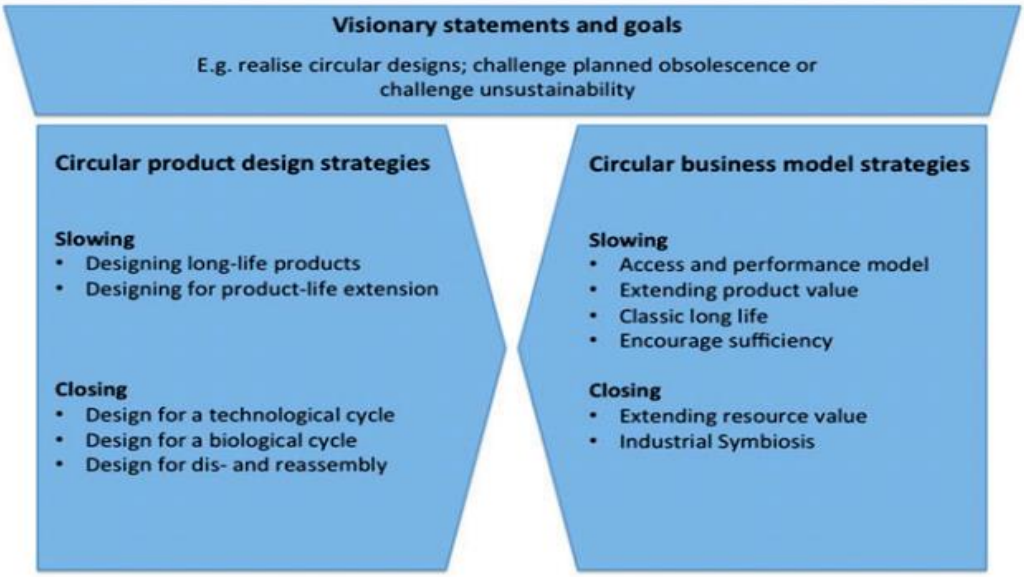


Figure 8. Circular economy product and business model strategy framework from Bocken et al., (2016)

In research (Ludeke et al., 2018; Geissdoerfer et al., 2018a) CEBM dedicate to the circularity, and sustainability of the BMI with CE principles adhered to for operationalizing recycling**,** diverse reuse potentials, and increasingly highlighted sustainable CBM maximizing the value by considering all elements. However, both focus on typology or ‘supply chain aspect of CBMs’ and they implied firms usually adopt CE principles to seek to enhance economic, environmental, and social performance, they further introduce dematerializing and intensifying resource loops: the dematerializing breaks, the ownership dilemma by renting as opposed to owning capital assets. Similarly, intensifying resource loops evaluates the idea of sharing user phases. The overlapping area illustrates the circumstances of sustainability met with CBMs based on closing, slowing, narrowing, intensifying, and/or dematerializing (Geissdoerfer et al., 2018a).

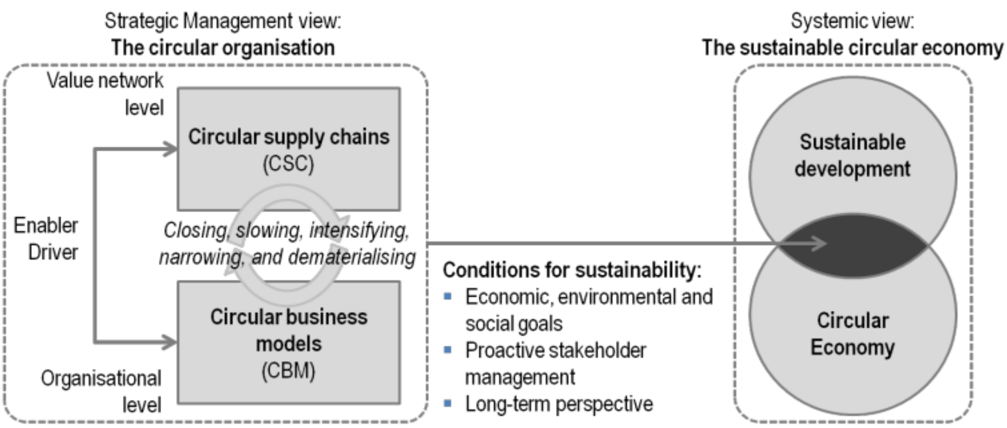


Figure 9. CBM’s conditions for the sustainable circular economy (Geissdoerfer et al., 2018a)

To establish an internal case for sustainability, the innovation paths for CBMs have been instantiated through various typologies. Geissdoerfer et al. (2020a) proposed the CBMs transformation scheme which points out the CBMs portfolios while stakeholders and ecosystem concepts are highlighted in one sketch and illustrate the relationships of these elements with a given clear picture when enterprises considering ‘innovate a CBM’ and how an ecosystem constituted with CBMs with a multi-stakeholder view. Meanwhile, they point to four types of CBM innovation strategies: 1) start-up, 2) diversification, 3) transformation 4) acquisition, and this contributes to the conceptual clarity of CBM&CBMI overview, and synthesis of 1) history, 2) Definition and 3) conceptual framework, CE BM are important to leverage to implement CE on the organizational level, while ecosystem partnerships play a significant role such as the (business models) portfolio element, though are interesting, but not yet discussed in most of the reviewed literature which turned to be interesting research phenomenon to observe in the research.

- The portfolio (business models)
- Ecosystem views
- Ecosystem analysis can also expand to entire organizations (i.e., a multi-stakeholder view) not only to several business units.

All contribute to CE from an organizational level, and ecosystem level, and such BM that creates value from waste, is identified as an SBM archetype (Geissdoerfer et al., 2020a; Bocken & Konietzko et al., 2020b), which distinct from a firm-centric motive and purely profit-oriented business models, albeit SBM must be economically sustainable preliminarily (Bocken et al., 2013; Boons & Lüdeke-Freund, 2013). Sustainable BMI impact could be a much larger scope, thus, substantially include all SDGs; Furthermore, Sustainable CBM innovation concentrates on configuring solutions that allow firms to capture sustainable value (Bocken, 2021) as Figure 10a, and transform to circularity at three stages (Accenture, 2020) 10b shown.

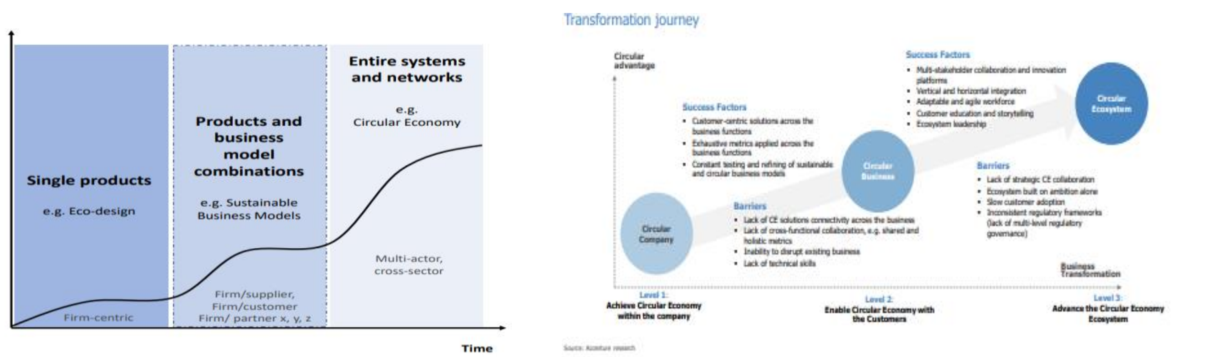


Figure 10(a, b) BM within sustainable innovation spectrum (Bocken,2021) and three stages transform to circularity (Accenture, 2020)

According to Juntunen (2017), BMs change can be seen as a dynamic capability to 'sense, seize, transform' to environmental change to realize the sustainable value with distribution and commercialization via a BM: the intensity of BM change affects its sustainability potential; any change in the BM is a form of BMI that involves a process of BM change (to create, diversify, acquire, or transform) corresponding to internal and external incentives (Pieroni, et al., 2019). In return, BMI can be either a subject of innovation or as a vehicle for innovation (Sarasini &Linder, 2018; Diepenmaat et al., 2020). As a result, this type of BMI yields higher than only innovation on product or process and turns out to be a substantial 'renewable' competitive edge for firms and organizations (Carayannis et al., 2015; Geissdoerfer et al., 2020). Pieroni et al., (2019) suggest a more dynamic view of BMI is required for the simultaneity of the sustainability and CE principles; a design implementation to consider more stages of BMI and human behavior aspects. They point out, governments, industry, and academia pay greater attention to CE, and sustainability, and it turned out to be fundamental to sustaining companies' competitive advantage over BMI for circularity and/or sustainability. They initially compare the value generation of BMI for CE/Sustainability on their scope or drivers and to advance these fields, the gaps and future research agenda were proposed simultaneously:

(1) to lay the consensual foundation and utilize the synergies,

(2) emphasize BMI for CE and or Sustainability is an iterative and unified process

(3) to adjust current methods/tools or figure out fresh ones to bridge the gaps,

(4) to implement various research methods.

Pieroni, Geissdoerfer, and others dedicated to novel notions of CBM and CBMI present the clarity of the conceptualization and theoretical field of BMI for sustainability or circularity, and they are credible scholars on this field and the findings mainly laid the foundation and clarifies key concepts about sustainable and circular BMI, on the exact definition of CBMs and SBM and clarification of underlined, in academia, there are many different ways to describe and classify different business models about their approach towards circularity (Bocken, Weissbrod, &Antikainen, 2020a) CBMs definitions, the relationship between CE contribute to sustainability are also in questions in most academic work, and in the research of Pieroni, et al., (2019) and Geissdoerfer et al., (2019), the gaps and synergies on current research of CBM and SBM and the BMI which are main concepts about are aggregated. According to Geissdoerfer, et al. (2020), CBMs are systemic, and co-development needs to identify key findings and outlined the trends of approaches to CBMs. They further discuss the ecosystem perspective of BMI at the organizational level, incorporate a multi-stakeholder view of BMI with a long-term view, and how they affect each element of BMI for taking up CE. They suggest, essentially, a multistakeholder view dedicates to viable economic solutions for long-term goals and addressing the challenges by forming a value network. Accordingly, the CBM and the related system need to capture value for both short and long-term sustainability.

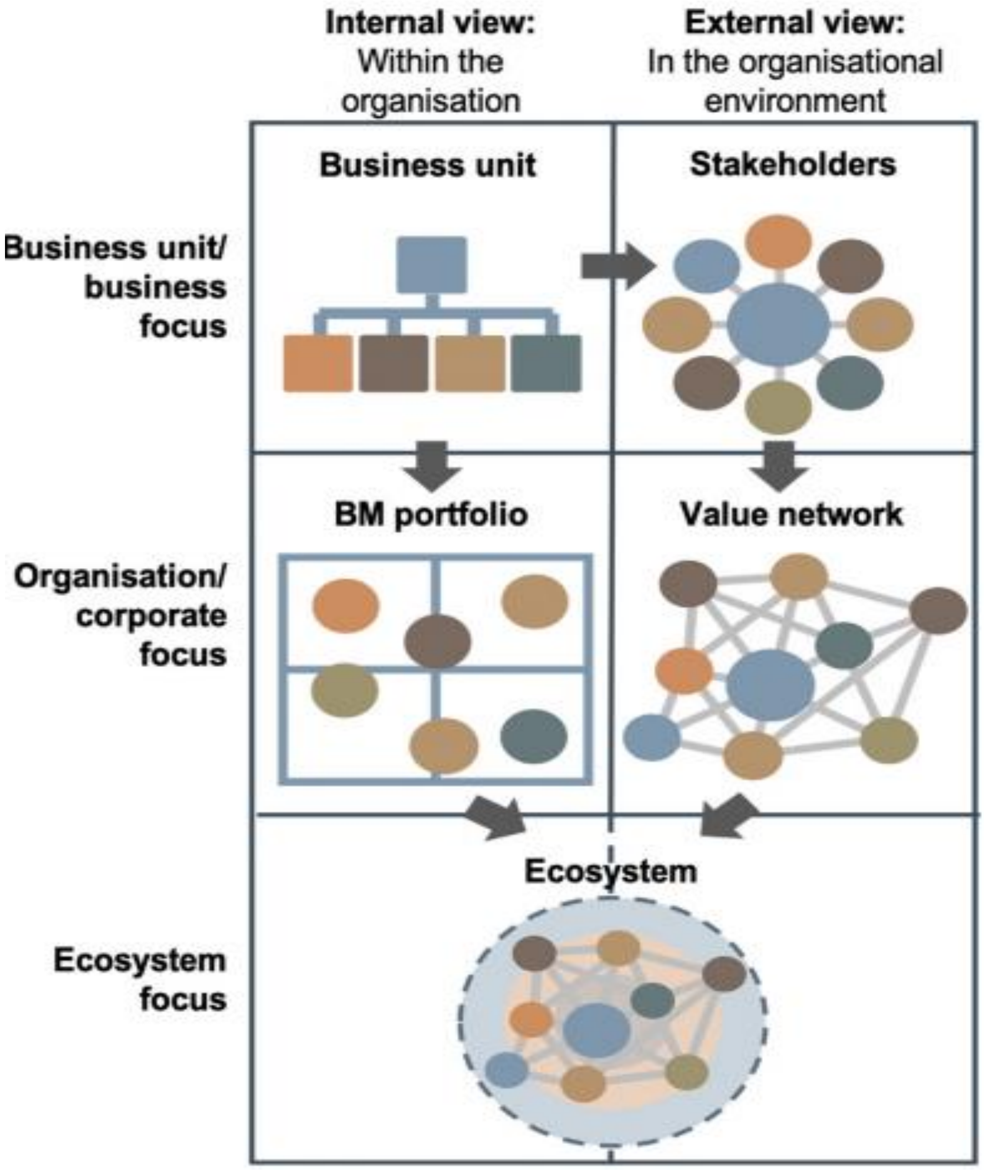


Figure 11. BMI unit analysis shift. (Geissdoerfer et al., 2020)

It is worth noticing that business competition on the CE BMI has shifted to ecosystem level from the business unit (Geissdoerfer et al., 2020), which provides an entirely new space of research on CBM, SBM, and the empirical case should be investigated. Working towards a BM's consideration and BMI view organization level of the sustainable development setting is recommended.

2.5 Business Models Ecosystem Approach to Innovation

Moor (1993) defined a business ecosystem as an interdependent economic community supported by a foundation of interacting organizations and individuals including industrial players, governments, universities, a collection of companies that work cooperatively and competitively to satisfy customer needs, and other relevant stakeholders, who co-evolve with each other to create and deliver value- that is, the organisms of the business world. To sustain the competitive advantage, and other factors, for example, current globalization already propel business competition at the ecosystem level, and the ecosystem is highly uncertain for individual enterprise, and to configure new business models regarding how to better collaborate with complementary players inside and beyond the ecosystem(s), and company needs to know how many ecosystems they have to manage with whom they collaborate, experiment, and coordinate with product/service is important to achieve their goal(s)(Kapoor, 2018). Figure 11 below presented the evolutionary path of business competition.

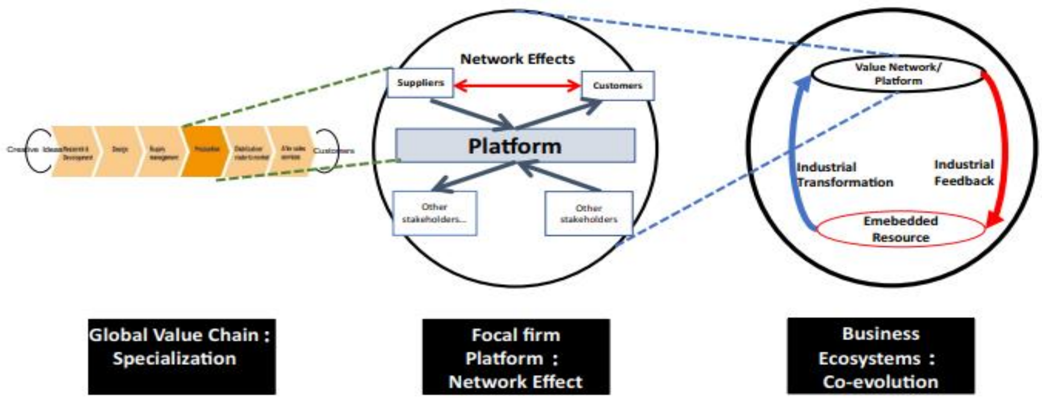


Figure 12. The evolutionary path of business competition (Rong, et al., 2018)

The concept of ecosystem is different from traditional ‘supply chain’ or ‘industry’ ‘cluster’ or ‘value network’, rather the ecosystem address new market to comprehensively represent the demand side of the supply chain, present the current cross-sector collaboration business (Downes & Nunes, 2014, p. 11) emphasize intense interaction and exerted competitive discipline, and an ability to quickly form new ventures as technologies evolve, with new markets Companies co-compete, co-evolve to collectively satisfy just like a natural ecosystem (Moore, 1993). To create and deliver sustainable solutions**,** a business ecosystem contributes various roles with an aggregate result, that is similarly described as the bundled, or hybrid business models that constitute a business ecosystem where ecosystem members aim to jointly bring value to customers together

(Rinkkala et al., 2019) and companies seek to (Iivari et al., 2016; Bocken et al., 2020) Value co-creation, proposition, and competitive advantage.

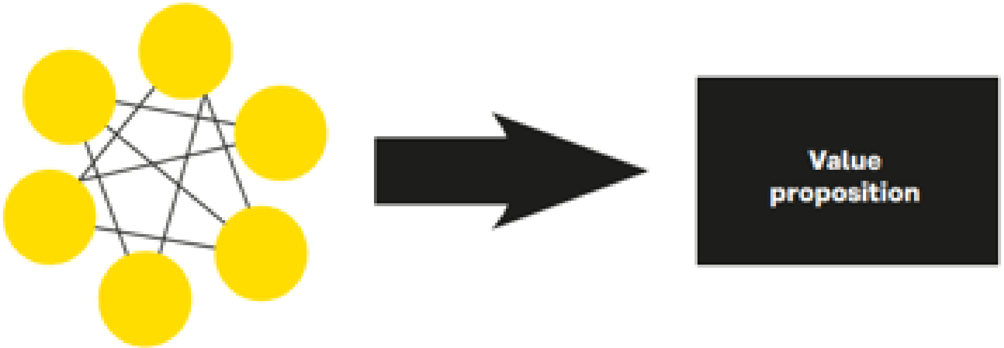


Figure 13. Jointly value creation for customers by ecosystem members (Rinkkala et al.,2019)

In eco-systemic contexts these activities could include, for example, connectivity offering to ecosystem players, providing services i.e., content creation, service-related context generation, and commercializing activities with various forms of context. Therefore, an Eco-systemic business model based on open innovation with the lens of BMs as a dynamic capability, and conceptualized as an innovation vehicle to explore, and exploit business opportunities, competitive advantage, create value, and business models of business ecosystem view connect to three strategic choices of their related key activities of firms within ecosystems:

1) opportunities to explore/exploit,

2) value to create/capture, and

3) advantages to explore and exploit (Zott, Amit &Massa 2011; Yrjölä, 2020)

Adner (2016a) defined an ecosystem as a multilateral set of partners that need to interact for a focal value proposition to materialize into an alignment structure. In line with this, a circular ecosystem can be defined as a system that coordinates itself across the different complementary business models to create sustainable value propositions with closed resource loops based on which to align product design. Against this background, CE can be perceived as the business models interplay and complement each other along a circular ecosystem (Desing et al., 2020) Considering Circular context relevant business eco-system: innovation, service, and platform ecosystems (Bocken et al., 2020). In Gomes et al., (2018) research, the business ecosystem concept is investigated with BMs lens as dynamic capabilities to enable the interaction between ecosystems in the context of a modern industrial ecosystem of e-health. In a similar vein, the perspective of BMs ecosystem from the firm’s perspective to be circular, which sees BMs of partners as equally important as its own (Konietzko et al., 2020): start with a product or service, expand to a business model, and reach out to the wider ecosystem., and finally firms create a circular solution and gain a competitive edge to generate sustainable value for multistakeholder: customers, employees, society, and our planet (Desing et al., 2020).

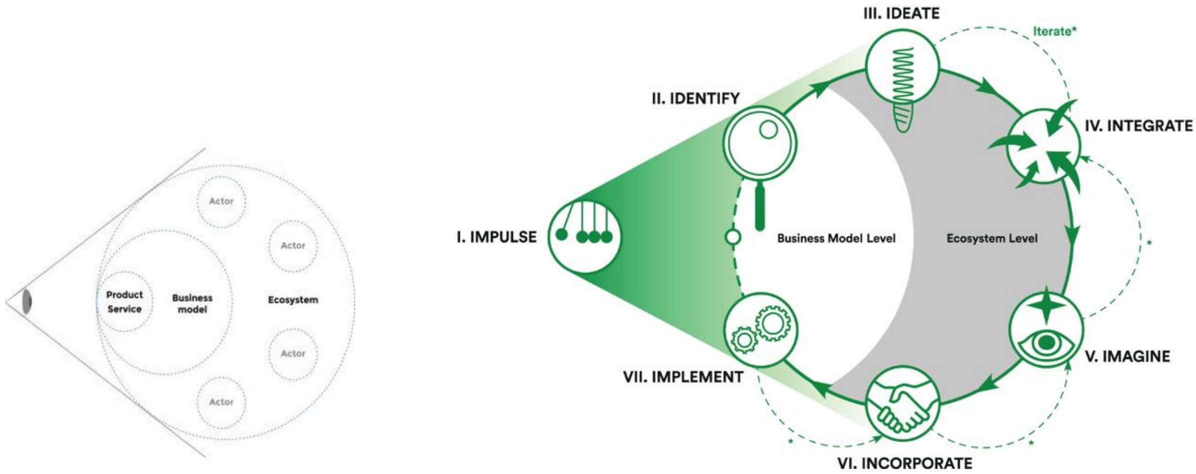


Figure 14. Ecosystem view and Circular Navigator (Bocken et al., 2020; Takacs, et al., 2020)

2.6 Synthesis of Theoretical Framework

The CEBM implementation for sustainable development of the EVB sector is a complex and novel phenomenon that requires whole-system participatory approaches, and parallel and consecutive changes from various stakeholders, however, the explicit relation of BMI for sustainability/CE is missing (Pieroni et al., 2019). According to the academic reflection on SBM innovation, i.e**.,** BMI for CE/sustainability, Pieroni**,** et al., (2019) implies SBM innovation is identified as pivotal to have a fully circular impact to capture sustainable value, for the synergy of BMI for CE/sustainability is key toward circularity and gaining sustainability. However, the research on CE and Sustainable development goes in divergent ways (Bocken& Geissdoerfer, 2018), the dynamic view of BMs innovation/ change for CE/Sustainability is necessary for system-level sustainability transition to CE paradigm for sustainable development (Pieronie et al., 2019; Diepenmaat et al., 2020). However, the SBM view needs alignment (Pieroni et al., 2019) for which variants of such BMs have been proposed for decades (Linder & Williander, 2015), the attention of BM for CE and/or Sustainability should draw back to its original concept that of more networked nature. This research advocates a circular ecosystem of a dynamic CBMs view (Hansen, Ludeke-Freund, &Fichter,2020).

To integrate wider scope of sustainability, SBM innovation and/or CBMI requires multistakeholder collaboration across the industries, communication, and coordination that take up CBMs, which by nature are interdependent processes, the success factors depend on iterative optimization and redesign of the current BMs and ecosystem to incorporate CE principles reconfigure the win-win-win solutions/situations. While practitioners view CE as an instrument in EVB sector sustainable development to set in motion mechanisms, others focus on tackling the barriers of technical and financial issues (Wrålsen et al., 2021), this research focus on SBM(CBMs) innovation that new business models incorporate CE principles to introduce regenerative industrial transform to CE paradigm that will pave the way for achieving a sustainable community. CEBM incorporating CE principles is core to moving towards circularity and system sustainability, in this way firms can renew their competitive edge with SBM innovation that CBMs advocate these Principles for sustainable development (Boon et al., 2013). Further, a more dynamic view of BMI is needed to promote BMfS to improve CE performance by engaging them in the design of Sustainable CBM through their potential exposure to environmental change. Therefore, to have a full impact on the circular economy, new business models are needed for more businesses B2B and B2C to uptake CE principles with the synergy of BMI for CE/Sustainability.

Considering different SBM innovation approaches: CBMs ecosystem and multistakeholder BMI with CE principles to innovation, a new way to innovate the incumbent business model that CBM integrate services from different part of ecosystems for sustainability, that has surpassed circular value chain analysis (Parida et al., 2019). Accordingly, the enablers of CE are considered circularity elements to be implemented into CBMs, they rely on 10 'R's principles which are key for CEBM by incorporating circularity elements to reduce resource utilization. The circular value chain concept (Pavel, 2018) is fundamental for CE sustainable development that the ecosystem approach to innovation is taken to incorporate CE principles **'**refuse, rethink and reduce' (R0, R1, R2) as referred to below figure 15. , that facilitate the other circularity elements in every stage of the circular value chain**,** multiple stakeholders BMI practice**s** with R-(X) throughout the value chain (Pavel, 2018) to optimize value and create sustainable value through enabling the simplicity of CE activities to iteratively proceed & execute circularity elements**.** A more detailed framework is proposed later in the discussion chapter, while the current one helps to presume a relationship among key factors & concepts(components), therefore it is so-called a comprehensible framework, that new variables can be added, and thus, can be changed over time as needed (Miles, M.B., et al.,1994). The adapted circular Value chain Development presentedwith Figure 15 .

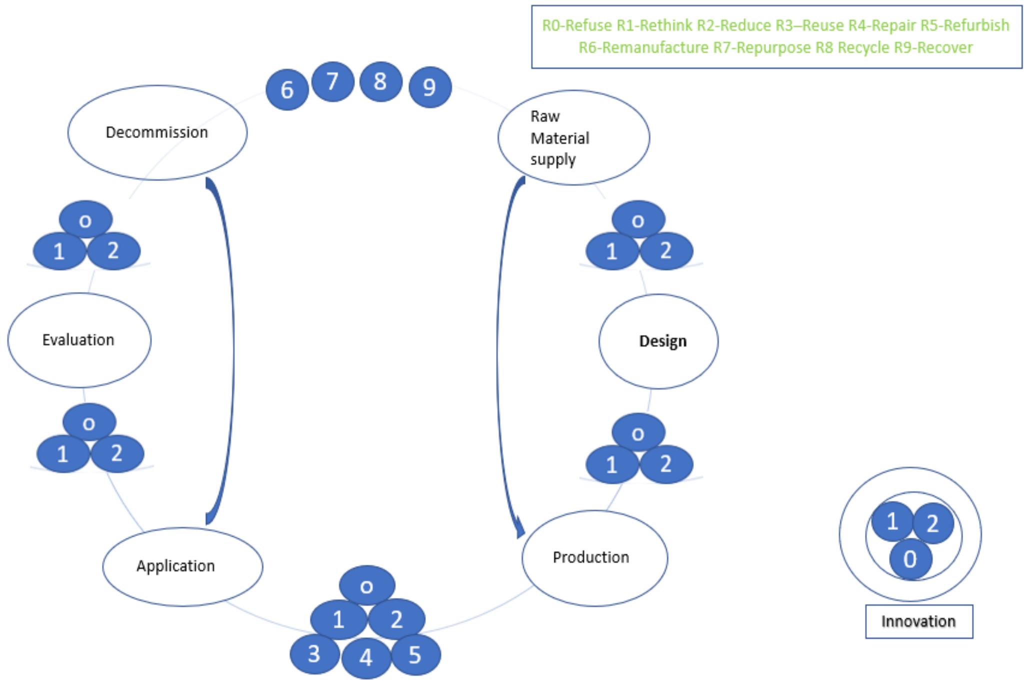


Figure 15. Circular value chain (Adapted from Pavel, 2019)

The synthetic framework in this research Figure 15,16 is adapted from a combination of current literature and interview result, this framework illustrates part of the flow chart of the new BM design with multi-stakeholder of SBMI with CE principles adhered to in the circular value chain development. For sustainable and circular BMs innovation/change, CBMs can be perceived as a dynamic capability, which is on top of ordinary capability, can be added up to or adapted to the changing environment to keep a competitive edge that CBMs advocate different loops to 'slow, close, narrow, intensify and dematerialize' resource loops (Geissdoerfer, et al., 2018), and finally contribute to organizational sustainability with CE principles adhered to EVB sector sustainable development. The Framework see below figure 16.

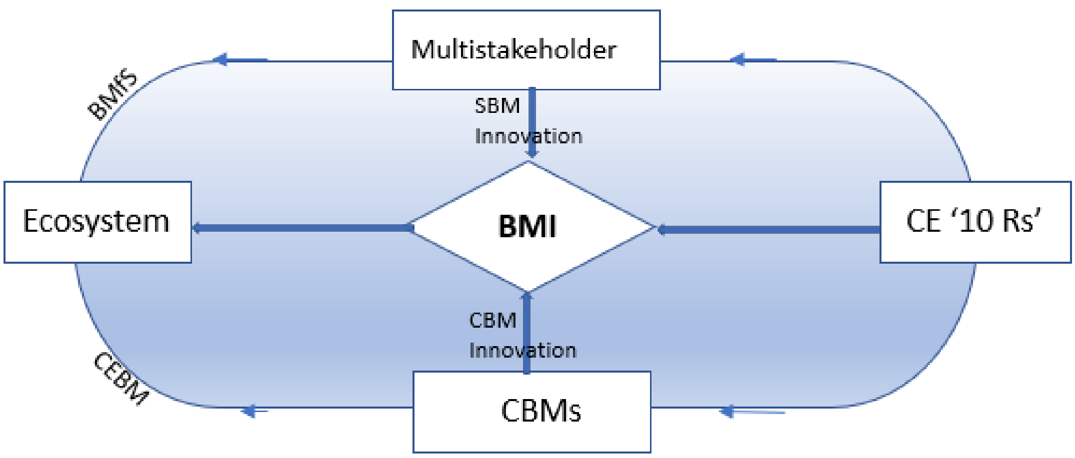


Figure16. BMI with CE principles adhered to: Eocystem approach to innovation.

This paper presents innitial consideration in understanding ecosystemic BMs in open innovation context. The research argue that modern BMs are centred around the value-creation of a focal company in a supply chain context and do now need to adress collaborative value creation in complex soeital cases, such as circular economy development in Finland EVB clusters. This transformaiton to CE ecosystem poses a major challenge for manufcturing companies because it requires them to co-ordinate and manage the incentives and investments of multiple companies(Ghisellini et al., 2016; Lahiti et al., 2018). Ecosystem focus is as the main unit of analysis for BMI in the context of CE, in which this shift is expected with the particular interest for stakeholder collaboration and systemic ecosystem view(Pieroni et al., 2019a). In these cases, the value is co-created and shared among a wide range of stakeholders, going beyond the value chain and including actors from quadruple helix. To understand value co-creation in these cases, new ecosystemic BMs are needed for mainstream business B2B, B2C to take up CE principles in EVB sector. Regardless of how successful they prove to be, ecosystem-based business model, rather building moats than operating turnstiles are important to understand in the Batteries/EV business ecosystem development.

This research explores Finland EVB sector to identify how they innovate and design a prospective sustainable and circular business model with CE principles adhered to, and further how a focal firm can innovate in, to resume CBMs (Sitra Finland innovation Fund, 2021) and BMI with partner's BM and ambient ecosystems considered transforming to CE paradigm for circularity, and gaining sustainability, for EVB sector sustainable development from Finland.

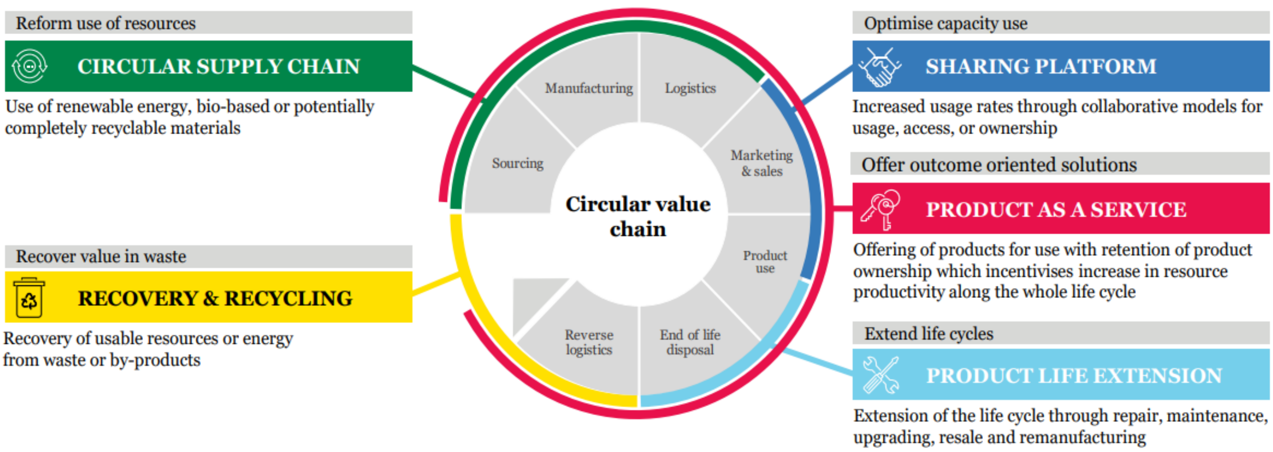


Figure 17. Five business models for CE and Sustianability(Sitra, 2021)

3. Methodology

3.1 Research Strategy

To investigate a business ecosystem setting and solve a 'real-world' problem of EVB CE substantial development, an interdisciplinary perspective is taken, and qualitative research is appropriate for demonstrating the initial development phase EVB sector from Finland rather than a quantitative one, especially for inter-organization business development (Geissdoerfer et al., 2020; Wrålsen et al., 2021). In this research, the objective is to bridge the knowledge gap between SBM innovation or CBM innovation for CE/ sustainability; business models for CE and Sustainability (Geissdoerfer et al., 2018a; Geissdoerfer &Nancy, 2017; Pavel, 2018; Pieroni, et al., 2019; Geissdoerfer, 2020a; Nancy, 2021) in the spectrums of business models, their innovation, and CE strategies (Pieroni, et al., 2019; Geissdoerfer et al., 2018a; Geissdoerfer, et al., 2020)for which CE is considered as a viable economic solution contributes to the EVB sector sustainable development(Pavel, 2018; Bocken, 2021; Silva, 2020; Wrålsen et al., 2021), however, this field is still evolving, for the firms embrace circularity, gain sustainability, and generate sustainable business, they need to consider the incumbent, partners', and ambient ecosystem BM, to resume the CE principles (Strategies).

This research is to study how the prospective BM can be innovated with CE principles adhered to. The research further advances the knowledge of CBM, BMI, and how the collective endeavour can foster sustainable development of the EVB sector with CE principles adhered through CE BM and SBM innovation that foster ecosystems interaction with CBMs advocating loops 'slowing, narrowing, closing, intensifying and dematerializing' the resource loops and BMI 'sense seize, and transform' to environment change (Geissdoerfer et al, 2016; Juntunen, 2017; Teece, 2018), therefore business models lens is used to view the ecosystem as a dynamic capability, with multistakeholder BMI with CE principles adhered toward sustainable circular ecosystem. This approach is inconsistent with the theory BMs offer a framework and provide a conceptualizing tool, to operationalize SBMs for sustainable business (Bocken, et al., 2014), and this is inconsistent with the interpretive approach to qualitative research. The abductive approach is dominant as well, as the theory is finalized after the interview is done. During the study, the patterns of the data collected are linked to theoretical insights which originate from the literatures: circular economy, sustainable development, BM, SBM, CBM, SBM CBM innovation, BMI for CE/Sustainability, and ecosystem. Therefore, qualitative research is opted for in this study, with an explorative case study: a case and combined multiple cases have been conducted with below steps:

1. A literature review has been conducted on BMs, CBM and/or SBM innovation; CEBM or CBMs, BMfS; circular, innovation ecosystem; and CE sustainable development.
2. First research step: Purpose case sampling of the derived CE principles from literature and others.
3. Thematic data analysis from the collected data from various sources: Interview and Expert View.
4. The result presented uses the pattern match method from the case study research data and others.

In this research, the BMs' lens is used as view of business ecosystem (Gomes et al., 2018) to look at the complex EVB sector CE development. In this research, the ecosystem approach to innovation in the circular value chain development, a multistakeholder view, and BMI with CE principles are taken for the sustainable development of the EVB sector from Finland in the EU and beyond. To delineate the view of a sustainable and circular business model: 1) Circular input, 2) raw material recovery, 3) information exchange platform, 4) life cycle extension, and 5) product as a service from the definition (Accenture, 2015; Sitra, 2020) and CE principles (Kircher et al., 2017) the '10Rs' 'reduce, rethink, refuse, reuse, repair, refurbish, recycle, remanufacture 'are taken to investigate how a focal firm can BMI to contribute to the sustainable development with CE principles adhered to and discover the success factors from Finland EVB sector:

- how companies innovate business models with CE practices are implemented
- provide stakeholders with applicable insights to benefit from the BMI with CE principles.

The researcher stresses the success factors of CBMs implementation through preliminary research with an empirical study on its implementation in the EVB sector from Finland, as CBMs and their sustainable innovation is a nascent research field that has been rarely done on the EVB sector, especially for the production side (Wrålsen et al., 2021), ecosystem and the industry are emerging, and the research has been in time conducted from Finland EVB sector for the sustainable development of this field. A holistic view of CEBM implementation is taken to study their sustainable innovation at system level; to underlying the success factors through exploring the mechanisms and incentives of their CBMs innovation at organisational level that could ultimately transform to CE and facilitate more businesses to take up CE paradigm for the sustainable development(Boon et al., 2013); analysing the current and future trends, and their potential solutions amongst these institutions, pioneer companies, and R&D departments, of their perspectives and their strategies analysed from the bigger context of the EU value chain of EVB filed(Macro), the regional Ecosystem (Meso) Finland, and to the CE active firms (Micro); and to answer the research questions:

How to innovate a business model with CE principles for sustainable development?

What are the success factors to innovate such a prospective business model?

These research questions both help to frame the purpose of the study and guide the framework of the proposed theoretical proposition of the case study toward a sustainable, circular ecosystem, and guide the framework followed by the CE principles of the methods to be used for sampling and data analysis. An Exploratory case study was applied in this research (yin, 2003; Booth et al., 2016). Exhaustive search of the literature was conducted before cases study that combine narrative and tabular methods for synthesizing literature (Ibid.), and to investigate how the incumbent firms innovate a CBM for sustainable development in the EU value chain context, for designing the sustainable innovation at system level where the cross-industrial collaboration, multi- stakeholder opportunities co-develop, design SBMs, and ecosystem settings are emphasized.

To answer the questions of 'how' and 'why' (Yin, 2003), an exploratory case study is considered in this research as research method (Yin, 2003, Booth et al., 2016): Exploratory research investigates the research questions that have not been sufficiently studied (George, T, 2021); To understand 'circularity', and further, better understand 'how' firms could innovate a prospective BM with CE principle adhered to for 'sustainability' and toward 'circularity' single case could be conducted; and for more clarity for ecosystem research, multiple case studies could also be conducted that further understand how firms could innovate in by taking account of the ecosystem perspective for CE sustainable development: an ecosystem approach to innovation in the circular value chain context, and firms BMI with CE principles adhered to at organizational level. The preliminary results often lay the groundwork for future analysis. The explorative case study was dominant of the abductive approach, for the theory development is not purely deductive from the existing literature review and from the interview and experts' views, the result and findings are complemented by the empirical data, with the themes identified from existing and/or prior research to compare that the gaps are found, and the researcher matches and explores CBM innovation in the EU and Finland EV battery and materials sustainable supply sector with the semi-structured interview.

In this research to study how organizations and firms can innovate the prospective BM with the ambient ecosystems considered and incorporate CE activities for sustainability, a single case and the combined multiple case study approach are applied. A case study approach helps to study the conditions of how firms can incorporate sustainability into CBMs with the ecosystem considered for which EVB in the raw materials and recycling sectors are not sufficiently studied (Walliman, 2006; Albertsen, 2020). In addition to the single case study approach, the multi-case study is also employed to supplement to examine of a more in-depth level of the phenomenon, however, compared to any other method, to generalize the conclusions and findings, the single case study is possible to exaggerate the available data (Eikelenboom et al., 2021), thus, the multiple cases study is used as well to shed light on the challenges and dynamics faced with EVB firms towards CE (Saunders et al., 2016); and furthermore, produce more generable knowledge from this emerging sector, a business ecosystem where the general CE activities take place, it is nevertheless reached the results from the keystone players within. As a result, the explorative case study is employed to obtain in-depth knowledge of CBMs innovation for sustainability, and thus, help the researchers understand a complex phenomenon using multiple data sources to examine through several lenses in a real-life context (Ozanne & Ander- son, 2010; Yin, 2013; Baxter & Jack, 2008) with a case and combined multiple case study employed(Stake, 2013) to make more sense of picture– the circular ecosystem and with a multi-stakeholder view. Data Collection from a case and multiple cases has enabled the researcher to better understand how CE initiatives are incorporated into the BMI process, contribute to circularity, gain sustainability, and generalize the findings from the multiple case studies from the firms, and a case study from a consortium.

3.2 Research Approach

Explorative Case studies are conducted with expert views to gain more insights on organization BMI for sustainability/CE and integrate ecological, climate, and sustainability benefits, taking account of ecosystems perspective into their BMs innovation with CE principles adhered to, taking up the SCBM (Sitra,2020). The qualitative explorative case study was conducted with two major steps to gather primary and secondary data, the abductive approach was dominant in an iterative journey between the primary data collection process and secondary data from the literature, and the other channels. To configure the success factors of EVB sector CBM transition, extensive literature was reviewed from scientific journals and grey literature includes but is not limited to EVB recycling and reuse or 'the second use.' The secondary data are from books related to CE topics, extant scientific journals, the conference channels videos and papers, and the webinars attended online, which are about the EU and others, Nordic countries platforms: 'EU, China 2050 Carbon

Neutral Society during January 2021-May 2022 and 'Nordic Battery Thursday' from October 2021 to December 2022, and the primary data are gathered from the interviews from May-August 2022.

A case and combined multiple case studies have been conducted from Finland revolving around a project and associated firms for a collaborative business model, an ecosystemic one with cross-sector stakeholders' collaboration on a continued CBMI improvement process for the sustainable development of the EVB sector, while only the general interactions are reviewed that occur at the organizational level in a business ecosystem, accordingly, multiple case studies are applied as well.

Firms are selected from Energy and Materials sectors, and they are from renewable sources; Interview respondents are from higher management team or innovation managers from modern EV contract manufacturer who also implement innovative BMs with EV battery assembly; and this study categorizes the key activities to appropriate themes originated from the concept of CE, CBMs ecosystem, sustainable business model, and BMI with CE principles for circularity.

All together 5 big companies are interviewed, and the primary data is collected from 10 in-depth interviews including experts from industries, institutions, and consortiums. The data from these firms' interviews could complement the framework and reveal micro-level change(how) by firms, they are not sufficiently revealed at 'Macro, Meso' level implementation of CE activities at national and/or industrial level(why), hence, besides the firms' interview and experts' view are also considered, on their area, for example, the head of Battery from Business Finland, and the expert who work and teach at the Oulu university business school, dedicated to smart energy and digital business models have been interviewed, and the Legal documents interpretation has been consulted and interviewed by the institution from Environmental Ministry of Finland; and the Consortium Project, two personals have been interviewed, and cross-examined on the innovation ecosystem's status and plan, among them, one is the project manager who has been involved with the project, holding a Ph.D. in EV Battery area, and another is the project coordinator who is the interface of the project between other research institutions, universities, and academia related to this project BATCircle2.0, and content analyses for specific CE activities have been found from other channels which have been included and double-checked during and after the interview, and all the research projects of the researcher have been supported and supervised by the associated degree depart and the thesis supervisor, and also with the research consortium, the details, and related contents credibility have been discussed during and before the research objective is reached.

3.3. Data Collection

The primary data was collected at the later stage of the research drafting with interviews of CE firms, the semi-structured interviews were utilized, in addition, with the real time seminars with relevant topics for example 'EU, China 2050 Carbon Neutral Society, 'Nordic Battery Thursday', and other circular economy events, the primary data is supplemented, and with but not limited to scientific journals, the academic research i.e., the master and doctoral thesis for the topics of 'reverse logistics' 'Battery second life or reuse' 'CBM deployment in the EV OEM', therefore, a shortlist of the research topic on the targeted firms is figured out with the assistance of expert's views, and of the targeted company on the research topic is sorted out in return, and the interviewees are mostly conducted with the higher-level management of these organizations and firms, i.e., firms' CEO, president, innovation managers, and project managers to address the research questions with their first-hand information.

The interview session started, by first receiving the agreement of the interview via prior emails regarding the general topic of the interview and the objective of the research. Then interviews were carried out, and all the interview meetings happens online during the Covid-19 period, the primary data is collected through Microsoft team meetings with semi-structured interviews, as it gives flexibility to the conversation of the structured interview which allows probing for additional details (Creswell, 2014), to identify the relevant business models and solutions. The interviews are held in English, as all the interviews are in English, simultaneously they are all recorded and transcribed by Microsoft TEAM AI software and saved in the systems, and later edited with the original video talking for minor errors and some are even sent back to the interviewees for the double confirmation, and those interviews video formats are backed up in the JAMK cloud; the Data was transcribed simultaneously from the Microsoft teams and coded in an Excel file to identify themes i.e., the more appropriate definition of CBMs and the solutions in the ecosystem settings.

The secondary data collected are from extant sources from the conference online Webinars, literature reviews from scientific journals, and grey literature, and the company's website for a broader view - of the business ecosystem(Eisenhardt, 1989), to configure the success factor by focusing on circular business model generation and innovation from Finland incumbent companies in this constellation; the scientific journals are collected from a wide range, but the timeline is after 2010 until now; Besides the official documents on Finland EVB business development aspects from Business Finland, Batcircle, and EU level from EU commission, i.e., EU circular economy action plan, etc., of their relevant development in the EVB sector at the industry level, i.e., Batteries Europe ETIP WG2, another related industrial forum, and for firms of all available information from the annual sustainable report. The secondary data the collection is not limited to but also from channels of websites and webinars organized in Nordic countries of the collaboration programs, and specialized industry news sources on the internet that have been identified through a review of the literature (e.g., Anderson et al., 2011). This also includes the other sources of data collected through grey literature, books, public channels, websites, related industrial forums, peer review articles from Google scholars, and Elsevier on the topic of EVB business models, Battery second use, green technology, and sustainability and available information from the annual report of the firm's sustainability report to have basic information of the interviewee companies.

Case sampling

For qualitative research, quality prevails over quantity. Ecosystem research is scant but advancing. For a holistic, dynamic view of business models ecosystem, a case and combined case study were selected based on purposeful sampling (Blaikie and Priest, 2019) for the firms to be conducted as part of the research, given the literature background from literature review, which defines a specific selection criterion, as theoretical sampling is necessary based on the research method of the case studies (Eisenhardt & Graebner, 2007). While this research reviews general interactions that occur in business ecosystem (Eisenhardt, 1989), CEBM (or CBMs) generation and innovation of the incumbent companies in this constellation were utilized as broader view focusing on BMI with CE principles adhered to.

A project is selected for a case study to better understand the environmental change of ecosystem consideration in addition to combined multiple case studies have been also conducted to better understand how such a prospective sustainable and circular business model can be innovated for sustainable development with multiple stakeholders involved toward circularity.

Based on the project, the companies are selected as a research object for investigating CBMs CE principles executed in these listed companies and to get more data of a better view of focal firm's Circular business models to change impact as an outcome of nested Ecosystem, which aimed for a competitive and sustainable European battery value chain is being delivered and one step closer to reality as WG2 through a collaboration of organizations, industry partners (Batteries Europe ETIP WG2, 2021). The large companies are selected for the research purpose from Finland EVB raw material Circular ecosystem project: the raw material sustainable sourcing and supply in the EU.

This research uses ecosystems as the base of sampling and eco-systemic BMs as the unit of analysis (Gomes, 2020) at an organizational level, ecosystem level in the context of Finland, EU circular value chain development of the EVB sector, 1 project and 5 case companies who are pioneers and potential ecosystem keystone players are selected. For a holistic multi-stakeholder, ecosystem view, Government institutions: Environment Ministry of Finland and Business Finland are interviewed, the case involved sectors of the raw material supply, energy, and Smart manufacturing, and the project BATCircle 2.0 from Finland is selected and instantiate an example of developing an EVB circular economy that targets adding value to the battery materials sector. Below figure 18 is the project is highlight in circle.

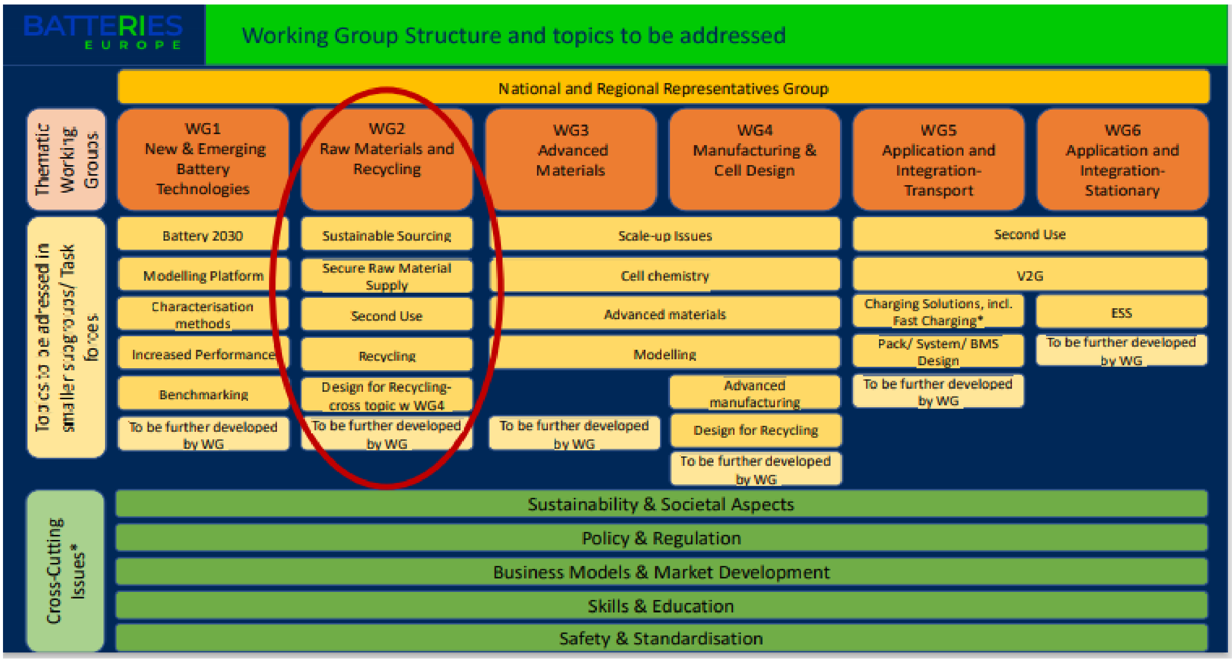


Figure 18. Aalto University, working group 2 and topics in BatteRIes (Hannula, 2019)

The project BATCircle2.0 was selected as a case study. It targets to add value to battery metals sectors, and its partners are tightly involved in EU-level decision-making and other activities through ETIP Batteries Europe selected for a case study; a combined multiple case studies was conducted with the incumbent companies who involves with this project, while their organization size is also considered (Oghazi &Mostaghel, 2018), i.e., they are keystone players and pioneered with the establishment of a CBM (in at least one business unit). The size limitation was established because the medium to large companies is usually better structured and have more in-house expertise to provide in-depth information (cf. Liu &Zhang, 2014).

There are five EVB business developers including EVB raw materials suppliers and Energy and electrification and EV contract manufacturers from Finland were located and their websites and other publicly available channels about CE strategies and business models were reviewed. First, The

'Ecosystem actors' CE active companies have been selected in this research according to several criteria as orchestrators at the initial stage of development in the business ecosystem and to demonstrate features: 1 the important roles in the EVB circular ecosystem, 2. These major organizations and institutions tend to innovate and support circular business models evolving with the ecosystem and there are many other different themed ecosystems involved at the same time and emerging ones are also are the horizon. Second, to select relevant case studies within the chosen industry, unstructured interviews with industry experts were conducted. Of these experts, two are from the consortium of the BATCircle, another one is a leading expert in industrial IoT ecosystem and its business models assessment (Florian, M., 2014), and finally, five big companies were listed because of the data saturation after a major interview with the leading actors in this project.

Company A: Valmet is one of the largest vehicle sub-contract manufacturers in the world, certified Carbon-Neutral as of January 2022, Tier 1 system supplier role in batteries, and its strategic goal to expand the EV system business line.

Company B: StoraEnso is a world supplier of biomaterials, approximately 22,000 employees in StoraEnso, annual is listed on the stock market Nasdaq Helsinki Oy (STEAV, STERV) and Nasdaq Stockholm AB (STE A, STE R), as well as in the USA as ADRs.

Company C: Wärtsilä, is active in the energy storage space and utilizes this lithium battery to store the excess renewable energy. Wätsilä has grown from Maritime leader and is a top three player in the energy storage space, competing against Tesla and Fluence. Wärtsilä is a big buyer and seller of lithium-ion batteries, and its core business is energy storage.

Company D: Fortum, is a leading European energy company and a forerunner in battery recycling technology. Fortum is one of the largest firms in Finland by revenue with general vision 'towards a great cleaner world' involved in many area businesses, even outside of Finland.

Company E: Akkuser, established in 2010 in Finland, recycle spent batteries: one plant related to inbound material streams, and another has a contract with the Finnish producer organization.

3.4 Data Analysis

Data collection and analysis have done simultaneously to make sense out of the data collected, and overall processes were revolved with the research questions and identify relevant segments (Merriam & Tisdell, 2016). Thematic analysis is applied with classification and interpretation (Flick, 2014), that both are to construct and consolidate the theoretical findings and they are collected through interviews, discussions from seminar meetings, company website reports, and theoretical text. Accordingly, interview data were analysed and categorized corresponding to the themes and categories that were formed to mirror the conceptual framework and illustrate links between the categorises within organizations as visualising data is effective for simply clarifying (Flick, 2014).

To make statements in the materials about implicit and explicit meaning that is represented in it, the researcher adopts the Data-driven thematic analysis (Boyatzis, 1998) to explicate the detailed elements of CBM innovation for sustainability. The transcription text independently was analysed so that they were ready for further analysis which size can vary from a single word to pages of field notes. After all, a thematic theme analytical approach was taken in the analysis, after the data collection, reduction, selection, recurring categories(segments, or units of data) were identified and coded, for example, *Three parts were divided for the circular value chain development analysis: Ecosystem approach to innovation; Smart manufacturing &recycling; Battery second life to Life cycle extension, and they are following BMI with CE principles in a certain way.*

The data analysis followed the constant comparison technique (Corbin & Strauss, 1990), thematic analysis method, which provides ways to identify patterns, in rich and complex qualitative data sets, was analysed then coded in themes, through triangulation with insights from expert view, the Literature review, and firsthand information from the practitioners of higher-level management from incumbent companies, *and the respondents were anonymously coded: V1(*Valmet informant number 1, Innovation Manager), B1(Business Finland, Battery head), W1(Wärtsilä , Vice president), AA1(Aalto University expert number 1) and AA2(Aalto University expert number 2), A1(Akkuser, Managing director), F1(Fortum, Commercial director), S1(StoraEnso informant, business development specialist), O1(Oulu university expert), and E1(Environment Ministry of Finland, specialist), then interview results were analysed and coded to resonate with themes corresponding to circular value chain development. After all, new innovative CEBM framework sketches are improvised, and they are presented in discussion chapter, referring to and reflecting from existed Literature and other secondary data combined with primary data. The entire process of data analysis was to find themes, categories and patterns, and answers research questions and they are presented in result chapter.

3.5 Validity and Reliability

Validity and reliability are both critical ethical factors to consider and essential parts when drafting a thesis of qualitative research. The thesis objective has been met, stated, and clarified answers in the conclusions part. Both primary and secondary data were collected and complemented with each other. On the validity, the research starts with a stringent literature review to obtain credible information and be critical regarding the sources, and data sources; On reliability, later the result was to compare and ensure the reliability of data analysis.

To strengthen the validity of the thesis, only the latest business and technology information was included, especially, Secondary data, from other sources, for example, the news website, and scientific articles peer-reviewed ones with their full text after 2010 were set to be the earliest publication year. Various sources such as websites, different research reports, and thesis from different perspectives and stakeholders, books, scientific articles, reports, online seminars and conferences, interviews, meetings, and data from the cases company and different data from different institutions: government, academia, incumbent case companies, have strengthened the validity of the research encompassing a purpose (theoretical)sampling for the incumbent business model innovation, and the cases were selected accordingly (Blaikie and Priest, 2019).

To achieve the research objectives, understand the phenomenon, or interpret it from the research base, purposeful cases sampling was conducted for the interview questions and corresponding to themes designed and formed around research questions, accordingly, secondary data were collected and categorised to these themes however in various perspective. While the interviewees share their insights around the same themes generated from the relevant themes, Subcategories were as well created from interviews results, as Corbin &Strauss (1990) suggested, the protocol reliability of the Case study was ensured by the replication logic from this multiple case study. Furthermore, the information accuracy was ensured that the transcript after the interviews was first calibrated with the data sources, and further accuracy was ensured that the part related to the correspondents confirmed with the respondents for there are no discrepancy, ambiguity, and research community ethics were observed with research integrity from Finland TENK 3/2019.

Furthermore, quality of qualitative research is ensured that with expert views, practitioners and institutional views are referred to and triangled with the information collected from theoretical ground. Both validity and reliability aspects correlated to the external and internal validity because the author has chosen this area from the empirical case and consolidated it with the theoretical and scientific views of appropriate representatives. All the ideas, preproposals, and any ambiguity have been discussed with the case companies and strengthened by the careful selection of the information with the experts and innovation managers from the organization and case companies. Based on these facts, the research conducted can be considered dependable and valid.

4 Result

The EVB materials sector from Finland focuses on driving the supply forward to ‘green procurement’ with the materials decarbonized. The prospecting business model is on development and strives for circularity with a set of strategies (Finland National strategy, 2021) laid out, with paralleled project BATCircle2.0 to make progress with industries, and the goal is to build long-term resilient EV battery and materials industry with a dynamic approach. Each workstream of the above advocated Finland organizations: EV licensee maker, NGO (nongovernmental organizations), and national and academic research institutions, and all contributed the insights through seminars, conferences, online webinars, and any response from this multifaced analysis including Business Finland, Aalto University, Oulu University, environmental Ministry of Finland, from EVB materials sector; Business models; Environmental ministry of Finland is responsible for the Legislation issues of the evolving industries, is under supervision, and the proposal drafting to let the voice of Finland's voice be heard from EU Commission.

Finland CE Context

EU target to build an innovative, competitive, and sustainable battery industry, Finland is part of it and aims for a circular approach to sustainability through solutions for securing key raw material availability, the materials recycling processes optimization with digitalization, and the ‘sharing economy to be a pioneer for CE. Additionally, research and development in the field of environmentally friendly e-transport and battery technology alternatives have been drawn up and promoted. (German-Finnish Chamber of Commerce, 2020)

Finnish battery industry development is driven by the increasing global demand for EVs and the renewable energy, which is a robust growth market for the Finnish battery sector. The strategic aims of Finland are to secure its role in sustainable battery production, and recycling and aim to strengthen the battery ecosystems, accelerate low-carbon economic growth, government strengthens to promote renewable business potential growth innovation, and create jobs. (German-Finnish Chamber of Commerce, 2020)

Finland is a major producer of battery raw materials in Europe and owes to its enormous mineral resources. The primary raw materials are mined and processed independently for Lithium-ion battery production. Finland also has concrete industrial expertise across the entire battery value chain from battery raw materials mining, refinery, technologies, battery production, and the relevant services, charging technologies, recycling, and utilization as per quest. The national program 'Distribution Network for Alternative Transport Forces' outlines e.g., the principles for building an electric car charging network and presenting the actors and controls needed to achieve comprehensive charging network. The program is based on the EU directive (2014/94/EU) on transport alternatives and the deployment of other fuels infrastructure (Distribution information Directive)

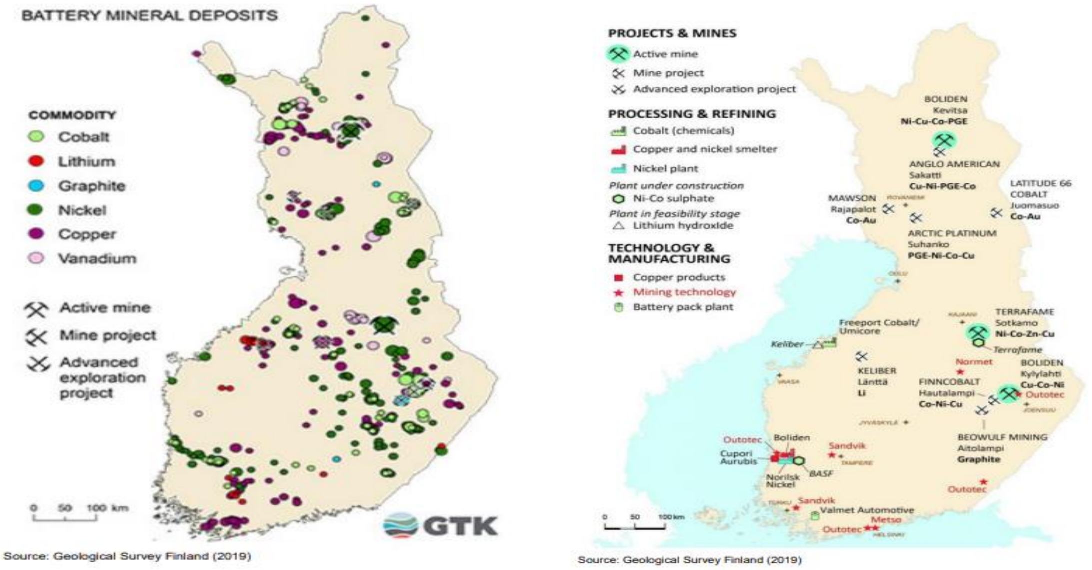


Figure 19. Mines, refining, and smelting capacity in Finland. (Finland National Battery Strategy, 2021)

Finland, like elsewhere in the world, is ready to adopt clean energy for climate goals, therefore, aiming to be a global leader in converting fossil fuels into sustainable energy sources. Finland has reached several or close to goals presented in recent the Prime Minister's office published review. 'sustainability' is not just a buzzword in Finland. The small Nordic country is aiming to transform itself into a 'socially, economically, ecologically sustainable society,' and its long-standing commitment to supporting sustainability has borne fruit. In 2020, the World Economic Forum's energy transition index analyses 115 countries in energy sectors to evaluate clean energy readiness with their energy access, environmental sustainability, and economic development and growth, Finland is the third.

In January 2021, Finland published its Finnish national strategy, it was among the first countries in the world, and another goal cantered around the EU and Nordic market, finding new opportunities and customers for Finnish battery companies, and set goals 'in 2030 at least 250,000 electric cars will *be in use* In Finland, which also calls for increasing the energy efficiency of the electricity system and envisages support for cost-effective new electricity generation based on renewable energy' (Sitra,2019) As a follow-up to the energy and climate strategy, the Transport Climate Policy Working Group (ILMO) of the Ministry of Transport and Communications examined how greenhouse gases from transport can be eliminated in the longer term. The working group's final report in December 2018 recommended a target of about 670,000 electric cars for 2030 and about one million for 2045.

Environmental Ministry of Finland

The Ministry of the environment oversees communities, the built environment, housing, biodiversity, sustainable use of natural resources, and environmental protection in Finland. The Minister heads the ministry of environment and Climate change, which represents Finland among other EU Member states, prepares legal matters, and proposes the newest regulation which will go from the EU member states, through the ministerial meeting and the European Parliament. regarding the newest EVB regulation, the legislation is mainly on recovery rates and recycling rates coming a few years behind the technology development, but a more comprehensive regulation will enter into force once the negotiation is finalized. Finland's government role and legislation play in the business development in the battery sector, in general, tends to have a so-called level 'playing field' so that they help for an ambitious European-wide battery regulation, which also addresses the aspect of sustainability so that the battery sector can compete on fair terms. The legislation should create a sustainability basis for the businesses and the associate, which has a positive impact on the legislation development so that it will apply to all European countries, E1 *'This battery regulation that is now being negotiated in the EU is the Key piece of legislation in that sector because it is in the European Union system, and it is a regulation and not a directive which is needed to be applied by all the member states and the regulation contains requirements for increased sustainability, additional recycling, additional safety, and other issues like carbon dioxide, carbon footprint, calculations for batteries, etc., and it is the basic base legislation for the aspirations of battery aspect and sustainability in Europe'.*

The regulation could encourage business development toward sustainability: the mandatory targets of recyclability, reparability in addition to strict requirements on the safety of batteries and minimum performance criteria, also the carbon footprint calculation, which is all included in the battery regulation, and they are legislative and will push batteries and battery manufacturers towards sustainability. Batteries play a key role to advance the EU climate neutrality target by 2050.

There is a new rule for EVB production, recycling, and repurposing, according to the new agreement (EU, commission, 2022).

EU's target is to foster a more competitive battery industry in the current energy context, to manage the entire lifecycle management of the EVB with both CE and zero emissions of GHG to make sustainable batteries from sourcing to recycling and repurposing to support clean energy transition. This all requires introducing the requirement on sustainability matters, i.e., carbon footprint, the content to recycle, and durability and performance that will be gradually introduced from 2024 onward.

The EPR (extended producer responsibility) regulations will apply to start 2025, over time there will be a higher collection rate: 63% in 2027 for portable batteries and 73% in 2030, while for the light means of transport batteries, the target will be 51% in 2028 and 61% in 2031. All batteries collected must be recycled and achieve high levels of recovery, especially for valuable materials i.e., cobalt, lithium, nickel, copper, and lead, and all this tends to ensure that valuable materials are recovered with efficient recycling: 50% by 2027, and 80% by 2031 (EU commission, 2022). For the batteries placed on the EU market, firms must demonstrate the materials sourced for the manufacturing are from responsible sources that require the produced materials must identify and mitigate the risks of social and environmental associated with the extraction, processing, and trading of raw materials.

The EU's clean energy package is a framework in which e.g., Legislation and investment aim to achieve 40% in the EU by 2030. SET-Plan is the technology pillar of the European Union's energy and climate policy. Competitiveness in e-mobility and energy storage batteries is one of the plan's priorities. The plan will be implemented e.g., exploring black and innovation by coordinating.

A government decree has also been issued on batteries and accumulators (520/2014), which defines measures to 'reduce the harmfulness of batteries and accumulators, promote other batteries accumulators improve quality of their treatment'. The EU Batteries Directive(2006/66/EC) set out, inter alia, in the battery collection and recycling targets. The collection target for portable batteries and accumulators is 45%. For industries batteries, the collection and recycling target is 100%. In addition, recycling efficiency targets (How much of the materials can be recovered) are accumulating., Lead batteries 65% Essentially related to battery raw materials e.g., Mining Act (621/2011), and the other 50% (this group includes lithium-ion batteries, NiMH batteries, and primary batteries).

In Finland, batteries and accumulators have been under manufacturer responsibility since 2008. The manufacturer's responsibility applies in principle to all batteries and accumulators, including those contained in electrical and electronic devices, vehicles, or other products. Only batteries and accumulators used for military purposes, for products related to the surveillance of important national security interests, or for space-related products are not subject to producer responsibility.38 Liability is based on the Act (520/2014). EU Battery Directive (2006/66/EC) legislation divides batteries and accumulators into three: accumulators, industry batteries, and vehicles, which require environmental data. According to the Finnish Waste Management Act (649/2011), manufacturers and importers of batteries and accumulators are obliged to arrange for the disposal of the accumulators that they bring on at their own expense**.** The government decree (520/2014) on batteries and accumulators provides more details on the regulation of waste management.

Business Finland

Business Finland is a government dual organization as known as a governmental-specific company financed by the Ministry of Economics and Employment, which focuses on themes through creating wealth and business for Finnish companies and support also, the universities and other stakeholders through divergent functions. Business Finland support Finnish companies doing export-making ramp up, and innovations attracting foreign investment to Finland, for instance, Fryer, a Norwegian company, and there are many more in the battery sector promoting a journey beyond industrial matters.

EU target to build an innovative, competitive, and sustainable battery industry in the EU. Finland's national strategy as part of the EU's aims to promote the sustainable use of natural resources through solutions i.e., securing the material availability and materials recycling processes optimization with digitalization and sharing economy to be a circular economy pioneer. Additionally, research and development in the field of environmentally friendly e-transport and battery technology alternatives have been drawn up and promoted, B1*'the role is evolving but has been dealing with the cleantech industry in a wide sense and the last five years, has been focusing on battery and value chain, battery ecosystems and dedicated to promoting the circular economy type of value chain, which is important. We are not isolated in Nordics, but we are connected to European Development. Finland is active on two sides of the store on one side business Finland is an active actor in circular economy and sustainability, on the other side how Finland is working in the battery sector toward circular and sustainability. Business Finland is asked to promote sustainability and a circular economy the reason behind this is Ministries and companies have been thinking for quite* *many years that this is a competitive edge for Finland because Finland is born to be. 'People like us circulate things and we do not throw bottles in the forest we collect them and bring them back. So, our mindset is circular, and we have sustainability. We are a circular economy within our mindset in Business Finland for battery business. We start five years ago, and since day one it has been quite clear we want economy type.'*

Finnish battery industry development is driven by the increasing global demand for electric vehicles and renewable energy, which is a strong growth market for the Finnish battery sector. The strategic aims of Finland are to secure its role in sustainable battery production and recycling and aim to strengthen the battery ecosystems and accelerate low-carbon economic growth, and the government strengthens to promote renewable business potential growth innovation, as well as creating jobs. European competitiveness is in the sustainable business model that 'reuse, recycling and remanufacturing,' which are intertwined. To make the whole ecosystem sustainable, the ecosystem players must collaborate and share specific, like a battery, the contents, and the lifecycle and aging, and it is that sharing the data across the value chain is very important, the traceability, which will be a key factor to be able to reuse the batteries to know the information of being used, the chemistries and conditions of the batteries, so that it can be connected safely, and it is key to have that information the usage of the history of the EVB, the chemistry content, the 'SoC', and 'SoH' and other LCA information so that to operate the batteries safely for dismantling and other reuse, recycling activities. These data need to share across the value chain to prove sustainability.

Europe believes that a competitive battery value chain can serve European players and can serve Global players in the future. Finland is strong in sustainability which is going to be the default in the business. Operators who can not apply the sustainability requirement for Europe will be more difficult for them to operate in Europe compared to Finland and the Nordics, B1 *'Sustainability will be necessary to operate in business in future. For the Chinese battery maker, if want to bring in the used batteries for reuse in Europe, then the full-blown lifecycle data must be provided for different applications needs the information and be clear on what the condition is and what are the chemistries to be able to reuse them no matter whatever different application might be. For climate change and greater sustainability, every country needs to obey the sustainability principles.*

Finland compares and needs to realize what the situation currently is and then look to the future. So far, the situations in huge cargo ships moving battery materials back and forth between Europe and Asia are far away from the sustainable goals and a lot of development work is to be done globally to facilitate sustainability across the value chain. Finland is making a great effort to try hard in Europe but across the borders across the continents and it's still to be seen in the future*,* responsible clusters further refining battery grade material, new generation EV and machines manufacturing and battery in use, charging infrastructure know-how and battery recycling capacity. Finnish companies from big to small, international companies to start-ups offer innovative ideas.

To strengthen this potential, Finland builds a strong battery cluster with the Finnish Ministry of Economic Affairs and launched the 'Batteries from Finland' program in the spring of 2018. Business Finland has implemented the program, which consists of different sectors of the battery industry, as the one-stop shop for government services in innovation and export promotion, investment, and tourism promotion. Finland is active in a program aimed to build networks that promote engagement in European and consequently the global energy grid. Finland has the goal to be one of the few countries that can manage the whole battery value chain with the raw materials traced across the entire value chain. Finland's operation is circular type starting from mining and refining and going to chemical manufacturing and there are applications for 'reuse and recycling' which are the core value of the whole picture since Business Finland started the EVB sector from day one. This is also a guideline for which Business Finland supports the companies to think similarly of the established connections across verticals across applications, B1 '*I think, it has been a successful journey, quite many European countries have been playing the same (CE) principles, we have been consulted by various European countries on us products and they have been applying the same (CE) principles.* Business Finland has been making events on circular economy themes, for example, Nordic Thursday webinars that Sweden and Norway also like to promote circular economy and sustainability for a competitive edge.

Quality comes not only from the raw materials sources but also from the applications and service sectors outside of EV and battery manufacturing. For the service sector: ICT, i.e., Nokia, angry bird, etc. Software companies, and the heavy-duty machinery expertise application, Sandvik, Normet, Clean Energy supply, and the first-class infrastructure to test out the new ideas, and the knowledge of the involved within this challenging and innovative EV battery and raw materials sector. In addition*,* Finland's culture supports innovation and entrepreneurship and allows research findings to be more directly applied to everyday life which is famous for a relaxing test bed to figure out modern technologies. Furthermore, the battery raw materials supply ecosystem is close to the Nordic Battery manufacturing base. Finland-produced EV and battery applications can either reduce CO2 emission or have increased handprint with less CO2 emission footprint, the eco-system players can save the environmental impact cost or gain a reputation.

BATCircle 2.0 Aalto University Recycle, reuse, and SOH.

In BATCircle, the consortium was launched in 2019, led by Aalto University, which seeks to strengthen collaboration and increase Finland's competitiveness in Metal-related business and research. Business Finland has been funding the consortium and the Large Finnish national battery metal ecosystem succeeded from the afore: that includes 22 companies, 2 cities, 4 universities, and 2 research institutes, and currently, the project is coordinated with Aalto university with the joint industry-academia includes: 15 companies, 4 universities, and 2 research centres, around 19 M€ budget (BATCircle2.0, 2021).

To ensure the normal operation of cities in the given complex and demanding circumstances. Below demonstrate the project WG2 connection with the EU working group which originated from Finland EVB raw material Circular ecosystem project. The road map: configure the areas of research and innovation to strengthen the areas of LIB-based battery raw materials, recycling, and where needs to improve the knowhow to make the EU competitive in LIB-based battery business; to collect all important imported to recover them sustainably for the benefits of 'technological, economical, and environmental.'

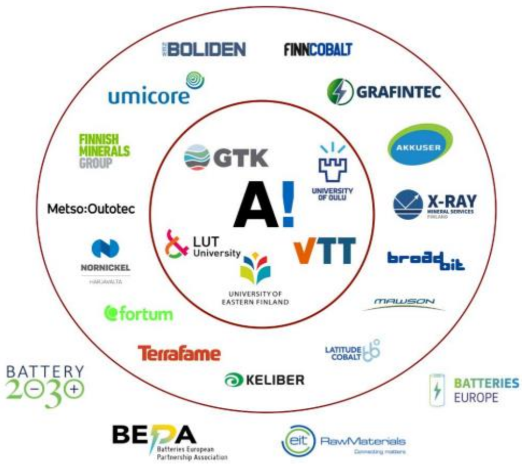


Figure 20. BATCirce2.0 Consortium (Nurmi, 2021)

The initiative has proven that is achievable, Aalto university, therefore, participating in the European union's 2020 HELIOS project, which aims to develop and integrate innovative materials, design, technology, and process to create smart, standards-assembled, scalable battery packs that can be widely used in EVs. Importantly, based on this success, Finland has been selected to be the

European Green Programme as a leading player in battery planning and manufacturing through the Action Plan of the Battery Strategy for Europe and the Platform for batteries for European countries**.** Finland has six Battery ecosystem themes are establishing:

1) Raw materials and chemicals.

2) Harsh environment application

3) Large scale recycling,

4) BMS Battery system engineering

5) Safety

6)Traceability in the value chain (Business Finland, 2019).

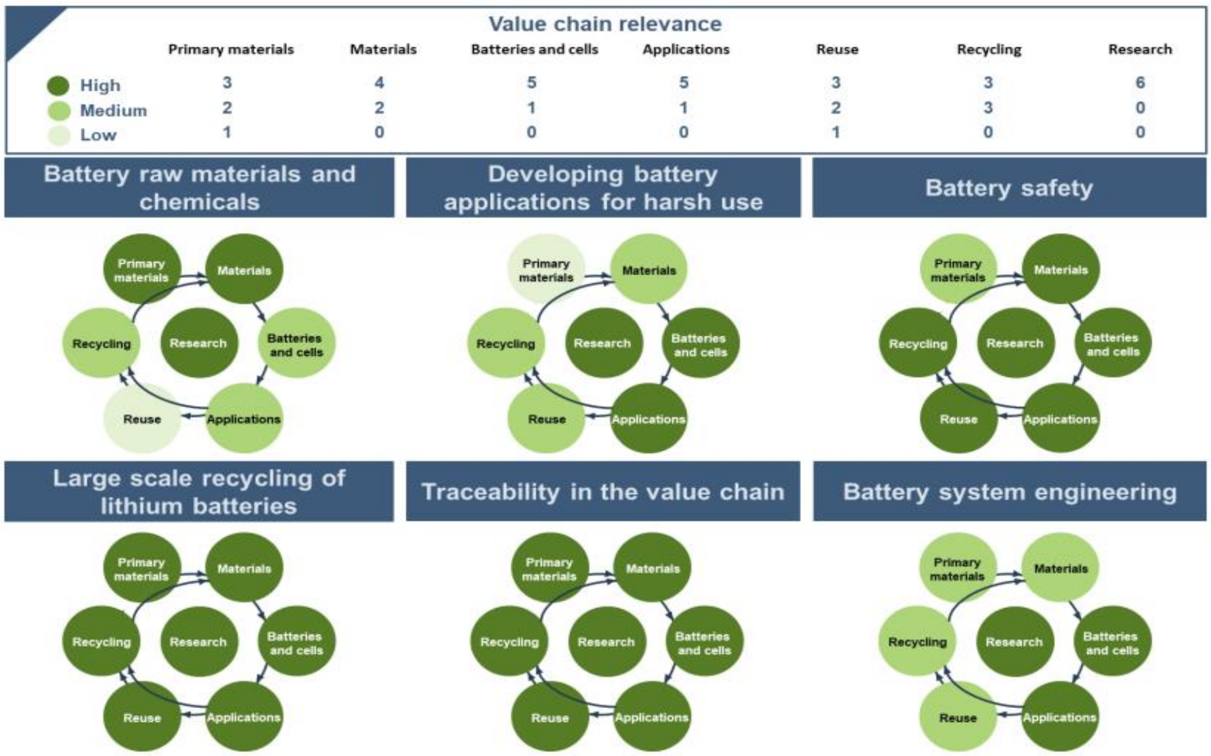


Figure 21. Finland ecosystems of the circular Value chain Relevance (Business Finland, 2019)

The value chain relevance for ecosystems themes is listed above figure 20. Business Finland takes an ecosystem approach to sustainable Innovation regarding CE principles of BMI with 'R0, R1, and R2' (refuse, rethink, and reduce). Building a competitive EVB ecosystem is emerging, and urgent, and need to be building up the EVB sector to overcome the multitude of challenges from business, technology, and legislation. From these ecosystems' view, the project manager from BATCircle 2.0 project, addressing: if the environmental legislation is high that like many factories and processes the number of harmful emissions is low. These parameters are monitored all the time, AA2 *'Finland ecosystem is like a lifecycle that the BATCircle 2.0 project is offering for the batteries besides companies and organizations have roles that they are playing in the wider perspective. For the batteries' metals that are not growing, it is not recommended that just pick them up from the ground, instead, they really must be manufactured on their own.'*

Considering having its raw materials for the EV batteries from the EU, Finland plays a significant role in this transition, as a country itself, all the companies and research organizations located here are interested in these topics and it's like the role of Europe worldwide. Building its own battery and raw materials value chain is imperative for Finland, which has one of the largest deposits of Lithium, Cobalt, Nickel, etc, Finland is like one kind of player since, in Finland, with nickel and cobalt, the raw material and metals refining is high on a global scale, Finland could have a whole life cycle of the batteries performed. Unlike some Asian countries and companies, Finland is competitive in the quality of the battery and environmentally friendly processing with high regulations and all environmental emissions complied at the EU level. Some Key actors in Finland and Europe Battery Sectors are presented below,

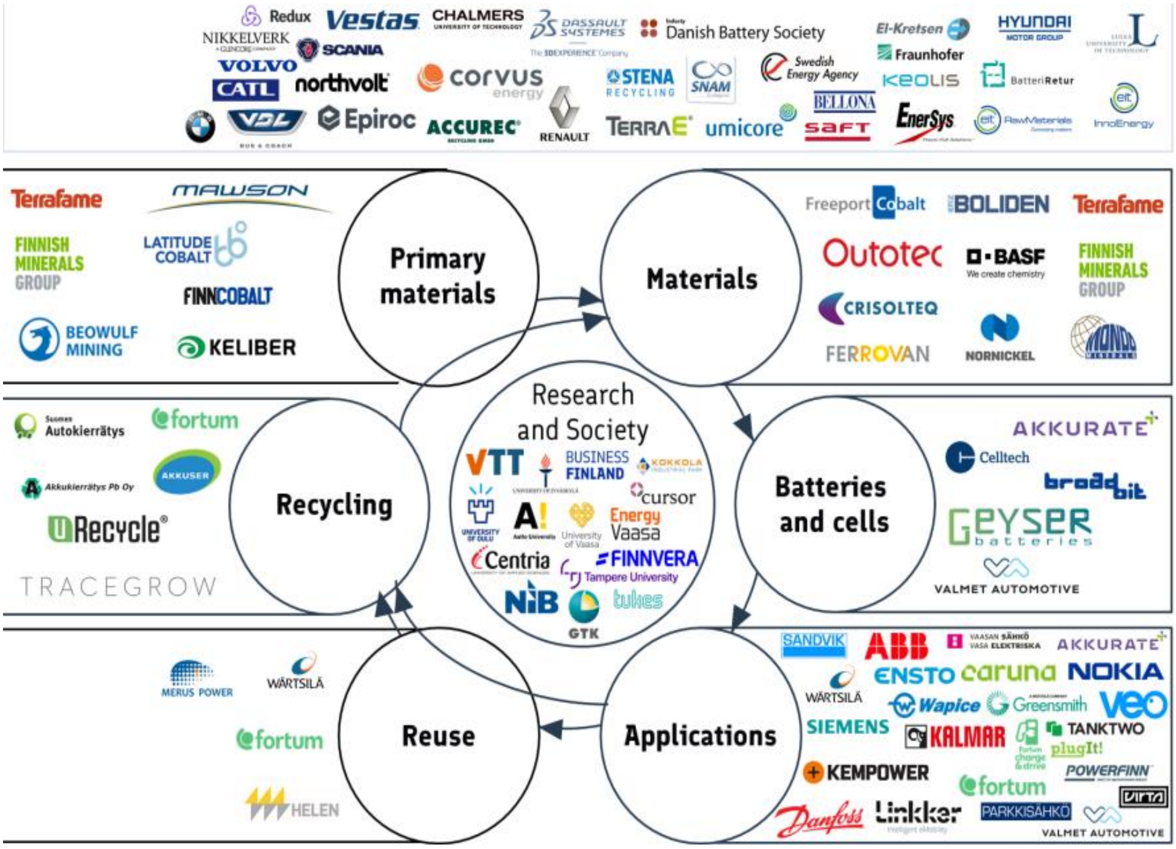


Figure 22. key actors in the Finnish and European battery industry (Finnish National battery strategy, 2020)

4.1 EVB value chain development from Finland

This research instantiated the project analysis, experts' view, and combined case studies for EVB circular value chain development. Finland's innovation ecosystem is initiated with sustainable goals and to generate sustainable value with the planet and society considered as important stakeholders through a systemic and transdisciplinary perspective (Pieroni et al., 2020), with the issues encompassing: 1) ecosystem approach to innovation, multi-stakeholder concerns of the sustainability aspects, and proactive way to SBM development 2) CBMs portfolio formed an ecosystem for long-term sustainability and sustainable value generation perspective, and 3) CE strategies operationalization to slow, close, and narrow the materials loops.

4.1.0 Circularity Activities in the EVB Value chain

For an organization to follow up CE principles, design from the pack, module, cell, and chemistry materials are essential to the 'circularity' of EVB, thus partnering with EV OEM from the design phase and could be operationalized with cell producers and the appropriate cathode materials producers, who are actual end customers, therefore, to decide the specification must l produce. Thus, collaborating with recyclers, cell producers, and EV OEMs could have a substantial reduction of GHG, with maximizing the material enabled them to cycle instead of forwarding their vehicles goes around the globe. Though interviewed firms differ, the Battery head from Business Finland respond *'Then one aspect for circularity is we can reduce the amount of a produced waste where it is used again, as raw materials, and another aspect regarding the emissions and waste streams, side products need to make sure it goes to everything in the circular economy and everyone is doing on their small circles, and we have a big circle in the middle but then from every small circle line we have an arrow out.'*

4.1.1 The Material Sources Evaluation(R6, R7, R8, R9)

CE stress using secondary and renewable material sources, in the circular value chain, two ways to source materials sourced from available consumed products or upcycling (Di et al., 2013; Schweitzer et al., 2017). Products are produced with the converted secondary materials in the value chain through circularities of (R6), (R7), (R8), and R (9), from remanufacturing, repurposing, recycling, finally, material recovery, Reuse- Remanufacture**,** uses designed part into different designs with quality materials, which are obtained, and energy is recovered during material recovery-incineration. Through circularities, R-(x)s, materials (waste) work as additional (Food) to generate value, extend life or maximize the value in it, and generate value for resale. The circularity is value creation and delivery without extracting more natural resources from the mines, establishing a new concept of materials sources.

As CE aims to use the natural resource as little as possible, more recycled materials from upcycling (A.k.a. Urban mining), the secondary or renewable sources are used to accelerate and implement circular supply chain practices, in addition, as some scholars suggested to facilitate circularity with some technologies and infrastructure design in the value chain (Pavel, 2018). At this stage, CE practices are implemented through innovative design with a continuous process; the circularities 'Refuse, rethink, and reduce' (R0, R1, and R2) are necessary for the available value creation system to slow, intensify, narrow the loops, and dematerialize, with complex designs to distribute, function, and practice reverse logistics, grow circularity, and gain sustainability (adapted from Pavel, 2018; Biloslavo et al., 2018; Bocken et al., 2014) for proactively managing stakeholders with a long-term view is needed for the natural sources and the secondary sources to the co-delivery system.

In the researched emerging EVB circular ecosystem, the core objective is 'innovation sustainability' through cross-sector collaboration while constantly demanding a certain amount of additional raw materials of the fresh one. To complement the recycled materials, and sustainable supply or 'renewable' sources are specially required by the experts (Appolloni et al., 2014), where products & services are sourced have a lower environmental footprint with the same main functions, to narrow the loops (Bocken et al., 2016) of raw material input, to integrate the closed-loop supply chain model (SCOR) with the increased efficiency and the resources input reduced, to ease up the supply chain process (Pavel, 2018). Expert suggests, fresh raw materials continued to be used to enhance secondary material, whereas procure from sustainable or green sources with goods &services for the same primary function because the natural resources are expensive and limited due to sustainability matters 'social, economic, and environmental, and the secondary raw material is additional 'food', to ensure circularity, leverage the imported resource and certainly ease up the raw material supply chain management risk and the final cost of input. To optimize recycled and renewable sources, it could be beneficial to develop a socially harmonious community from production to consumption user end to help maintain economically growth and prevent natural resources consumption through sharing economy (Kjaer et al., 2018) which needs to consider,

1. design intelligent goods or services to generate more value for sustainability benefits, procure the same primary function goods or services taking account of sustainable or green sources to lower environmental footprint, and narrow the resource loop,

2. integrate the closed-loop supply chain, Industrial symbiosis, to use the value to a maximum of 'waste is food,
3. Life cycle assessment (LCA), facilitate production factor and make sure they are utilized, accelerate through diversity and cross-sector,
4. collaboration and industry-standard are guaranteed for development. (Adapted from Pavel, 2018; Bocken et al., 2014).

Different stakeholders and players were identified as having different roles to participate in this project in different ways. As described before, these actors were categorized based on the 'five sustainable and circular business models' by Finland Innovation Fund *Sitra* (2020). According to the result analysis, some firms solve the need for 'Product as a service' of EVB sector services and solutions, i.e., Battery as a service, electricity as a service, and network charging and collection infrastructures partners. Furthermore, for the EVB circular ecosystem context, the 'SOH' and 'SOC' data are considered essential content for the information exchange platform,' players analyzing those i.e., EV car users, the fleet manager, and charging infrastructure. There are also firms already start to establish services in the EVB sector, EVB service providers, end users, service providers businesses, an infrastructure platform issues recognized that multifarious to build the services from the platform to make I.e., 'SOH' Blockchain, AI and analysis business and automation, 3D printing, etc., Among all the players in the ecosystem are identified and can be observed as roles of a good mix of early-stage high-tech start-ups, software companies, and large organizations. As concentrates on collaboration that uptake CE principles and multiple larger organizations are key stakeholders in the alliance too from different industries encompassing the EU and other countries. The core value offer that the business ecosystem highlights are related to the available growing 'SOH' data collection through the platform-connected services. Principally, the EVB 'SOH' data assessment is considered a lifecycle management approach, but in the future, technology solutions and services will become mature to offer applications with the data offered. Therefore, this business ecosystem enables cross-sector industries' collaboration with the bridge between lifecycle management-focused 'platform information exchange' CBM and contemporary EVB sectors. Through the CBMs discussions with the key stakeholders, various mechanisms of CBMs innovation on what and how they contribute to sustainable development drivers, firms by incorporating CE principles brings value to the ecosystem.

4.1.2 Materials Sources to design innovation (R0, R1, R2)

To address green, ethical procurement related to the battery raw material is particularly important for circular model from the beginning, and it is emphasized by several interviewees from the organization these experts highlight the importance of the low GHG emission of proximity cluster production, with cross-sector collaboration from mining to recycling to get quality battery-grade materials with lower footprints with using a relatively clean renewable energy mix, from ethical sourcing and shorter distance with distribution and delivery to the partners close by. As a result, the recycled materials could potentially decrease the pressure of mining primary raw materials, thus with a higher handprint and good reputation, which can be utilized with marketing 'green' therefore, the overall cost could be optimized, and the revenue model could be enhanced. The secondary material from recycling and Smart manufacturing with the primary raw materials produced by the responsible mining and refining industries from Finland. Finnish Batteries and raw materials are good enough not to follow the sources in question. Driven by recent major investments in industrial production and green innovation. Finland is already at the forefront of the battery industry.

To meet economic, social, and environmental benefits, organizations and societies need to pursue both the same objectives and extend sustainable procurement, and firms benefit from green procurement from organizational brand value generation, Customer satisfaction (Pavel, 2018) enhancement, law, and policy risk reduction, shareholder value maximization with cost reduction. Green public procurement (GPP) is the recent and broader notion of the sustainable procurement which is defined by the EU Commission (2008). The significant goals of Europe will reach a critical point in carbon reduction, and many innovations in Finland help to achieve these goals. Battery power will become ubiquitous because it can meet broader, more ambitious environmental goals, which put more emphasis on how to develop a battery value chain without consuming the earth's resources. There is a lot of happenings in the green battery ecosystem, and can be divided into three parts:

1. Mining and recycling.
2. Battery grade materials Refining including secondary raw materials.
3. Battery and Cell Production**.**

Aiming to accelerate the supply of clean batteries and meet the expected increasing demand for localized and decarbonized battery solutions. City Vassa from Finland has a lease agreement with FREYR battery and entered a strategic partnership with 130 hectares (1,3000,000m2) of land, and build a cell factory to be established in the year 2025 in the Giga Vassa area. With the city developing industry-scale battery technology, starting production in Finland, and exploring the opportunities for joint site development is significant for stages with the progress of the project. The site is the first Gigawatt hour-scale battery cell facility in Finland, which is an ideal Giga factory to produce battery cells in the future and the new plant will be an important part of the Vassa, green battery industry ecosystem called Giga Vassa. In this city, there are local demand for environmentally friendly batteries is huge in this region, for instance, ABB, Hitachi, ABP power Grid, Wärtsilä, Danforss, and Yskawa are using batteries as energy storage facilities in their applications.

Lithium-ion-based battery technologies remain the focus in the foreseeable future although battery technology in general varies. Large capital investments are required for battery production throughout the value chain. Battery cost is a key competitive advantage, when it is brought down**,** demand will be better met via economies and manufacturing of scale (Business Finland, 2019) The critical elements such as new market trends, companies' strategies, and tactics, are decided by the global battery value chain's interconnected nature. Large capital investments are needed for the battery production, which requires associating such investment with strategy for LIB based technologies throughout the value chain to achieve sustainability benefits of 'economic, social & environment'. In line with the approach, a holistic platform for the supplier, procurement, and public institutions with convenient and guaranteed green materials sources are necessary that aim to help narrow the loop and purchase virgin materials at large to justify the triple bottom (Slaper & Hall, 2011), B1 *'I do not know Asia, and I think the situations are similar. It is not possible across the value chains. However, the battery passport needs cross the whole value chain as data is important. Now, the data is not shared, I have many times said that it's like island-based data. We have data in them, we have data in the battery manufacturing, and we have data in the battery application, but we do not have a single standard for the data and my statement has been that maybe it's possible on the EU level'* To generate and underpin the Sustainability theme in the market**.** for sustainability, EU-regulated standard data sets should and can be established, which will be open data, and then when it was standardized as open data and then the value chain can be discussed across the borders to make it circular.

4.1.2.1 EVB application in Harsh Environment

Battery applications are widely used and range from a variety of products and services from health care to the electric vehicle sector driven by the electronic vehicle and energy storage applications which are growing fast, in Finland many industries have been involved, and the competitive EVB application especially reflected from the aspects of harsh environment application and focusing on the EU first, for this Business Finland, B1 ***'****Finland is a small country that heavily relies on export but can bring Significant value added for European development in various aspects. Firstly, Finland has* *battery minerals available not for the world's needs but for European needs. Finland has a considerable amount of minerals and the capability to provide and for investments for Sales, Manufacturing. For the application sector, Finland has substantial application area, industry, and products for instance mining equipment by Sandvik and Normet, which are electrifying.'*

4.1.2.2 Smart production Traceability, BMS, Safety Ecosystem

Transitioning to a circular battery value chain is expected to gain the related benefits of sustainability, Blockchain enables the various **s**takeholders to transition to CE from their business model decision-making of the value chain, such as the ecological gains and the critical raw material supplies are secured. Data is essential to retrieve sensible information for decision-making with respected value chain stakeholders. Further, valuable data sources for value chain stakeholders are available which can support them to pursue sustainable product management (SPM) efforts (cf. Honic et al., 2019), particularly, with a new regulation which is proposed by EC (European Commission) on batteries and batteries waste management, explicitly requires, by January 2026, that all the battery applications: industrial batteries and EVB, need to implement digital battery passport (DBP)which are vastly applied in the logistics and charging stations, below figure 23. presents the recycling value chains critical for the safety perspective.

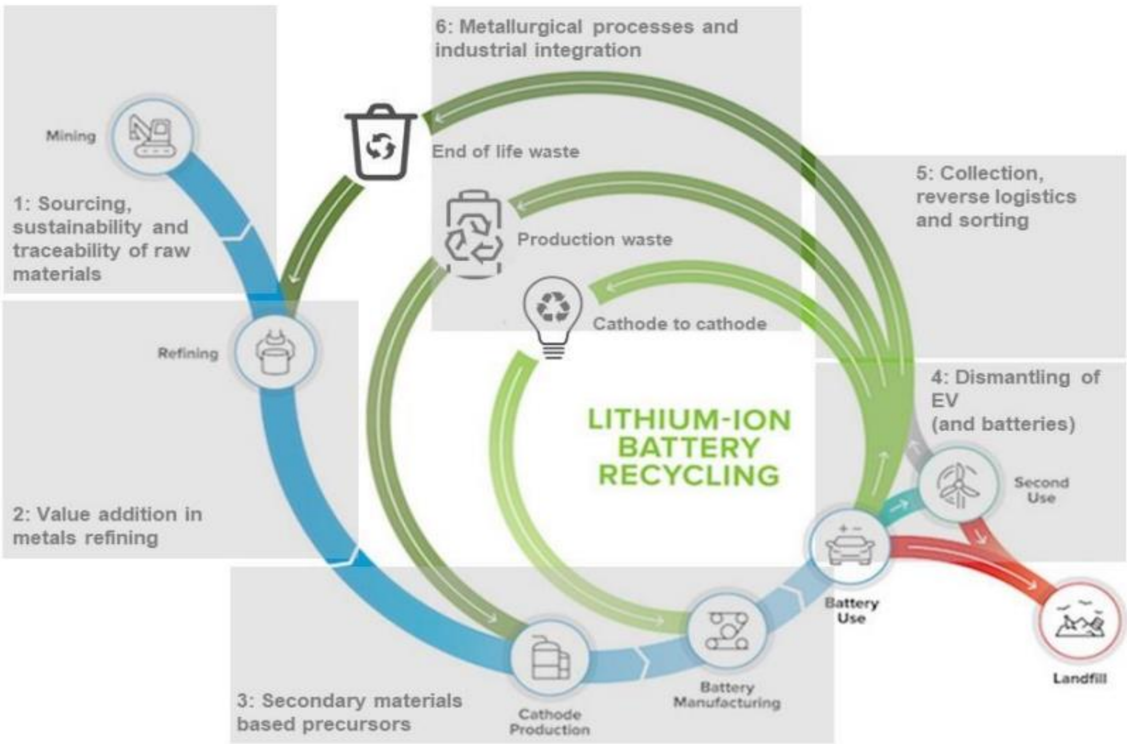


Figure 23. LIB-based battery value chain-critical for recycling and safety (Kauranen et al., 2021)

Finland is well known for its fame in ICT (Internet communication technology) solutions globally. Incorporating digital technology is especially beneficial to the safety management of Li-ion batteries, logistics cross-border could be improved with a digital solution. Asian battery's lifecycle profile li-ion battery, however, is difficult to assess. There is a need for a 'green' movement from the legislation to standard. Certified collection systems are needed like the conventional lead collection chain, transversely for EVB collection. The expert O1 commented *'The reason why the blockchain is used in logistics and the planned usage in this kind of materials and the energy system, I think it as kind of enabling technology for this* from a safety point *of view.'*

4.1.2.3 Sustainable material supply and large-scale recycling

In Finland, it is lithium, cobalt, and nickel three major battery minerals that are currently mined or in the process of being mined. Producer Responsibility System in Finland is complex, the material planning needs to be improved for nickel and cobalt which will increase production in volume in the future, as the international demand is increased. Presently, nickel and cobalt refineries are also produced for example, sulphates which are utilized in the battery industry. Finland is also the only country in the European Union that produces primary cobalt, and there are three Finnish mines where cobalt is produced, 113,000 tons of cobalt reserves are contained, and 370,000 tons of cobalt resources, which are estimated by the Geological Survey of Finland (GTK) (Strade, 2018).

To diminish the GHG emission of the batteries and improve the LCA, Battery expert O1 respond: there are many companies i.e., Clibre, Umicore, and BASF have factories in Finland. They can be divided into three parts, and they are Lithium production, Lithium mining, and lithium processing into battery materials, for example, Clibre is in western Finland, 200 kilometres from the South of Oulu, which has a unique way of the sustainable materials that it has both the lithium mine and the Lithium process, because typically globally almost everywhere they are separated. Mining is a thing and processing is another thing. But in Here, this calibration next extreme case; the third part is battery manufacturing where the black mass is and making a battery which put together different components so that these manufactured batteries then they are sold to the vehicles.

For 'circularity' is extremely important for these companies, and there are three parts that need to be paid attention to. Everything they do in mining needs to be circular from scratch because these kinds of side streams are running out. When digging the Lithium, different materials come, so the side stream circularity is one thing. Then, the mining part of Lithium production, typically when the second part is *th*at two different levels of materials be made, high-grade and low-grade materials, for making batteries, these low-grade materials need to be refined to the higher level, and some companies are refining the low grade.

In Finland, Calibre is planning to produce high-quality battery material so that they can directly sell the material to the battery producers. Regarding the circularity in the mining industry, it means all the production side streams are managed and commercialized; the second part has two parts, this processing the lithium into items low grade, and only high-grade materials can be directly used for battery production. The third part, in this processing part, is when making high-grade materials, the circularity means these old used batteries could be recycled into making the battery materials. The problem is the recycled materials, for the old batteries where need a lot of cars, and there are more EVs and more users in Central Europe countries, where these locations can get the battery raw materials.

EVB Circular value chain analysis relies on both internal and external analysis, across all stages from materials sourcing, smarter manufacturing, EVB application, and reverse logistics every activity should be connected to support to solve the agency problem with technology adapted, dematerialization (Allen, J., 2007), ensure competitive advantage, and cost and differentiate strategies must be utilized in CE activities with technology improvement, for example, to outsource the operations or establish long-term partners all are ways to deploy technology in the organization for cost-effectiveness with high-tech organizations, which need skill and human resources to manage the new technology.

In addition, Business Finland B1 states '*Green growth as a promise to society successfully transformed into a carbon-neutral society in technology and business development in the last decade has been tightly tied to the ICT, and Internet of Everything, this has applied to the modern supply chain to guarantee this has been in ritual, and accordingly, both renewable energy and transportation sectors have greatly improved their product and service toward this transformatio*n. *In terms of sustainability, the Nordics, Finland, Norway, and Sweden, are on top of the world index on sustainability, taking from this, we do have a responsibility also to bring the mindset and drive environmental-friendly innovation forward toward a circular economy, and sustainable value chain*.'

4.1.3 Design thinking and Applications

(R0, R1, R2) +(R3, R4, R5) Manufacturing, distribution, and marketing & services to reuse.

In this phase, design thinking is applied to meet the circularity goals and retain the secondary raw materials at end of the first life, and the value is generated through the design of the desired goods and services, and three parts are included: 1, smart goods production, outbound logistics, and end users' consumption. Ecosystem approach to (R0, R1, and R2) innovative thinking 'rethink, reduce, refuse' in production (efficient Energy use, productive materials, and production adjusting), outbound logistics, end-user awareness generation, bridging the knowledge gap and innovative products operation, Business Ecosystem approach to innovation (R0, R1, and R2) are for smart manufacturing, efficient energy, and material usage, outbound logistics, generating consumer awareness, bridging the knowledge gap of product and operation innovation. Here (R3, R3, and R5) are for circularity increasing for the consumption to extend products' life cycle and intensify the loops of the resource. At this phase, design thinking is for generating the economic value of a product, realizing the circularity goals, retaining, and reusing the secondary raw materials after the first use and managing processing costs by creating the desired product, considering industrial 4.0, through Re-use (Davis, 2016; Lombardi &Laybourn, 2012).

During the manufacturing phase, the price of the final product generated from the secondary raw materials could be reduced with energy and production efficiency, and this helps to maximize the value; the efficiency of technology and human resources are required for the secondary raw materials processing in the circular value chain. In addition, some divisions play vital roles in the material collected in this circular supply chain of inbound, outbound, and reverse logistics: smart production, consumption, and outbound logistics, among which the inbound logistics are mostly ignored or renewable sources. Developing a community for value sharing & socially responsible consumption is also stressed in CE.

Finland's innovation ecosystem covers large-scale recycling, raw materials supply, harsh environment, safety, BMS (battery management system), and traceability tracking materials from mining to recycling with a Battery ID across the value chain. when the industry pursues a business model, it is not impossible government indirectly interfere in case of market failure, and a certain form of goods might be required, for example, a digital passport for EVB, or like another case, for example, prescribing medicine when public health is affected directly with the consumption only. The leasing or service models are likely to be helpful to retain ownership and responsibility when they are encouraged to do so.

4.1.4 Consumption to use to Reverse Logistics for Evaluation

At the level of consumption or utilization, before Reverse logistics, collection through evaluation or sorting of the wastage is needed and prepared for input as secondary raw materials recovery, before acting, decisions need to be made through evaluation on whether technological or biological processes. Many countries implemented Reverse logistics part is discussed, considering Reverse logistics (REVLOG, 1998) defined by the European Working group as a process that plans, implements, and controls, recaptures value or properly dispose of, and the related information from the point of origin (Dekker et al., 2005), and the objective is to properly handle the waste, close the loops, and prevent landfill from the adulterating environment after consumption and usage is maximized with EVB lifecycle with sharing, reusing, repairing, refurbishing or intensifying, and retaining the value to recover and send the raw materials prevent the landfill or directly to the manufacturer for new batteries, through the evaluation or sorting, decision and take action on the technological, biological cycle, and collect the wastage through reverse logistics.

According to respondents V1, F1, and S1, and others, Finland is rich in key materials-cobalt, nickel, and Europe's largest Lithium mine. Compared with other countries, there are also world-leading Material processing and recycling expertise clusters such as Norway and Sweden, and others, the main consideration of the Nordic value chain is to increase the use of EV cars and/or the battery amount produced in the EU. Finland has tight ties with these Nordic countries and is active in all areas of the recycling sector, starting from the optimal organization process of recycling, through the innovative dismantling, to the advanced machinery processing the secondary raw material. Finland has advanced digitalization expertise, which provides a functioning ecosystem with networks and digital infrastructures and has established numerous investments and projects with other countries and foreign companies. (German-Finnish Chamber of Commerce, 2020)

4.1.5 Supporting activities for Circularity: Ethical procurement and Sustainable Supply

Finland has many strengths, especially good at comprehensive solutions relevant to the harsh environment and demand (Business Finland, 2019). Regards 'ethical procurement' to make a more conscious choice and this made product development and marketing more concrete 'green' roads. Different roles of customers more than before, aware of the issues. A challenge for a lithium-ion battery to be efficiently recycled is the lack of adequate batteries. For efficiently recycling lithium-ion batteries, battery second life applications to the users. Clear battery labelling as above mentioned would make recycling highly efficient and this is because different types of battery require for this topic is not only about future generations altogether, but also about lifecycle. Below are the business models canvas from Company E *to* illustrate the nature of business and activities that sustainably facilitate reverse logistics (Pavel, 2018).

CE advocate always when purchasing, always select secondary or renewable materials that could be intra-industry through sustainable or green or green public procurement. To understand recycling outsourced BM, table1 presents company E's BM canvas which conducts Sustainable procurement that can be understood to secure objectives with sustainable development principles adhered to, i.e., to ensure a robust, healthy, and just society, endure within environmental limits, and advocate suitable governance.'

Business type	Innnovative Spent Battery Recycling companies
Customer Segment	Finnish producer organisation, Industrial organisation &General Battery recycling companies from European countries Sweden, Denmark, Germany, Austria and Poland; metal refineries, customers utilize the refined methods in the new EV batteries
Value proposition	European Finland recycling platform; Earning a reward for waste, Large scale spent battery recycling
Channels	importe, and Website: https://www.akkuser.fi/en/service/
Customer Relationships	Producer extended responsibility, social awareness, long term partnership with industrial organisations, https://www.akkuser.fi/en/contact-us/
Revenue Streams	Supported by raw materials metal refining companies, selling recycled to battery manufacturers
Key Activities	taking in wastes and transforming those in the new raw materials: import around 90% high cobalt, Lithium-ion batteries from other countries, treat, recycle mechanically more than 90% of the volume, alkaline, lithium-ion, nickel and metal hydride batteries in mobile phones and laptops, and test processing for EV batteries units; cobalt material recovery for a new batteries, in future nickel, cobalt and manganese etc.
Key resources	part of battery value chain; process for efficiently recycling the sustainable raw material source
Key Partners	Metal refineries as partners for battery cathode active material or other battery chemical produced
Cost structure	Strategic organisational cooperation covers the operating costs.

Table 1. BM canvas which conducts Sustainable procurement

4.2 Business Models Ecosystem to Innovation

A triangulated data analysis was performed with case companies' sustainable reports of the visions or goals from their website and interviews combined with expert views. All five companies are for-profit organizations, which sell either products or services to cover the cost and profit generation. The case companies are for-profit organizations by selling EVB-related products or services. Valmet is a tier-one EV system assembler *and* one of the largest vehicles sub-contract manufacturers in the world*,* StoraEnso is a high-quality anode materials supplier, and Wärtsilä is a clean energy system provider, Fortum provides the material recovery solution from recycled EV batteries with the lifecycle extension facilitated, and Akkuser serves EU countries with waste battery recycling. When asked about the environmental impact, Finland's ecosystem has a positive impact on carbon emissions with collective effort. The relevant aspect of SCBM relates to multiple stakeholders and the value generation and delivery are presented as the CBM portfolios below are like each other in that more job opportunities are created and engage with the sustainable supply of EVB materials for the EU.

4.2.1 multi-stakeholders formed Strategic Alliances

During the research project for the thesis, the minor incremental changes of all the participants observed change and it is identified that all the enterprises adopting CBMs consider re-think their business model regularly to incorporate CE principles. Furthermore, alliances formed such as StoraEnso and NorthVolt (2022); Fortum and Valmet (2021); Wärtsilä and Hyundai (2018); Umicore; Sandvik; Fortum, BASF, Nornickel, Terrafame, etc., Industries player*s* form a strategic alliance (2020). Earlier in 2017, Wärtsila partnered with Hyundai Motor Group to utilize second-life electric vehicle (EV) batteries in the growing energy storage market. Wärtsila is one of the Top three players in the energy storage space and competes against Tesla and Fluence, and a big buyer and seller of LIB-based batteries, and more...

Fortum and Valmet formed strategic alliances to build green and responsible, close-loop battery production and recycling by innovating their business models, with more companies using more recycled materials, and Fortum taking scrapes of the side products or scrapes from Valmet. Fortum is a big company, the largest company in Finland, involved in many area businesses, even outside of Finland. With the general vision and slogan ‘towards a great cleaner world,’ Fortum is trying in every way in all its operations to make the world a better place by producing cleaner energy, trading wastes, and optimizing energy efficiencies and lowering CO2 footprint, whether it is EVB charging or a running power plant.

StoraEnso and Northolt joined together to develop and create batteries using sustainable material lignin-based from the renewable source ‘Nordic Forest,’ aiming for sustainable sourcing with cost lowed. *StoraEnso, anode* material is made of lignin, bio-based materials, which is a binder and a component of a tree that keeps everything together in that phase. StoraEnso believes tomorrow's renewable everything will replace today's fossil-based materials*,* S1 *'StoraEnso and other firms are working with the battery minerals, cathode side Lithium, Nickel, Manganese, and anode side is usually carbon-based, typically graphite in the anode side, and are mostly working with cluster. StoraEnso has many different product areas and many different business models and different markets. Regards the business model of StoraEnso, there is not only one. StoraEnso uses virgin materials taken from the forest, when making the pulp, we are circulating chemicals, used by products typically to make bio-based energy. In this sense, we are in the circular economy'.*

NorthVolt is a European battery cells and systems provider. Northolt is founded in 2016. Providing the world's greenest lithium-ion battery with an ideal CO2 footprint and a diversity of nationalities of people, Northvolt has 3,000 people from one hundred different nationalities, and the mission is to decarbonize the future of Europe. Northvolt reserves the contracts from BMW, Fluence, Scania, Volkswagen, Volvo Cars, and Polestar, to support its plans to meet the requirements by establishing the recycling capability that 50 percent of its raw materials can be recycled and reused in the batteries by 2030.

4.2.2 Circular business models Portfolio

For a sustainable business model is pivotal for transforming the organization from linear to circular paradigm, collaborative approaches call for firms to reengineer and adapt to innovative values and propositions (Charter, 2016). Furthermore, the intra-disciplinary approach, an ecosystem to innovation and multi-stakeholders view has been taken for CBM transformation that business models change as the dynamic capability to foster businesses interaction, co-evolving with the ecosystem partners for more business, B2C to resume CE principles that emphasize the cross-sector collaboration and ecosystem actors across their organization boundaries for value co-create co-capture. Incumbent firms from the Finland EVB sector form strategic alliances and take up the portfolios of CBMs as shown below table2.

This research also identified some required enablers for these solutions to achieve the full circular impact. Together with the solutions, they help drive higher levels of circularity with the project BATCircle2.0 which pilot to testifying the technical and economic feasibility of such application for repurposing the battery as well as recycling initiatives. Several players are currently research potential closed-loop recycling business models, but currently only Fortum officially set up closed-loop recycling systems for a few valuable metals such as cobalt and Nickel and other companies have put their sustainability strategy forward to steer their CE strategy as well. To ensure a fully circular economy model that all the materials are tracked across the value chain at the same time to ensure a climate neutral impact, are as motivations for the repurposing project, and that has been mentioned by the communication manager from these firms, and as the most important driving factor for their closed-loop recycling initiative in Europe, thus these sustainability goals and ambitions can not be achieved without incorporating CE principles.

Summary of the case studies					
CE Solutions\Business models	Circular Supply	Resource Recovery	Product Life extension	Sharing Platform	Product as a service
Remanufacturing	Valmet: BMS: autonomous car network, but own BMS, life cycle assessment and trace materials	Valmet: EV contract producer, governing and software developers for mobile apps,	remanufacturing parts, aftermarket repair and guanrantee	OEM platform, open platform and sharing	
Recycling	Fortum: mechanical recycling process, hydrometallurgical recycling rate above 95%	Car charging network and platform	High quality raw materials recovery, and supply, second life	Car charging network and platform	Raw materials as a service
Reuse	Wärtsilä: industrial-scale energy storage and intelligent energy systems and Applications in Maritime	Recovery system provider	Refurbish and reuse in marine sector, battery second life application	Own platform, closed platform with other closed partners	Existing network, component or key part as a service
Material design	StoraEnso: Raw materials extraction and production; renewable materials from sustainable sources				Raw materials as a service
Reverse logistics and collection	Akkuser: service provider for 3PLs and recyclers with existing Lead battery collection network	Dismantling, storage and transport	Transforming in the new materials	Metal refineries Industry	

Table 2. The sustainable value creation and delivery of the Multistakeholder CBMs portfolios.

4.2.3 Sustainable value creation

According to the Raw Materials and Recycling Roadmap (Kauranen, et al., 2021), to optimize all sustainability aspects' economic, environmental, and social results, BATCircle2.0 (Batteries Europe ETIP WG2) also highlight the CBMs- sustainable innovation entails a holistic view of CEBM implementation at the organizational level from product design, manufacturing, and use at the end of first life management. Accordingly, the relevant aspects of a sustainable and circular BM relate to multi-stakeholders adopted the CBMs portfolios to enhance 'circularity' and the sustainable value generation and delivery are presented in table 3.

Sustainable Value Capture by Stakeholders					
	Valmet	StoraEnso	Wärtsilä	Fortum	Akkuser
Share holders/investors	Innovative high growth and sustainable business	Supply risk deduction for the long term sustainability	satisfaction of business with sustainaiblty purpose	Satisfactoin of business with sustainablity purpose	Innitiation and Fulfillment
Employees	opportunity working for sustainability purposes	satisfaction of business with sustainaiblty purpose	satisfaction of business with sustainaiblty purpose	Motivation towars challenging recovery tasks of the increasing	Innitiatives for future increasing challening taks of recycled products content
Clients	Long term products for sustainability with services of CE related	quality and partnershipwith technology clients to develop low GHG green EVB	Sustainabilty Purose driven products	Low GHG emission, quality and price for the material and recycling services	relation to local collection system,
suppliers	Equipment suppliers to address the tehnical challengs of high reycled EVB raw materials content	Anode materials suppplier to address the renewable and green	Close relatiohsip with suppliers of materials such as E-mobility or Smart home community	business purpose connection; network of the sustainability purpose	Chance to sell waste stock recovred for remanufactruing process
society	jobs created in EU	Environment awareness.	service supplier to address the system sustainability	transition to a circular economy	organisation engamenment to collect recycled materials
Environment	Landfill relief	renewable raw material sources	low GHG solution for renewable energy system	Landfill relief	GHG reduction during the entire process
Governement	Jobs created for local, supply risk relief, circular business representative	sustainaining the circular busness with renewable sources	Retaining local green procurement rather than abroad purchase.	Taxes	CE advocater

Table 3. CE approaches for enhancing circularity' and creating sustainable value.

For complimentary of 'circularity' in the sustainable value chain, active CE players adopt CBM to enhance the 'circularity, and a multi-stakeholders view needs to include organizations, big companies, and start-ups for the 'refuse, rethink, reduce' principles in the loop, the ecosystem approach is taken to innovation for taking up the CE principles, the new business model needs to be engineered, which depends on Enterprises' capabilities to experiment, innovate, and implement a circular business model for sustainability. In this research, an evolutionary view of 'CE pioneers' current practices in Finland and the EU are instantiated, where there is other themes ecosystem, and more collaborations are still going on.

4.3 SBM innovation towards Circularity

For sustainability circumstances met with CBMs to achieve circularity, higher strategies of CE of Finland EVB sector are presented in this session. Firms increasingly start to implement the CE concept in design strategies and business models as a principle to reduce resource use and impact on the ecological system to improve sustainable development to close, slow, and narrow the resource loops to inform flows of the material and energy with the loops dematerialized and intensified (Geissdoerfer et al., 2018; Oliveira et al., 2020).

4.3.1 Narrow the loop: Smarter product use and manufacture.

EVB a large cost and big essential component of EV is the key part of the vehicle, especially battery cells, if the OEM does not have its in-house production, and partnership with the manufacturer is to avoid 'off-the-shelf' specification from the vehicle batteries. This will attract new entrants into the EV battery Ecosystem and the challenge remains whether invest in the design for the OEMs specification or manufacture its own 'off-the-shelf' solution. Meanwhile, battery packs also pose a challenge in serving EV regards EoL, the disposable cost of reusing and recycling batteries before they enter the EV battery business, for the established manufacturers need also to consider the partnership includes domestic energy storage, remanufacturing. Direct recycling is prioritized for the raw materials to be recovered from the used EVB, especially for the reuse in new EVB (Yang et al., 2020). The Recycling company D addressed that near site assembly is necessary for the battery cell close to the battery pack production, as they are challenging to transport. However, most cell production is Asian manufactured, to improve on this, battery manufacturers need to negotiate with OEMs and well arrange the suppliers' reliance on this.

The Utility and manufacturing companies A and D have commonly agreed for both manufacturers and new entrants, it is crucial to forming a strong network of production to secure European EV expansion, manufacturers of EVB should consider moving the production site to their EV production and Company A. Environmental protection is the key to implementing a circular economy strategy for EVB business development, as the EV is only a 'green wash' if the renewable energy was not in any context connected with EV charging. However, for companies who want to secure a place in the current EVB ecosystem, having a strategic partner with the OEM is the key to making space to survive in the ecosystem of EVB, and this is because OEMS of EVs has the advantage of having built credentials with customers across the world over years already. *In addition,* the smart grid-related charging infrastructure still needs to make the strategic decision of where and how to build efficient and flexible utilities with smart sensors and meters to solve the billing issues, EVB as a tie connected with both EV and Smart grid with substantial electricity buyers of renewable energy is the topicality for nowadays research and interesting to be observed as the market is still evolving.

All this can be concluded, as an ICE vehicle for EVs, the energy provider for the EV, EVB is a key differentiator with a related service bundle for EV car user experience during and after the sales market, and whether during car daily using process. For capitalizing on aftersales credentials and customer charging experience, EVB products, and its service connection with charging infrastructure and utility provider is key for the enhancement of user experience and aftersales service for the EVB circular perspective. To uptake the EV car sales, and capitalize on the aftersales credential, the EVB business ecosystem provides a potential future to improve on this. Companies form strategic alliances for example, StoraEnso & Northvolt; Fortum & Valmet*,* F1*'Finland is in a great position in that way, there are many players, many companies in different genres, as Finland's a small country and people know each other. Regards to thenational strategy, people can sit down together and talk about how we should do this and how could we benefit each other and have good relationship with the companies who are in the value chain but not in the same parts so that beneficial feedback is coming from different companies to understanding the value chain better*.'

4.3.2 Close the loop: Recycling.

For Battery recycling, reverse logistics, and manual disassembly are considered high-cost drivers for CE activities. Especially for countries with high EV sales volume, Albertsen (2020) suggests that a regional pre-treatment solution could lower the overall cost of high-cobalt EVB significantly; outsourcing to the local recycling companies to benefit from the high occupancy rate if EV OEMs' sales volume is not high, and the decentralized disassembly of the module level, even to cell level pre-treatment to enable localization of recycling of basic material i.e., steel, aluminium in the conventional recycling facilities has been identified as a potential solution that is promising for high-EVB. Next to logistics, manual disassembly is another cost driver for recycling, which is why decisions need to weigh up between those two aspects. However, the EVB technology is still evolving, and the different pack, and cell designs, as well as chemistry from different EV OEMs, hinder the effectiveness and the efficiency of the collection system. Companies A and D formed alliances for the synergy of the manufacturing scrapes and the secondary materials recovery and utilization.

For the close loop recycling, expert AA2 from the consortium BATCircle2.0 comment *‘Normally the battery is reused first but not until the end of the life of the battery then it is recycled. However, it is like even though in BATCircle, the focus is more on recycling the raw material. It should not be done before the end life of the battery. So, the reuse comes first and when they are not reusable anymore just then recycled the material, now, of course, it's always like do use it at the end of it, but there must be also careful calculations and lifecycle assessment at what point would it be feasible to use the batteries again and how long if the few cells get so low that not efficient to use anymore, then they should be recycled as materials. but first comes reuse, and that they would be like stationary storage after automotive usage.’*

Company E's main cause is why both supply chains (reverse and forward)as market demand for the battery raw materials is high, recycling could provide an important part of the materials and mining is necessary to meet the gap, however when applying the CE strategies which need to be carefully considered, as the current market situation, the data set is like an island, and as an expert and Company E director commented on the data sharing is important in the process of recycling, if the ‘what, when,’ the battery is known, it is much easier for downstream recycling companies to arrange the schedule and capacity for it, through the shared platform for the outcoming materials, this also benefits the process further, thus the platform information exchange is important to make the whole recycling process efficient, and according to an expert from Business Finland, at least at the EU level, that data should be shared .

4.3.3. Slow the loop: Reuse.

The energy storage system provider and energy company designed, and deliver energy storage enclosures, and put all the battery modules to have great capabilities on the delivery side. Firstly, the energy storage business is national in Finland, for the repurposing the lithium-ion batteries on the EV side, W1 responded *‘Wätsilä and Hyundai in 2018, did a test to see if the batteries that are used on the EV side could also be used on the energy storage side, taking some of the older EV batteries and utilizing them for energy storage applications, as a result, it is quite difficult from a business model point of view, especially to make some business out of it, it is time and labour consumption at least, could not see an economic benefit out of it, lot of work needs to do to recalibrate the batteries, if want to get some money out of it then you would need to get all of the raw materials for free’.*

As energy storage business has evolved, the company sees that the batteries used on the EV side, are not the same type of batteries that are used on the energy storage. They have a different use case of the battery on the EVB side compared to what is on the energy side. It is difficult to cross-utilize batteries from E-mobility to energy storage based on just how chemistries are optimized on the case side. Many of the big battery suppliers need to consider how they are organized, usually, they are organized according to EV and then energy storage because of the functionality of the battery. In terms of the CE taking off for the energy storage side, W1 *'It takes 5-10 years from now and if we think about asset deployment now, especially in the energy storage side, it is still not big volume, and it will become more relevant in the next few years, there are some good potentials also to take materials, recycle the raw materials and then utilize them again. Some OEMs are already on the pilot, because certain NMC, chemistries already are reutilized and will be reutilized for 70% of the raw materials. It would make sense that they sort of buy or get back the batteries and can reutilize them again in their production. The end customers in the future will have the opportunity to settle the battery to either an OEM or some other company that is then doing business within the circular economy so that we can reutilize or repurpose the battery as much as possible.'*

Regarding battery reuse, other challenges are the ownership of the battery that who owns the battery after the life of the car, for the producer, there are many uncertainties, and the usage data is deciding factor whether reuse or recycle. The second life is identified as EVB related business ecosystem. The challenges: range anxiety, charging infrastructure, and environmental pollution because of the sources of charging still hinder this sustainable development with the unsustainable sources and Battery EOL disposal.

The second life could turn-still EVB ecosystems with *the* diagnosis of the lifecycle of EVB that underlies the continuum of challenges as key opportunities. The expert AA1 responds, *'Regards with batteries and the second life, it is going to be difficult to fulfill the demand, so every battery manufacturer will be competitive. Every country needs these batteries for its own. Also, for the EU, there are strict regulations, maybe it is easier to follow if the battery comes from a closer source, and if they meet the regulations, they are needed, however, there should be restrictions and guidelines on how to use and reuse, collect that data and store that data about digitalization guidelines in the European Union'.*

5. Discussion

This chapter reveals the main findings of this research and their contribution to earlier research, the best practices for CE implements are demonstrated, and future research recommendations are presented to answer the main research questions and enhance the circular value chain with 'circularity, multi-stakeholders, organizations, big companies, of how the incumbent BM is innovated in the ecosystem context and adhere to CE principles. These discussions are in line with the measures accommodated in the European Commission's Strategic Action Plan on EVB 'to make Europe a global leader in sustainable battery production in the context of the CE (COM (2018) 293 final, 2018). Hence, a more pragmatic approach is considered in this research to prioritize CE for more material efficiency and reduction of other forms of resources usages, for circularity to integrate more sustainability aspects i.e., social dimension to the notion of CE (Murray et al. 2015; Geissdoerfer et al., 2019). Accordingly, Sustainable, and circular BM design integrate continuous innovation in the ecosystem context for CE/sustainability, as dynamic capability in the process was reviewed in section 2.4 based on related research, the CBMI process was investigated through section 2.5, together with BMs as dynamic capabilities framework, to get a better understanding of different dimensions of the needed organizational change under the circumstance of ecosystems and continuous process for CE transition with findings of these types of companies. The empirical results in BMI demonstrate several success factors (BM design, Evaluations of materials, and the synergy of BMI for sustainability and circularity) to help innovate a sustainable and circular BM.

This research presents the preliminary consideration of new BM design with a view of multi-stakeholder, ecosystem considered, and holistic way of how to innovate in the value chain development from Finland EVB sector, the author argues contemporary BMs need to stress collective efforts of value creation in complex societal cases rather than focusing only on focal firm value creation, taking the case of CE development with the circular ecosystem considered to address the new trend of market, technology, and legislation. A synthesized conceptual framework has been proposed to transit to paradigm: circular BM adoption and with CE principles for example case companies' portfolio adoption, a business ecosystem, and sustainable material sourcing in EVB development cluster from Finland, a brief categorization of BMI with CE principles that CBMs change and transformation in the empirical study is beneficial for a holistic view of CE BM research, that organization interacting and co-evolve with Ecosystem, the BM design process as dynamic capability enhances the 'circularity' /circular value chain for the long-term view of CE development for 'sustainability'.

Managerial implication

The study holds the managerial implication for management from the battery and the raw materials supply and recycling, from battery application to manufacturing in the EU EVB value chain towards understanding and identifying opportunities for sustainable development. This research presents a framework that can be used for discussion and joint alignment of BMs among circularity and sustainability. Indeed, depending on the specific operational process and the extent of the firm's competence, various types of relationships may be required. The framework further emphasizes the importance of circularity for adopting the circular BMs with CE principles adhered to for sustainable development or reconfiguring BMI to create a better fit.

Second, several success factors for BMI with CE principles for sustainable development need to consider and manage BMI for both circularity and sustainability with performance evaluation, which is only means to the end, and the facts are that LCA still evolving methodology, various factors for successfully innovating a BM considered CE Strategies, need to reconfigure, and redesign for sustainability. However, this research is not specifically focused on how to mitigate the identified barriers instead, the researcher finds it is important for engaging ecosystem players with cross-sector collaboration to overcome them for sustainability, and accordingly, close and narrow the loop. Indeed, for cross-sector collaboration to work out, close interaction and a trust-based relationship are crucial success factors for not only circularity but also for creating additional value for end users for sustainability.

Third, the results address that green procurement with integrated services where sustainability play an active role in the BM innovation with CE principles considered differs substantially from the simple procurement of product and services regardless of specific ecosystem theme(strategy) and understanding of the whole context. Indeed, the roles of both sustainability and circularity change. Thus, considering Ecosystem strategies, which BMI needs to be based on, should do, and deliver (i.e., result) rather than tangle on specific components of BM or what BMs should be employed.

Research Contribution

The findings present a multi-stakeholder view for circular value chain management on incumbent BMI with ambient ecosystem considered in the circular value chain development context, that how they facilitate the change to BMs with CE principles adhered to enable more business to 'sense, seize, transform' with their capabilities developed with CE approach, as CE transformation may require system-level change. (Kirchherr et al., 2017; Velis, 2018).

This framework (Figure24) presents multistakeholder view in the context of EVB circular value chain management (Hussain, M., Malik, M., 2020): how Business model innovation with circular economy(10'Rs') principles adhered at organisational level for sustainability. The stakeholders are instantiated, for example, governments and institutions, EV original manufacturers, and other industry players such as Battery, materials, and cell makers; the CBMs portfolios and adoption of a combo of CE strategies are success factor for organizations enabling CE; and importantly, the planet and society are considered as important stakeholder, the ecosystem , and dynamic capability approaches to innovation are essential for sustainability. In this framework, a sustainable circular process represents an iterative path of the material sources evaluation and design of product, process, and BMs of CE (Fruend et al., 2017) for sustainability. Given the importance and need for ecosystem orchestration to be able to enable other ecosystem players to innovate their BM with CE strategies (CE principles), diverse roles have been identified, such as keystone, dominant, and niche players. Wrålsen et al. (2021) identified key stakeholders, they are EV OEM, and battery-related businesses, and the results show that they need to collaborate to overcome the challenges.

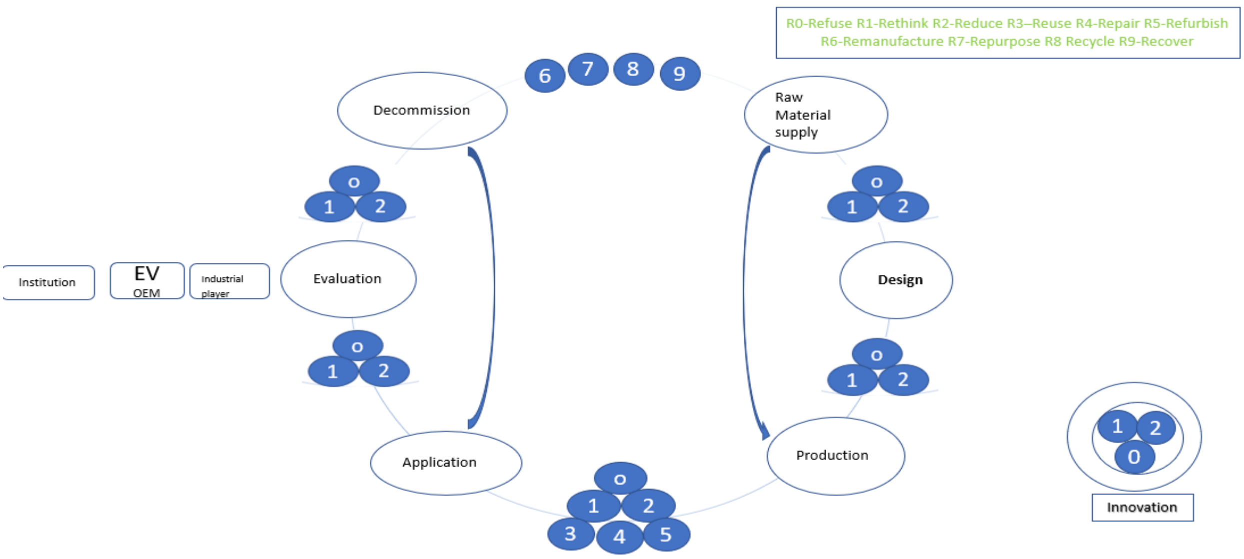


Figure.24. Multi-stakeholder view of Circular Value chain: Ecosystem approach to innovation.

For businesses, firms that tend to transform to the CE paradigm, resuming CEBM/CBMs portfolio, forming a strategic alliance, BMI with CE principles for the synergy of sustainability and/or CE, to harvest the sustainable value of the 'economical, environmental, and social' benefits following a continuous innovation manner. The Ecosystem theory explains how company CBMs can be dynamic capabilities of multi-stakeholder view, as manufacturing companies utilize ecosystem to integrate services for individual BM ‘sense, seize, transformation’ with environment change, which are increasingly seen as enablers for the transition towards a CE for the greater ‘sustainability.’ To help individual firms' environmental value proposition to reach system level changes (Manninen et al.,2018), and to understand better how companies’ BMs innovate in at ecosystem levels to achieve the transformation to CE sustainable development.

Adoption of a combination of various CE strategies into CBMs is a success factor for organizations enabling CE. In the context of sustainable EVB circular value chain management (Hussain, M., Malik, M., 2020), the ecosystem and dynamic capability approaches to innovation are essential. Ecosystem business co-evolving and circular BMs co-existing with the synergy of CE-oriented and Sustainability oriented BMI leverage new technology will ensure value co-created and new opportunities co-explored, and advantage co-exploited of concrete growth of BMs underpinning CE principles, as CBM are a subcategory of SBM, CBMs as networked nature they do not have to close the loop by itself that they can be part of the ecosystem, collaborate with others to close the Loop. Further, a BM is commonly acknowledged as how businesses create deliver and capture value, CBM in a similar vein it described how the BM is in the close loop, this research recognizes circular ecosystem creates, captures, and delivers value, as a business can not capture value before it creates value, BMs as the framework, accordingly, were conceptualized as a dynamic capability, analytical tool, and as a boundary-spanning tool foster the ecosystems interaction so that the sustainable value is co-created, opportunities co-explored. BM in a Circular ecosystem context and it is indicated through the case studies in this research that a deeper link exists between CBMs of a focal firm and its ecosystem players, as a result, which takes the form of an iterative journey with dynamic nature of the prospective BM configuration, *rather than highlight alone the outcome of CBMs innovation; the entire BMs change; the role of the orchestrator; and the circular ecosystem (*Zucchella & Previtali, 2018).

The synergy of BMI for circularity and sustainability perspective

As the business competition has been already transferred from platform to ecosystem level, with the web 2.0 and 3.0 development of digitalization, competition also transgressed from product design to value chain design, ecosystem approach to innovation is highlighted in this research that data sharing at least at EU level is a precondition for EVB circular value chain sustainable development from Finland and the EU.

In this research CE for sustainable development happens at Macro, Meso, Micro: Macro: Regional level, NEED EVALUATION for Sufficiency in the long run because CE is a contested concept; Higher efficiency is needed i.e., Legislation adaption; Data and cloud management; Meso: industrial level, Design for industrial wide collaboration: BMs, systems, products, i.e., CBMs portfolio; strategic alliances; Technology advancement; CE strategy Organisation; Micro: company level, Product, process; Bio cycle and/or Tech-cycle. Process: i.e., Chemical Circulation on site; CE strategy on Business unit level. Evaluation' and 'Design' are interchangeable and iterative processes that design sits at the centre of CE, however, for a business to develop 'sustainably', the metrics of the performance of CBM and CE need to be measured for example, the battery materials need to be evaluated for the improvement of the chemistries of the batteries or optimize the process, as well as from system level (Industrial) change of the EVB sector.

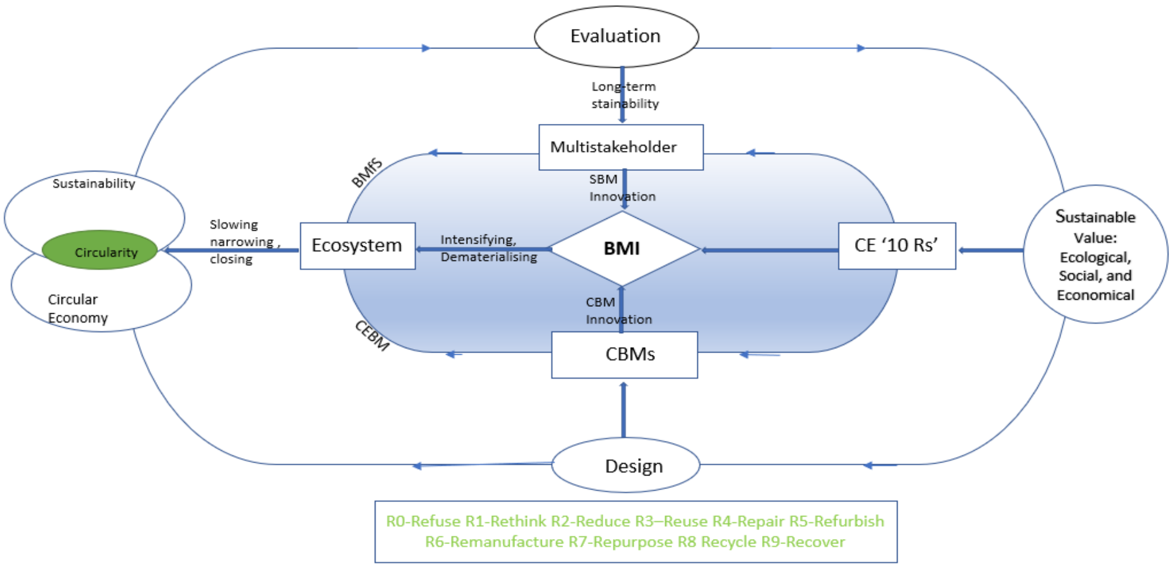


Figure 25. Circular BMs Ecosystem approach for Sustainable development: Dynamic perspective.

The synergy framework (Figure25) is to demonstrate the relationships of various BMs elements and the interplay, and close the gap of multistakeholder BMI with CE strategies for the synergy of BMI for circularity and sustainability which is guided by the BMs process (Wirtz, & Daiser,2018), namely of how to innovate such a prospective BM collectively to incorporate CE strategies into their operation, then the iteration of the design thinking with whole battery material production in Europe that have been planning and is emerging for the value chain of EU EVB sector. Evaluation of the BMI process, to integrate the CE strategies towards circularity (Geissdoerfer et al.,2018) with higher CE strategy to close, slow, and narrow the resource loops for CE sustainable development. For EVB sector CE sustainable development: 1). BMs networked business ecosystem 2).

Ecosystem approach to innovation (R0, R1, R2) in the value chain development 3). Design and Evaluation to slow, narrow, and close the resources loops.

To construct more sustainability and avoid the rebound effect of CE in the future on one hand and on the other, avoid landfill, the evaluation of the materials of EVB needs to be done at an ecosystem level, accordingly, BMs can be seen as dynamic capabilities as an ecosystem approach to innovation and multistakeholder view to innovate the prospective BM with CE principles adhered to and facilitate businesses, more B2B, B2C to 'VCC, OCC, and ACC' (value cocreate, opportunity co-exploit, and advantage co-explore) and 'sense, seize, and transform' to environment change (Juntunen, 2017; Gomes et al., 2018; Teece, 2018). For EVB sector is evolving and affected by market trend uncertainty, technological advancement, and adapting to legislation. Design is the centre and iterative path for EVB CE but never finished and collectively slows, narrows, and closes the loops by using renewable sources and recyclable materials. (Pavel, 2018; Gomes, et al., 2018; Pieroni et al., 2019; Silva, 2020; Geissdoerfer et al., 2020, Wrålsen, 2021). Figure 25. presents the framework for CBM transformation: the synergy of BMI for circularity and sustainability.

Importantly, the information and material flow circles are enabled by digitalization through design, PSS, evaluation, reverse logistics, product reuse i.e., EVB second life for renewable energy storage, and material reuse. The centre element for CE strategy implementation is the 'sharing economy' through the whole value chain' with data reliability; the left half ring represents the renewable energy with sources diversity; the right half ring is another key elementof PSS A.K.A. the product as a service system includes design for product and materials to phase out the waste; and redesign for product and material reuse and process efficiency and cost-effective for pricing strategy. As the result of this research confirms CBM is key to mitigating climate by reducing GHG emissions i.e., in the raw materials sector, better use of materials and products, and contributing to CE strategies (Batteries Europe ETIP, 2021).

Combined with a sustainability strategy to increase product material circularity with eco-redesign, optimize the production process with a low footprint, extend life with reuse, remanufacturing with second life, recycling and valorise the secondary material the life-cycle concept of EVB encompasses use, reuse, and recycle across the whole value chain. Most efforts have focussed on contracting or redeveloping such EVB facilities. For the former, the results have been slow aging and retirement of EVB. For the latter, redevelopment has taken place through repurposing cases and redesigning using new materials.

The design sits at the centre of CE (Silva, 2020), however, it is an iterative process never finished, for the rebound effect of CE, Evaluation for the impact is as well important, so that a well-designed BM coupled with a well-designed product to be successful. To innovate such a sustainable and circular BM, it is about circularity that leverages the retained economic value after the initial life of the products and generates new offerings to innovate the mechanisms of the value proposition, value creation, and delivery and value capture (Linder & Williander, 2017). Circular product design involves, and accordingly the new BMs are needed for the sustainable development of the EVB sector; for BMI incorporate these strategies (CE Principles) is crucial for the main stream business to facilitate more business B2B and B2C to assume the CE principles, which recapture value after the first life of a product, access to products and components and materials during and within the post-usage loops, and configure who are available in the system to collaborate, experiment, and support the solutions that are feasible in the near, intermediate, and long term, in circumstances of the solutions are not possible at the current moment. (Silva, 2020).

Success factors of innovation toward a prospective BM

Given CE is recognized as a driver for sustainability, the CE and CBM transformation also brought uncertainty on the potential environmental impact of new circular BMs (Mont, 2002; 2007; Tukker, 2015). In addition, the direct relationship of sustainability with CE-oriented BMI needs further investigation, for which current research has identified circular BM evaluation on their contribution to environmental impact, need to be evaluated for sustainability; With recognizing the importance and the need for ecosystem orchestration to be able to enable other ecosystem players to innovate their BM with CE strategies (CE principles), diverse roles have been identified, such as keystone, dominant and niche players. This indicates the importance of the ecosystem orchestrators emerging as owners of platforms that facilitate CE transformation. Therefore, the role of the orchestrator in the ecosystem as well as the diverse types of ecosystem partners, need to be oriented toward the CE paradigm with CE principles implemented.

This research highlights the anecdotes of sustainable BMs, and especially BMI leverage the modern technology advancement requires firm digitalization with the demand side of PSS system with lifecycle considered to get more accurate information flow to avoid ‘garbage in and garbage out.’ This research also recognizing to better understand the community, big data analysis is essential to optimize the system efficiency and efficacy from a circular BM implementation perspective to diminish the waste with a proactive strategy and system design thinking, since data collection is not a problem from a technology perspective, however matching demand from starting point of end users behaviours analysis, the ecosystem interaction is also highlighted, regards get information feedback system from connect to upstream manufacturing supply strategic planning, to target the segmented customers through the system taking advantage of this information flows with partners or alliances, marrying (with good strategy) the sustainability with desire is the key to the sustainability of every part of a system and this also answers the second question**.**

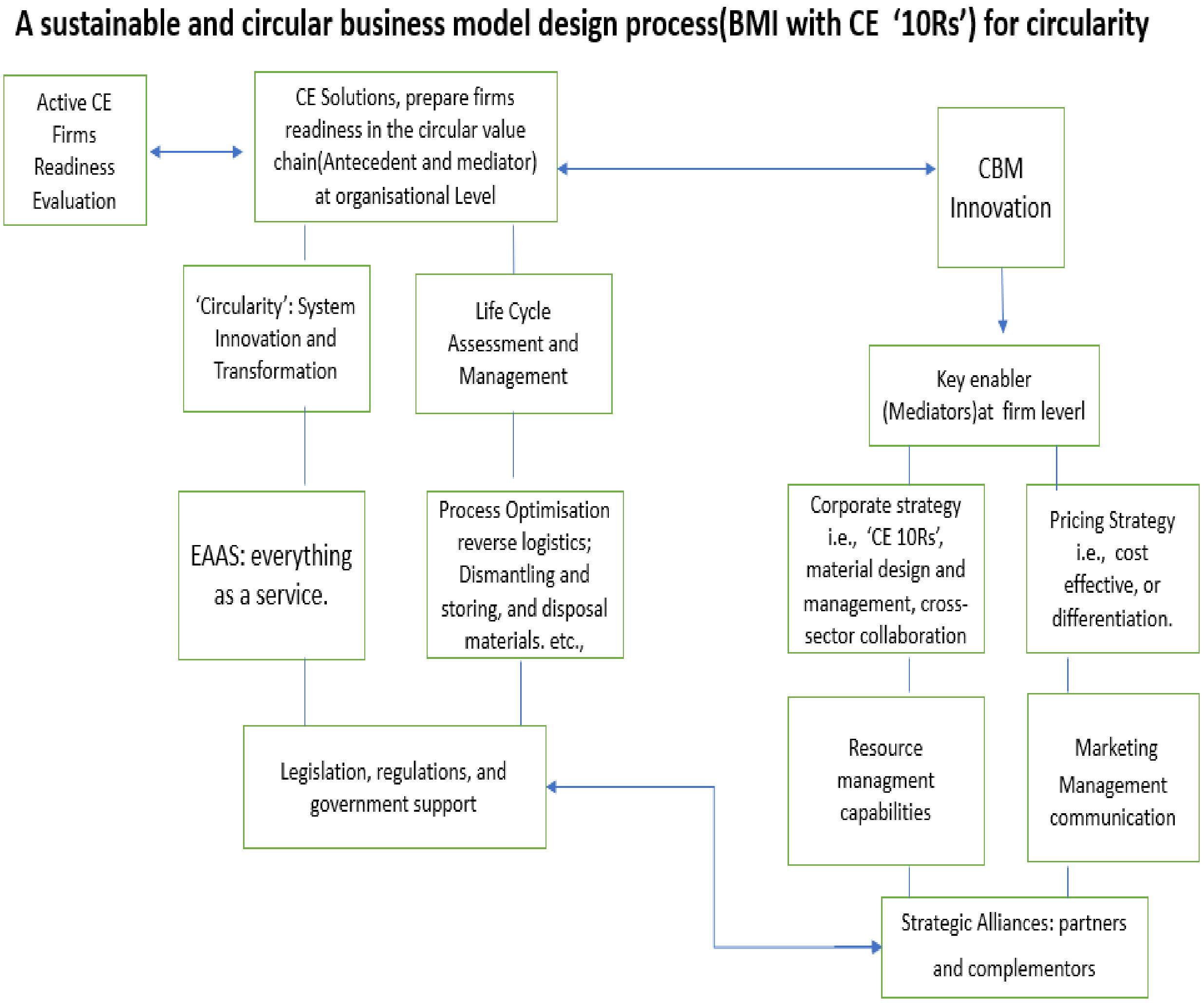


Figure 26. Success factors of Business Model Innovation for Circularity with CE Principles followed.

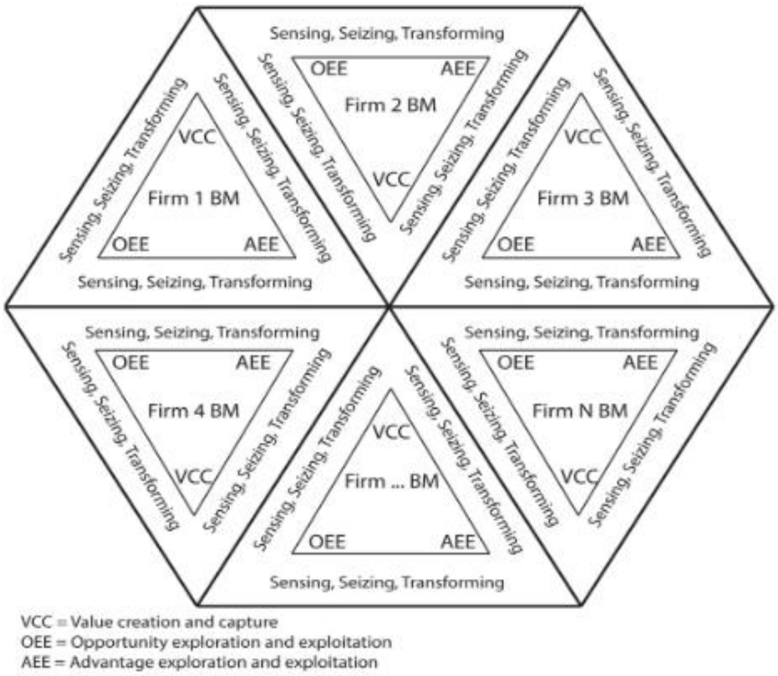
As illustrated in the empirical results Business is featured a systematic nature for BM innovation, Cross-sector collaboration needs to be managed under the innovation ecosystem via exchanging information with relevant actors through information flow with the material flow as Principles underlined, which facilitate the focal company and whole ecosystem advancement**.** The result shows that with the synergy of the BM**I** for 'circularity 'and 'sustainability', the BM design process models to incorporate, especially the enablers or the key success factors highlighting the business to carry out the CBM innovation process with these success factors that can affect BMs change for transformation, namely: 1. Design for 'circularity' i.e., Materials for repair, reuse recycling, etc.2. life cycle assessment and management 3. EAAS: everything can be designed as a service. 4. Process optimization: reverse logistics; Dismantling and storing, and disposal of materials. etc., 5. legislation and regulations and government support. The findings from these multiple case studies of the innovation ecosystem demonstrate the dynamic capability for BM change and collaboration with multi-nation, institution; cross-sector, and intra-discipline stakeholders for optimizing the process and price strategizing mechanism due to system thinking, and for lack of capability for handling uncertainty and volatile changing environment can be understood as part of a possible transformation to a sustainable CBM(s).

According to the research findings, the single case study revealed the identified CBM challenges for firms to conquer that can be mediators if the firms successfully conquer these challenges and the prospects to earn the legitimacy to get a competitive advantage to facilitate between organization readiness for the change. The framework factors BM design elements and entrepreneurship components, showing the key challenges and strategies of CBMI, summarizes that the dynamic capabilities of a firm can likewise influence innovation transition through business strategy: 1. Industrial symbiosis, 2. Design of products and services, 3. Extending the recourse value. 4. Reverse Supply Chain, 5 Integration of information processing (Mattos &Alburguerque, 2018) besides the factors to develop the BM more circular: 1. renewable energy usage increase. 2. Co-design: eco-design for recycling, reuse, and remanufacturing, 3. Advanced technology engineering 4 Pricing strategy: cost-effective through overall process optimization 5. Resource management capabilities to align the resources for transformation. 6. Marketing management communication. 5. Strategic alliances and complementary. This research identifies the strategies which are firm perspective CBM transformation.

Managerial implication of organization

There are bulks focus on static view CBM literature and this study offers dynamic CE BMs view present in the emerging EVB sector in Finland, and hopefully, this work will further the research in this area. As illustrated in the empirical results CE business featured a systematic nature for BM innovation, Cross-sector collaboration needs to be managed under the innovation ecosystem via exchanging information with relevant actors through information flow with the material flow as CE principles underlined, which facilitate the focal company and whole ecosystem advancement. In this study, the business ecosystem is seen as a 'bundle of interlinked BMs,' where value co-creation, co-capture, and co-opetition as well as co-evolution are visible (Ahokangas, et al., 2014). and stresses the need to understand how the integrated, co-dependent processes of value co-creation and co-capture influence on BMs of individual firms in co-evolving business ecosystems**.** Below the sketch represents E-health (cf. Gomes et al.,2018) BMI for sustainability, with an ecosystem approach, the same as the 'SoH' ''SoC' is fundamental for EV battery, recycling, and reuse.

Figure 27 Typology of BMs ecosystems interaction as dynamic capabilities (cf. Gomes, et al., 2018)



CBMI immerged as a success factor that incorporates several BM design elements for transition to a sustainable and circular BM to enable various products, the process of production, and post the market, to consider a unified proactive approach to the sustainable innovation of BM, this research enhances understanding of the benefits of collaboration, value chain engagement; marketing and education from the materials recovery perspective and resource management for the economy (Awan, 2022). Understanding of circularity and change is seen to foster interaction with the ecosystem, and that will help enterprises to innovate a circular BM for sustainable development with CE principles adhered to, and take account of BM design elements such as, the moderator: i.e., Legislation and government support for material reuse; competencies i.e., various key strategic for CE implementation i.e., pricing and other business strategies such as cross-sector collaboration for the overall process optimization, and all these concepts supports BMI with CE principles thus, contribute to scale a successful CBM innovation for materials reuse system (Awan ,2022).

The ecosystem stakeholders rather co-developing their capabilities in the ecosystem from the perspective of BMs, and they are conceptualized for enabling the ecosystemic and symbolic interaction in the circular ecosystem through OEE (opportunities co-exploration and exploitation), VCC (value creation and capture), and AEE (advantage exploration and exploitation) (Gomes, et al., 2018) with CE principles adhered to BMI, and the co-development is the key through sensing, seizing, and transforming to CE environment change to enable sustainable circular ecosystem's success and sustainability. A more dynamic view of BMI needs to promote and resume CBMs (Accenture, 2015; Sitra, 2020) for CE incorporating wider scope of sustainability, create new and/or innovative BMs for more businesses B2B, B2C resume CE principles, taking account of the ambient ecosystem of BMs dynamic view (Pieroni et.,2019), BMI with *CE higher strategies 'slowing, closing, narrowing' the resource and energy loops implemented at the organizational level to* generate the sustainable value of 'ecological, social, and economical', and *ultimately contribute to EVB sector sustainable development.*

Gap exploitation process of BMI for CE/ Sustainability for EVB sector

This research also adds to CBM unfolding the whole value chain engagement for the 'circularity' in the industrial internet network system. Achieve widespread CE acceptance, requires increased business and end users to resume CE principles, to consider industrial societal patterns of an industrial and/or reason the circular economy, the distinction between B2B and B2C blurred. This research presented a generalized exploratory analysis of how to innovate a BM with CE principles for sustainable development can be implemented at CE active firms and capitalization needed for overall cost-effectiveness and the overall process must be optimized, starting from material design and the government support and regulations are fundamentally important to enabling all the actors in the whole value chain engaged to achieve the sustainability objectives in designing CBM innovation. Further, for BMs to change or transform and integrate with the synergy of 'circularity' and 'sustainability' BM design elements of BMI, the transition is not straightforward, and it is a complex journey that flexibility of design elements and CBMs portfolios all need to be considered so that the entire BMs change is possible, and it is an iterative process. However, the BMI is not meant to be radical, the entire BM of the organization must be aligned with the goal of the ecosystem, otherwise, the strategy of the whole ecosystem must be changed. Below is the research about the process of BM design for firms from the EV industry in early-stage innovation ecosystems (Cambridge Service alliances- Weiller &Neely, 2013) and a dynamic perspective of the BMs design framework of BMI for 'circularity' in emerging ecosystems as below:

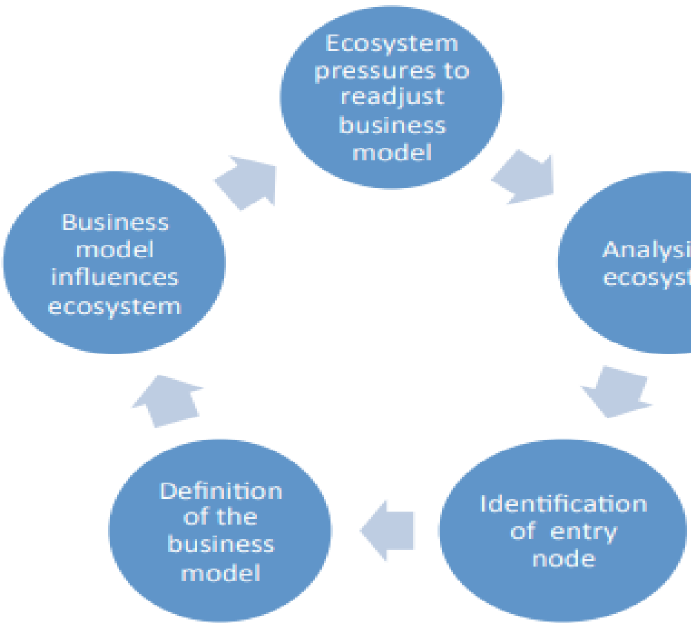


Figure 28. Dynamic theory of BM design in an ecosystem context (Cambridge Service Alliance-Weiller &Neely, 2013)

The dynamic theory (Gap exploit) combined with sustainability strategy is necessary to BMI for circularity, increase product material circularity with eco-redesign, optimize production process with a low footprint, extend life with reuse, remanufacturing with second life, recycling and valorise the secondary material the life-cycle concept of EVB encompass use, reuse, and recycle across the whole value chain. More efforts should canter on i.e., EVB infrastructure contracts and redevelopment. As a result of the former, there is slowing aging and retiring EVB; for the latter, the redevelopment occurs through repurposing, and for some occasions, redesign with new materials. Lately, it was emphasized that the transport and power sector will eventually couple together with the circular battery value chain for example, V2G (Vehicle to Grid) also be developed (WEF & Global Battery Alliance, 2019) to produce more renewable electricity to produce 'green' smart EVB, thus fulfilling two purposes: reuse the EVB for less demanding applications: the renewable energy storage and recycling retired battery materials would be otherwise expensive to manage or treat. As the research results indicate that innovating the prospective BM with the CE principles adhere to could be a promising way in securing EVB's future and contributing to its circularity, and that of the city/region where they operate for long-term sustainability.

6. limitation and Future Research

The present research shed light on the initial discussion on sustainable development of EVB sector analysis on BM innovation with CE perspective, a holistic, multi-stakeholder view of BMI for the synergy of sustainability/CE (Pieroni et al., 2019; Wrålsen, et al., 2021), however, EVB ecosystems are only emerging from Finland, there are: sustainable supply, large recycling, battery management system, traceability, harsh environment, safety (Business Finland, 2019), Further study and longitude study is recommended for the mid- or long-term sustainability.

While CEBM implementation at a system level facilitates more firms to transform to CE paradigm, only big firms are opted to study the emerging topic of firms BMI with CE principles adhered to. For circularity, big firms have more resources than SME**,** easily create a win-win-win sustainable situation (Antikainen &Valkoikari, 2016) that is determined by pioneers' circular spirits and their entrepreneurial capabilities (De Los Rios & Charnley, 2017)**,** ultimately, they contribute to sustainability and drive 'growth', here organizations core capabilities can be seen as dynamic capabilities. However, the start-up role can not be ignored, as they have high flexibility and responsivity to market changes. Importantly, more start-ups could collaborate with the incumbent firms that are also active to realize the CE strategic goals in this CE field, as radical innovation plays also a central role and have a direct or indirect impact that has been argued to have a higher capacity to adopt more disruptive CBMs, and for BMI 'sense, seize, and transform' to environmental changes (Teece, 2018; Juntunen, 2017; Bergset and Fichter, 2015; Hockerts and Wüstenhagen, 2010; Rizos et al., 2016) with CE principles adhered to for the long term sustainability, so future research could focus on more dynamic capabilities view of start-up, to innovate such a prospective BM, or lean start-up approach is recommended.

For circularity is essential for the value chain of the EVB sector's sustainable development, this research core focus is of the key stone players organizational level BMI for sustainability benefits, mainly the production side of CE is focused, although the services provided between the industries have been analysed,, the future research could be conducted more on consumption side i.e., consumer or end users' perspective for the ecological benefits, address the applications and reverse logistics segments in ecosystem context (Pavel, 2018). For CE decouple economic growth from the mother earth resource depletion, the continuous evaluation of the sufficiency of critical raw materials in the future are highlighted, for Climate change and resources saving are the global issues, every country should consider them.

References

Accenture – Lacy, P. & Rutqvist, J. (2015). Waste to Wealth: The Circular Economy Advantage. 1st ed. English: Palgrave Macmillan.

Ahokangas, p., Jansson, N. Iivari, M., Perälä-Heape, M., & Salo, A. (2014). The competitive advantage of an ecosystemic business model: The Case of OuluHealth. *Interdisciplinary Studies Journal*, 3, (4), P282-294.

Adner, R., & Kapoor, R. (2016a). Innovation ecosystems and the pace of substitution: Re-examining technology S-curves. *Strategic Management Journal*, 37, P625-648.

Adner, R., & Kapoor, R. (2016b). Right tech, wrong time. Harvard Business Review, 94(11): 60-67. Altman, E. J. 2016. Dependency challenges, response strategies, and complementor maturity: Joining a multi-sided platform ecosystem. Working paper.

Anderson, L, Rosenbaum, M.S., Corus, C., Ostrom, A.L., Fisk, R.P., Gallan, A.S., Giraldo, M., Mende, M., Mlder, M., Rayburn, S.W., Shirahada, K., &Williams, J.D. (2011). Conceptualisation and Aspirations of Transformative service Research. *Journal of research for consumers*. 19.

Antikainen, M., &Valkokari, K. (2016). A framework for sustainable circular business model innovation. *Technology Innovation Management Review,* 6(7).

Albertsen, L. (2020). Circular business models for electric vehicle Lithium-Ion batteries, An analysis of current practices of vehicle manufacturers in the EU and the potential for innovation at Volvo Group.

Albertsen, L., Richter, Peck, P., Dalhammar, C., &Plepys, A. (2021). Circular business models for electric vehicle Lithium-ion batteries: An analysis of current practices of vehicle manufacturers and policies in the EU. *Resources, Conservation and Recycling,* 172. https://doi.org/10.1016/j.resconrec.2021.105658

Awan.U., &Sroufe. R. (2022). Sustainability in the Circular Economy: Insights and Dynamics of Designing Circular business models. *Appl.Sci.,*12(3), 1521. https://doi.org/10.3390/app12031521

Almshref. N. (2022) Factors influencing the implementation of circular business model among Small and Medium-sized Enterprises in Sweden.

Auerbach, C. F., & Silverstein, L. B. (2003). Qualitative data: An introduction to coding and analysis*. New York University Press*.

Appolloni, A., Sun, H., Jia, F., &Li, X. (2014). Green procurement in the private sector: A state of the art review between 1996 and 2013. *Journal of Cleaner Production*. DOI: 10.1016/j.jclepro.2014.08.106

Batteries Europe ETIP- Kauranen, P., Kojo, I. V., Salmi, O., Vassart, A., Lundström, M., Sayfritz, S., Wiesner, E., Trapp, V., Forte, F., Faucheux, V., Zygmunt, M., Tomboy, W., Bazin, J-L., Hilario, F., Päivi, K., Pereira, B., Pettit, C., Van der Eijk, C., Roschger, P., ... Le Petit, Y. (2021). Batteries Europe ETIP WG2: Raw Materials and Recycling Roadmap.

Battery supply chain-Alkio, M., Mordsröm, Rouvinen, P., & Virtanen, J. (2019). Battery supply chain-Roles for Europe and Finland. *AVANCE Insight* 01/2019.

Biloslvo, R., Bagnoli, C., &Edgar, D. (2017). An eco-critical perspective on business models: the value triangle as an approach to closing the sustainability gap. *Journal of Cleaner Production*, 174, P746-762. https://doi.org/10.1016/j.jclepro.2017.10.281

Business FInland-Adolfsson-Tallqvist, J. (2019). Batteries from Finland: Final Report 2019.

BATCircle2.0-Nurmi, S. (2021). BATCircle 2.0 & Batteries Europe WG2: Raw materials and recycling – Roadmap. Prometia 8th Scientific Seminar.

Blaikie, N., &Priest, J. (2018). Designing Social Research: The logic of Anticipation, 3rd Edition. ISBN: 978-1-509-51741-1

Baxter, P., &Jack, S. (2008). Qualitative Case study methodology: Study design and implementation for novice researchers. *The Qualitative Report,* 13(4). http://www.nova.edu/ssss/QR/QR13-4/baxter.pdf

Booth, A. (2016). Searching for qualitative research for inclusion in systematic reviews: a structured methodological review. *Systematic Reviews,* 5:74. DOI:10.1186/s13643-016-0249-x

Boons, F., &Ludeke-Freund, F. (2013). Business models for sustainable innovation: State of the art and steps towards a research agenda. *Journal of Cleaner Production,* 45, P9-19. DOI: 10.1016/j.jclepro.2012.07.007

Boons, F., Montalvo, C., Quist, J., &Wagner, M. (2020). Sustainable innovation, business models and economic performance: an overview. *Journal of Cleaner Production,* 45, P1-8. https://doi.org/10.1016/j.jclepro.2012.08.013Get rights and content

Bocken, N., Short, S., Rana, P., &Evans, S. (2013). A value mapping tool for sustainable business modelling. *Corporate Governance*, 13 (5), P482-497. https://doi.org/10.1108/CG-06-2013-0078

Bocken, N. (2021a) Sustainable Business Models. *Encyclopedia of the UN Sustainable Development Goals. Springer,* Cham Book accessible at: https://www.springer.com/us/book/9783319958668#about Book. DOI: 10.1007/978-3-319-95867-5_48

Bocken, N.M.P., De Pauw, I., Bakker, C., &Van der Grinten, B. (2016). Product design and business model strategies for a circular economy. Sustainable design and Manufacturing for Circular economy*. Journal of Industrial and Production Engineering,5* (33). https://doi.org/10.1080/21681015.2016.1172124

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *J. Clean. Prod.* 65, 42–56. https:// doi.org/10.1016/j.jclepro.2013.11.039.

Bocken, M.M.P., Rana, P., &Short, S.W. (2015). Value mapping for sustainable business thanking. *Journal of Industrial and Production Engineering,* 32(1), P67-81. DOI: http://dx.doi.org/10.1080/21681015.2014.1000399

Bocken, B. Weissbrod, I., &Antikainen, M. (2020a). Business experimentation for sustainability: Emerging perspectives. *Journal of Cleaner Production*. DOI: 10.1016/j.jclepro.2020.124904

Boyatzis, E. (1998). Transforming Qualitative Information: Thematic Analysis and Code Development? Sage: London, UK.

Bergset, L.., &Fichter, K. (2015). Green start-ups-a new typology for sustainable entrepreneurship and innovation research. *Journal of Innovation Management*. DOI: 10.24840/2183-0606_003.003_0009

Carayannis, E.G., Girgoroudis, E., Campbell, D.F.J., Meissnr, D., &Stamati, D. (2017). The ecosystem as helix: an exploratory theory-building study of regional co-opetitive entrepreneurial ecosystem as quadruple/Quintuple Helix innovation Models. *R&D management.*

https://doi.org/10.1111/radm.12300

Centobelli, P., Cerchoione, R., Chiaoni, D., &Vecchi0, P.D. (2020). Designing business models in circular economy: A systematic literature review and research agenda. *Business Strategy and the environment,* 29(4), P1734-1749. DOI:10.1002/bse.2466

Carraresi, L., &BrÖring, S. (2021). How does business model redesign foster resilience in emerging circular value chains? *Journal of Cleaner production,* 289(6-7). DOI:10.1016/j.jclepro.2021.125823

Chesbrough, H. (2007). Business model innovation: it's not just about technology anymore. *Strategy & Leadership*, 35 (6), P12-17. https://doi.org/10.1108/10878570710833714

Chesbrough, H. (2010). Business model innovation: Opportunities and Barriers. *Long Range Planning*, 43, P 354-363. DOI: 10.1016/j.lrp.2009.07.010

Carayannis, E.G., Sindakis, S. & Walter, C. (2015) Business Model Innovation as Lever of Organizational Sustainability. *J Technol Transf,* 40, 85–104. https://doi.org/10.1007/s10961-013-9330-y

Corbin, J., &Strauss, A. (1990). Grounded theory research: procedures, canons, and evaluation criteria. *Qual. Sociol,* 13, 3–21.

Charter, Martin (2016*)* Sustainable innovation 2016: circular economy innovation & design: towards sustainable product design: 21st international conference. *The Centre for Sustainable Design, Farnham, Surrey.*

Davis, N. (2016). What is the fourth industrial revolution? *World Economic Forum Geneva*.

Diepenmaat, H., Kemp, R., & Velter, M. (2020). Why sustainable development requires societal innovation and cannot be achieved without this. *Sustainability,* 12, 1270. doi:10.3390/su12031270

Downes, L., & Nunes, P. (2014). Big Bang disruption: Business survival in the age of constant innovation. *Penguin UK*.

Dekker, H.C., &Anderson, S.W. (2005). Management Control for Market Transactions: The Relation Between Transaction Characteristics, Incomplete Contract Design, and Subsequent Performance. *Management Science*,51(12), P1734-1752.https://doi.org/10.1287/mnsc.1050.0456

De Bernardi, P., Bertello, A., & Forliano, C. (2023).Circularity of food systems: a review and research agenda. *British Food Journal*, (125) 3, P1094-1129. https://doi.org/10.1108/BFJ-05-2021-0576

De los Rios IC, Charnley FJ, (2017). Skills and capabilities for a sustainable and circular economy: The changing role of design, *Journal of Cleaner Production,* 160, P 109-122.

Daou, A., Mallat, C., Chammas, G. (2020). The Ecocanvas as a business model canvas for a circular economy. *Journal of Cleaner Production,* 258(2). DOI:10.1016/j.jclepro.2020.120938

Eisenhardt, K.M. (1989). Building Theories from Case study research. The Academy of Management Review, 14(4), P532-550. https://doi.org/10.2307/258557

Eisenhardt, K.M., &Graebner, M.E. (2007). Academy of Management Journal, 50, (1), P25-32. Published by: Academy of Management Stable URL: http://www.jstor.org/stable/20159839

Ellen MacArthur Foundation (2015). Towards a circular economy: Business rationale for an accelerated transition. Available from www.ellenmacarthurfoundation.org.

EU COM. (2008). 400 Final, Public procurement for a better environment. Brussels.

EU COM. (2019). State aid: Commission approves €3.2 billion public support by seven Member States for a pan-European research and innovation project in all segments of the battery value chain. https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6705

European Commission. (2018). COMMISSION STAFF WORKING DOCUMENT - Report on Raw Materials for Battery Applications. Published by the European Commission. Brussels, 17.5.2018. SWD (2018) 245 final. Retrieved from https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/swd20180245.pdf

European Commission. (2018). Inception impact assessment - Sustainability requirements for batteries.

European Commission. (2018a). EU Battery Alliance: Major progress in establishing battery manufacturing in Europe in only one year. Retrieved from European Commission: http://europa.eu/rapid/press-release_IP-18-6114_en.htm

European Commission. (2018a). European on the Move - Sustainable Mobility for Europe: safe, connected, and clean. ANNEX 2 – Strategic Action Plan on Batteries. European Commission. Brussels, 17.5.2018. COM (2018) 293 final. Annex 2.

European Commission. (2018b). Europe on the Move: Commission completes its agenda for safe, clean and connected mobility. Retrieved from European Commission: https://ec.europa.eu/transport/modes/road/news/2018-05-17-europe-on-the-move-3_en

European Commission. (2018c). Critical Raw Materials. Retrieved from European Commission: https://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical_en

European Commission. (2019). Circular economy perspectives for the management of Batteries used in Electric Vehicles. doi:10.2760/537140

European commission. (2020). Batteries Europe: Strategic Research Agenda for batteries. *European Technology and Innovation Platform on Batteries – Batteries Europe*

European Commission, (2020). A New Circular Economy Action Plan for a Cleaner and More Competitive Europe. Brussels.

Eikelenboom, M., Long, T.B., Jong, G. (2021). Circular strategies for social housing associations: Lessons from a Dutch case. *Clean Production,* 292. https://doi.org/10.1016/j.jclepro.2021.126024

Fernandez Minguela, A., Foster, R., Ho, A., Goosey, E., &Park (2022). Valuable- Transition of automotive supply chain to the circular economy. *Journal of Circular Economy and Sustainability,* (1), P587-608. https://doi.org/10.1016/B978-0-12-819817-9.00008-9

Fallahi, S. (2017). A Process View of Business Model Innovation. Ph.D. Thesis, Chalmers University of Technology, Gothenburg, Sweden, 2017. 24.

Foss, N.J., &Saebi, T. (2016). Fifteen years of research on Business model innovation: how far have we come, and where should we go? *Journal of Management,* 43, 200–227. DOI: 10.1177/0149206316675927

Flick, U. (2014). The Sage handbook of qualitative analysis. *SAGE Publications.*

Green deal. (2020). EU agrees new law on more sustainable and circular batteries to support EU's energy transition and competitive industry. https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7588 Accessed December 9, 2022

German-Finnish Chamber of Commerce (AHK Finland). (2020). The battery industry in Finland

Galvao, G., Homrich, A., Geissdoerfer, M., &Evans, S.(2020b). Towards a value stream perspective of circular business models. *Resources Conservation and recycling ,*162. DOI:10.1016/j.resconrec.2020.105060

Guarnieri, G. (2021). How does Fashion move to circular? Research into fashion brands approaching circular business models.

Geissdoerfer, M., Pironi. M.P, Pigosso D. A. C., &Soufani, K. (2020a). Circular Business Models: A review. *Journal of Cleaner Production, (*277). https://doi.org/10.1016/j.jclepro.2020.123741

Gomes, J.F., Livari, M., Pikkarainen, M., &Ahokangas, P. (2018). Business models as enablers of ecosystemic interaction: A dynamic Capability perspective*. International Journal of Social Ecology and Sustainable Development (IJSESD),*9(3), P3. DOI: 10.4018/IJSESD.2018070101

Geissdoerfer, M., Paulo, S., Bocken, Nancy, M.P., &Hultink, E.J. (2017). The circular economy-a new sustainability paradigm? *Journal of Cleaner Production* 143, P 757–768. DOI: 10.1016/j.jclepro.2016.12.048

Geissdoerfer, M., Vladimirova, D., Evans, S. (2018b). Sustainable business model innovation: A review. *J. Clean. Prod,* 198, 401–416.

Geissdoerfer, G., Morioka, S.N., Carvalho, M.M., &Evans, S. (2018b). Business models and amount of a produced waste where it is used again as raw materials, and another aspect supply chains for the circular economy. *Cleaner Production*, 190. DOI: 10.1016/j.jclepro.2018.04.159

Geissdoerfer, M., Morioka, S.N., Carvalho, M.M., & Evans, S.(2018a). Business models and supply chains for the Circular Economy. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2018.04.159

Guldmann, E., &Huulgaard, R.D. (2020). Barriers to circular business model innovation: A multiple-case study. *Journal of Cleaner Production*, 243, https://doi.org/10.1016/j.jclepro

Hockerts, K., & Wüstenhagen. R. (2010). Greening Goliaths versus emerging Davids- Theorising about the role of incumbents and new entrants in sustainable entrepreneurship. *Journal of Business venturing,* 25, P481-492. DOI: 10.1016/j.jbusvent.2009.07.005

Guldmann, E. (2019). Circular Business Models-Innovation Journeys Towards a Circular Economy. Aalborg University Press Skjernvej 4A, 2nd floor DK – 9220 Aalborg Ø.

Hedman, J., &Kalling, T. (2003). The business model concept: Theoretical underpinnings and empirical illustrations. Jonas Hedman, Department of Informatics, School of Economics and Management, Lund University, Ole Romersvag 6 SE-223 63 Lund, Sweden.

Hannula, M. (2019). Finland based Circular Ecosystem of Battery Metals

Hussain, M., Malik, M. (2020). Organisational enablers for circular economy in the context of sustainable supply chain management. *Journal of Cleaner Production*, 256(6). DOI:10.1016/j.jclepro.2020.120375

Hill, N., Clarke, D., Blair., &Menadue, H. (2019). Circular economy perspective for the management of batteries used in electronic vehicles. Final Project Report by Ricardo Energy & Environment for the JRC. Publications Office of the European Union, Luxembourg, doi:10.2760/537140, JRC117790

Hansen, E. G., Lüdeke Freund, F. & Fichter, K. (2020). Circular Business Model Typology: Actor, Circular Strategy and Service Level (IQD Research, No. 2020-1). Institute for Integrated Quality Design (IQD), Johannes Kepler University Linz, Austria.

Jensen, B. (1997). Make it simple! How simplicity could become your ultimate strategy. *Strat. Leader.* 25(2), P35-39.

Janssen, K., Ambavaram, A., Dungen, S. (2022). Collaboration Principles for cascade systems in a regenerative circular economy.

Jabbor, C. J.C., Sering, S., De sousa Jbbour, A.B.L., Jugend, D., DeCamargo Fiorini, P., Latan, H., & Lzeppi, W.C. (2020). Stakeholder, Innovative business models for the circular economy and sustainable performance of firms in an emerging economy facing institutional voids. *Journal of Environmental Management,* (264). https://doi.org/10.1016/j.jenvman.2020.110416.

Juntunen, M. (2017). Business model change as a dynamic capability [Doctoral Dissertation]. Acta Universitatis Ouluensis, Oulu.

Kirchherr, J., Reike, D., &Hekkert, M. (2017). Conceptualising the circular economy: an analysis of 114 definitions. *Resources, Conservation &Recycling,* 127, P221-232.http://dx.doi.org/10.1016/j.resconrec.2017.09.005

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., &Hekkert. (2018). Barriers to the circular economy: Evidence from the European Union (EU). *Ecological Economics*, 150, P264-272. https://doi.org/10.1016/j.ecolecon.2018.04.028

Korhonen, J., Nuur, C., Feldmann, A., &Birkie, S. E. (2018). Circular economy as an essentially contested concept. *Journal of Cleaner Production.* 175, P544-552. https://doi.org/10.1016/j.jclepro.2017.12.111.

Kapoor, R. (2018). Ecosystems: broadening the locus of value creation. Journal of organisation design, 7(12). https://doi.org/10.1186/s41469-018-0035-4

Kanzari. A., Rsmussen. J., Nehler. H., & Ingelsson. F. (2022). How Financial performance is addressed in light of the transition to circular business models- A systematic literature review. *Journal of cleaner production.* (376). https://doi.org/10.1016/j.jclepro.2022.134134

Konietzko, J., Bocken, N., & Hultink, E. (2020b). Circular ecosystem innovation: An initial set of principles. Journal of Cleaner production, (253), 20 April 2020. https://doi.org/10.1016/j.jclepro.2019.119942

Kolk, M. (2018). Balancing the positives and negatives – The rise of the battery ecosystem

Kauranen, P., Kojo, I. V., Salmi, O., Vassart, A., Lundström, M., Sayfritz, S., Wiesner, E., Trapp, V., Forte, F., Faucheux, V., Zygmunt, M., Tomboy, W., Bazin, J-L., Hilario, F., Päivi, K., Pereira, B., Pettit, C., Van der Eijk, C., Roschger, P., ... Le Petit, Y. (2021). Batteries Europe ETIP WG2: Raw Materials and Recycling Roadmap. European Commission.

Kotak, Y., Marchante Fernández, C., Canals Casals, L., Kotak, B.S., Koch, D.; Geisbauer, C.; Trilla, L., Gómez-Núñez, A., Schweiger, H.-G. (2021). End of Electric Vehicle Batteries: Reuse vs. Recycle. *Energies*, 14, 2217. https://doi. org/10.3390/en14082

Kok, L., Wurpel, G., Ten Wolde, A. (2013). Unleashing the Power of the Circular Economy. *IMSA Amsterdam for Circle Economy, Amsterdam, the Netherlands*. http://mvonederland.nl/system/files/me- dia/unleashing_the_power_of__the_circular_economy-circle_economy.pdf

Kill, N., Clarke, D., Blair, L., &Menadue, H. (2019). Circular economy perspectives for the management of batteries used in electric vehicles, Final Project Report by Ricardo Energy & Environment for the JRC. *Publications Office of the European Union, Luxembourg,* doi:10.2760/537140, JRC117790

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221-232.

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., &Hekkert. (2018). Barriers to the circular economy: Evidence from the European Union (EU). *Ecological Economics,* 150, P264-272. https://doi.org/10.1016/j.ecolecon.2018.04.028

Kjaer, L.L., Pigosso, D.C.A., Mcloone, T.C., &Birkved, M. (2018). Guidelines for evaluating the environmental performance of product/service-systems through lifecycle assessment. *Journal of Cleaner Production.* https://doi.org/10.1016/j.jclepro.2018.04.108

Klapalová, A. (2020). How Knowledge Management is Approached in Circular Economy Academic Research?

Kohonen, L., Kuula-Luumi, A., & Spoof, S.K. (2019). The ethical principles of research with human participants and ethical review in the human sciences in Finland Finnish National Board on Research Integrity TENK guidelines 2019. *Finnish National Board on Research Integrity TENK 3/2019.*

Lombardi, D.R., &Laybourn, P. (2012). Redefining industrial symbiosis. *Journal of industrial Ecology*,16(1). DOI:10.1111/j.1530-9290.2011. 00444.x

Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: A comprehensive review in context of manufacturing industry. *Journal of Cleaner Production*, 115, 36–51.

Livari, M.M., Ahokangas, P., Komi, M., Tihinen, M., &Valtanen, K. (2016). Toward Ecosystemic Business Models in the context of industrial internet. *Journal of Business models*. 2(4), P 42 -59.

Laukkanen, M. (2019). Sustainable business models for advancing system-level sustainability.

Liu, C.L.E., &Zhang, Y. (2014). Learning process and capability formation in cross-boarder buyer-supplier relationships: A qualitative case study of Taiwanese technological firms. International Business Review, 23(4), P718-730. https://doi.org/10.1016/j.ibusrev.2013.11.001

Filho, L., Walter, Frankenberger, Fernanda, Salvia, Amanda Lange, Azeiteiro, Ulisses, Alves, Fatima, Castro, Paula, Will, Markus, Platje, Joost, Lovren, Violeta Orlovic, Brandli, Luciana, Price, Elizabeth, Doni, Federica, Mifsud, Mark and Ávila, Lucas Veiga. (2021). A framework for the implementation of the Sustainable Development Goals in university programmes. *Journal of Cleaner Production*, 299. ISSN 0959-6526

Linder, M., &Williander, M. (2015). Circular Business Model Innovation: Inherent Uncertainties. *Business Strategy and the Environment*.DOI: 10.1002/bse.1906

Luedke-Freund, F., Gold, S., & Bocken, N.M.P. (2018). A renew and Typology of Circular Economy Business Model Patterns. *Yale University,* 23(1) . DOI: 10.1111/jiec.12763

Ministry of Economic Affairs and Employment. (2021). National Battery Strategy 2025. ISBN pdf: 978-952-327-725-0 ISSN pdf: 1797-356

Massa, L., &Tucci, C.L. (2013). Business model innovation. https://www.researchgate.net/publication/291215157

Mankins, M., Harris, K., Harding, D. (2017). Strategy in the age of superabundant capital. *Harv. Bus. Rev.* 95(2), 66-75.

Mentink, B. (2014). Circular Business Model innovation: A process framework and a tool for business model innovation in a circular economy.

Mont, O., Plepys, A., Whalen, K., &Nussholz, J.L.K. (2017). Business model innovation for a circular economy: Drivers and barriers for the Swedish industry – the voice of REES companies. *Mistra REES.*

Manninen, K. (2022). Conducting Sustainability Target-Driven Business

Michelini L., Minà A and Alaimo Di Loro P. (2022). Proceedings of the 7th International Conference on New Business Models: Sustainable Business Model Challenges: Economic Recovery and Digital Transformation, LUMSA University. ISBN 979-12-210-1188-3

Miles, M. B., Huberman, A. M., Huberman, M. A., & Huberman, M. (1994). Qualitative data analysis: An expanded sourcebook. *Sage.*

Mont, O.K. (2002). Clarifying the Concept of Product-Service System. *Journal of Cleaner Production*, 10, 237-245.
http://dx.doi.org/10.1016/S0959-6526(01)00039-7

Mont, O., &Plepys, A. (2007). System perspective on service provision: A case of community-based washing centres for households. *International Journal of Public Affairs* 3.

Ministry of Economic Affairs and Employment of Finland. (2021). National Battery Strategy 2025: Executive Summary. http://urn.fi/URN:ISBN: 978-952-327-725-0.

Merriam, S. B., & Tisdell, E. J. (2016). Qualitative research: a guide to design and implementation. Fourth edition. Jossey-Bass, San Francisco, CA.

Nußholz, J.L.K. (2017). Circular Business models: Defining a concept and framing an emerging research field. *Sustainability*, 9, 1810. doi:10.3390/su9101810

Nevmerzhitskaya, J. (2019). Can Open Innovation offer new perspectives for the development of ecosystemic business models?

Olsson, L., Fallahi, S., Schnurr, M., Diener, D., &Loon, P. (2018). Circular Business models for extended EV battery life. *Batteries,* 4, P57. doi:10.3390/batteries4040057

Osterwalder, A, & Pigneur, Y. (2010). Business model generation: A handbook for visionaries, game changers, and challengers. Publisher: John Wiley and Sons, Inc., Hoboken, New Jersey.

Oghazi, P., &Motaghel, R. (2018). Circular business model challenges and lessons learned-an industrial perspective. *Sustainability, 10, 739*. doi:10.3390/su10030739

Oliveira, C.T., Dantas, T.E.T., &Soares, S. (2020). Nano and micro level circular economy indicators: Assisting decision-makers in circularity assessments. *Sustainable Production and Consumption*, 26(4), P455. DOI: 10.1016/j.spc.2020.11.024

Ozanne, J.L., &Anderson, L. (2010). Community action research. *Journal of Public Policy & Marketing,* 29(1), P123-137. American Marketing Association ISSN: 0743-9156 (print), 1547-7207 (electronic).

Pieroni, M.P., McAloone, T., & Pigosso, D. A. C. (2019). Business model innovation for circular economy and sustainability: A review of approaches. *Journal of Cleaner Production,* 215, 198-216. https://doi.org/10.1016/j.jclepro.2019.01.036

Pieroni, M., McAloone, T.C., &Pigosso, D.C.A. (2020). From theory to practice: systematising and testing business model archetypes for circular economy. *Resources Conservation and Recycling*. DOI: 10.1016/j.resconrec.2020.105029

Parida. V., Burström. T., Visnjic. I., &Wincent. J. (2019). Orchestrating industrial ecosystem in circular economy: A two-stage transformation model for large manufacturing companies. *Journal of business research.* (101) P715-725. https://doi.org/10.1016/j.jbusres.2019.01.006

Proko, V., Stejskal, J., Horbach, &Gerstlberger, W. (2022). Business Models for the circular economy: a European perspective. Management Model for Dairy production based on a business ecosystem. *Journal of Business Ecosystem*, (1)1, P25.DOI: 10.4018/JBE.2020010103

Prevolnik, F. (2019). The reverse logistics of electric vehicle batteries

Pavel, S. (2018). Circular Economy: The Beauty of Circularity in Value Chain. *Journal of Economics and Business*, 1(4), P584-598. DOI: 10.31014/aior.1992.01.04.52

Richardson, J. (2008). The business model: An integrative framework for strategy execution. *Strategic Change*, 17(5/6): 133-144.

Roome, N., &Louche, C. (2015). Journeying toward business models for sustainability: A conceptual model found inside the black box of organisational transformation. Journeying toward business models for sustainability.

Rinkkala, M., Launonen, P., Weckström, N., Koponen, P. (2019). Internationally significant innovation and growth ecosystems in Finland. Spinverse Oy.

Rizos, V., Behrens, A., Gasst, W.V., Hofman, E., Loannou, A., Kafyeke, T., Flamos, A., Rinaldi, R., Papadelis, S., Hirschnitz-Garbers, M., &Topi, C. (2016). Implementation of circular economy business models by small and medium-sized enterprises (SMEs): Barriers and Enablers. *Sustainability,* 8(11), P1212.

Ranta, V., Aarikka-Stenroos, L.., & Väisänen, J. (2021). Digital Technologies catalyzing business model innovation for circular economy-Multiple case study. *Resources, Conservation and recycling*, 164. doi.org/10.1016/j.resconrec.2020.105155

Reinhardt, R. (2019). Sustainable business model perspectives for the electric vehicle industry: the case of battery second use.

Reinhardt, R., Christodoulou, L., Gasso-Domingo, S., &Carcia, A.B. (2019). Toward sustainable business models for electric vehicle battery second use: a critical review. *Journal of Environmental Management*, 245 P432-446. https://doi.org/10.1016/j.jenvman.2019.05.095

RevLog, the European Working group on Reverse Logistics. (1998). http://www.fbk.eur.nl/OZ/REVLOG/.

Sitra. (2019). Tulevaisuuden akkuekosysteemi: https://media.sitra.fi/2018/06/17112857/tulevaisuuden-akkuekosysteemi-nykytilaselvitys 2.0-10.06.2019.pdf

Slaper, T.F. and Hall, T.J. (2011) The Triple Bottom Line: What Is It and How Does It Work? http://www.ibrc.indiana.edu/ibr/2011/spring/article2.html

Schweitzer, J.P., & Pardo, R. (2018). A long-term strategy for a European circular economy-setting the course for success. Brussels

Schaltergger, S., Ludeke-Freund, F., &Hansen, E.G. (2012). Business cases for sustainability: the role of business model innovation for corporate sustainability. *Int. J. Innovation and Sustainable Development*, 6(2), P95–119.

Sivula, E. (2021). Barriers and Enablers to Circular Business Model Innovation: Finnish Forest Industry.

Silva, M, A. (2020). Design –The starting point for a circular battery value chain.

Stahel, W.R. (2010). The performance economy.

Sagat, E &Speiser, A. (2022). Stakeholder management in SMEs and how it drives Sustainability.

Sarasini, S., &Linder, M. (2018). Integrating a Business Model perspective into Transition Theory: The ex ample of new mobility services. *Environ. Innov. Soc. Transit*. 27, 16–31.

Saxena, S., Le Floch, C., Macdonald, J., & Moura, S. (2015). Quantifying EV battery end-of-life through analysis of travel needs with vehicle powertrain models. *Journal Power Source,* 282, P 265-276.

Tukker, A. (2015). Product services for a resource-efficient and circular economy-a review. *Journal of Cleaner Production,*97, P76-91. https://doi.org/10.1016/j.jclepro.2013.11.049

Teece, D. (2010). Business models, business strategy and innovation. *Long Range Planning*, 43(2-3), 172–194. DOI: 10.1016/j.lrp.2009.07.003

Teece, D.J. (2007). Explicating dynamic capabilities: The nature and micro foundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28(13), 1319– 1350. doi:10.1002/smj.640

Teece, D. J. (2012). Dynamic capabilities: Routines versus entrepreneurial action. *Journal of Management Studies*, 49(8), 1395–1401. doi:10.1111/j.1467-6486.2012. 01080.x

Teece, D. J. (2017). Dynamic Capabilities and (Digital) Platform Lifecycles. *Entrepreneurship, Innovation, and Platforms (Advances in Strategic Management, vol.37) J. Furman, A. Gawer, B. Silverman, and S, Stern, editors. Emerald Publishing Ltd.,* P 211-225. DOI:10.1108/S0742-332220170000037008

Teece, D. J. (2018). Business models and dynamic capabilities. *Long Range Planning,* 51, P40-49. http://dx.doi.org/10.1016/j.lrp.2017.06.007

Usama, A., &Sroufe, R. (2022). Sustainability in the circular economy: Insights and dynamics of designing circular business models.

Valio, J. (2019). Akkuekosysteemi – nykytilaselvitys

Voss, C., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations management. *Int. J. Oper. Prod. Manag*. 22, P195–219

Vermunt, D.A., Negro, S.O., Verweijm P.A., Kuppens, D.V., &Hehhert, M.P. (2019). Exploring Barriers to implementing different circular business models. *Cleaner production*, 222, P891-902. https://doi.org/10.1016/j.jclepro.2019.03.052

WEF & Global Battery Alliance. (2019). A vision for a sustainable battery value chain in 2030: Unlocking the full potential to power sustainable development and climate change mitigation.

Wrålsen, B., Prieto-Sandoval, V., Mejia-Villa, A., O'Born, R., Hellström, M., & Faessler, B. (2021). Circular business models for lithium-ion batteries-Stakeholders, barriers, and drivers. *Journal of Cleaner production*. 317. DOI:https://doi.org/10.1016/j.jclepro.2021.128393

Wang, q., Wen, J., &Stoliarov, S. (2020). Special issue on Lithium Batey Fire Safety.*Springer Science Business Media, LLC, part of Springer Nature Manufactured in The United States* https://doi.org/10.1007/s10694-020-01048-z

Wieringa, R. (2019). What is your Ecosystem? The ecosystem Architecture Modeling Framework

Weiller, C. (2013). Business Model Design in an Ecosystem Context. © Cambridge Service Alliance 2013.

Wirtz, B.W., &Daiser, P. (2018). Business Model innovation processes: A systemic Literature review. *Journal of Business models*,6(1), P40-58.

Walliman, N. (2006). Social Research Methods. *SAGE Publications, Ltd.* DOI: https://doi.org/10.4135/9781849209939

Yin, R.K. (2003). Designing case studies. Identifying Your cases and establishing the logic of your case study: general approach to designing case studies.

Yin, R.K. (2013). Validity and generation in future case study evaluations. Sage Journals, 19(3). DOI:https://doi.org/10.1177/1356389013497081

Yrjölä, S. (2020). How could blockchain transform 6G towards open ecosystemic business models?

Yang, J., Gu, F., & Guo, J. (2020). Environmental feasibility of secondary use of electric vehicle lithium-ion batteries in communication base stations. *Resources, Conservation and Recycling*, 156, 104713.DOI: https://doi.org/10.1016/j.resconrec.2020.104713

Zott, C., &Amit, R.H. (2008). The fit between product market strategy and business model: implications for firm performance. *Strategic Management Journal*,29(1), P1-26. DOI:10.1002/smj.642

Zucchella, A., &Previtali, P. (2018). Circular business models for sustainable development: A 'waste is food' restorative ecosystem. *Business strategy and the environment*. DOI:10.1002/bse.2216

Appendix 1. Interview questions:
Can you introduce yourself except for names (if you do not want), i.e., titles, positions and every other related matter in your organisation and company about the business development in EVB sector?
Five Circular business models as well as circular economy principles will be the themes to be interviewed and want to hear from, and you can find related information from the attachment of the invitation email.
Please answer the questions below during the interview session:
Business Scope in EVB sector
What of your businesses is/are related to EVB sector or is/are going to develop?
What are your core capabilities to build successful business of EVB sector?
Please describe the development of your company's business in EVB sector, particularly at different stages?
Circular Economy
How is your business related to Circular economy?
How does it approve or disapprove your business?
What do you think of lifecycle management in EVB business sector? how your company deal with it?
What are the best practices and principles poised to Circular economy development of EVB sector?

CBM Portfolio and CE Principles
What are your circular business model portfolio or is going to build? If not, any misconceptions or visions?
What Circular economy Principles your business is following up or are going to follow up? If not yet, what are the misconceptions and visions?
What do you think of CE principles? How does it relate to circular business models?
Any suggestions for new business models or business model innovation for embracing CE principles?

Ecosystem and Strategic Allies
What is your company position in the EVB Ecosystems? Have you identified the types of your stakeholders?
What are the challenges at different stages of the ecosystems of EVB development? Success factors?
Who are your strategic allies for sustainable development of EVB sector business?
How do you complement each other's business? How do you share information and knowledges?

Sustainable Development
What sustainability aspects 'Social, Environmental, Financial' impacts your business is/are after?
Please describe the product, process, and their roles regarding sustainability in your business.
Any plans or ideas to implement a sustainable and circular business model in future? If not, what might be the misconceptions and vision.

Appendix 2. Interview respondents and Data Collection

No.	Institution or Firm	Interviewee Data	Duration of the interview(Min)	Purpose
1	Finnish Ministry of the Environment	EU new battery regulation prosal	42 Mins	Present findings, receive feedback
2	Business Finland	Finnish Battery Head in value chain,	53 Mins	Ecosystem mapping initiation
3	Aalto Univeristy	EU Project Coordinator	35 Mins	Understanding BM, role in ecosystem
4	Aalto Univeristy	Project Manager/PHD	57 Min	Understanding BM, role in ecosystem
5	Oulu Univeristy	Professor, Smart Energy Futurist	48 Mins	Further discussion of business models. Futuristic discussion
6	Valmet Automotive	Innovation Manager	31 Mins	Understanding BM, role in ecosystem
7	StoraEnso	Business Develoment Specialist	33 Mins	Understanding BM, role in ecosystem
8	Wärtsilä	Vice President; Head of Strategy and	40 Mins	Understanding BM, role in ecosystem
9	Fortum	Commercial Director	30 Mins	Understanding BM, role in ecosystem
10	Akkuser	Managing Director	56 Mins	Further understanding of the company’s participation in the ecosystem