This paper was presented at ISPIM Connects Valencia – Reconnect, Rediscover, Reimagine, on 30 November to 2 December 2021. Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-691-7. Order number in series 110.

Reuse innovation in construction industry: Value creation and the ecosystem

Leena Aarikka-Stenroos*

Lauri Alkki

Linnea Harala

Mari Riuttala

Tampere University, Unit of Industrial Engineering and Management, Korkeakoulunkatu 7, 33720 Tampere

e-mail: leena.aarikka-stenroos@tuni.fi

* Corresponding author; Names are in alphabetical order and all authors have contributed equally

Abstract: Circular economy innovations are diversified spanning from recycling to reduction, but they all tend to change how value is created in the system. By this far, less in known how innovations stemming from reuse principle can shape value creation among the actors of circular value chains and ecosystems. Therefore, this study aims to expand our understanding on reuse innovations and their value creation in multi-actor, industrial ecosystem setting, particularly in construction sector. We conduct a comprehensive single case study – based on primary interview data, observation and secondary sources - in Finland among diversified construction companies and organizations from a nascent concrete rebuilding ecosystem within the ReCreate project (EU Horizon 2020) Our findings display the diversity of reuse innovation(s) enabling rebuilding; the actor ecosystem needed for innovative concrete rebuilding, and the business value of the concept to different ecosystem actors. The study contributes to circular economy innovation, ecosystem and circular construction research.

Keywords: circular economy; innovation; reuse; construction; value creation; value capture; ecosystem approach; circular construction; concrete

1 Introduction

The circular economy (CE) aims to increase environmental sustainability of the society and business through resource efficiency, conservation of natural resources, and increasing carbon neutrality (Ghisellini et al., 2016). It is strongly driven by innovation, as it requires companies and public sector to develop and adopt novel, more sustainable, circular products and processes, instead for linear, from virgin-to-waste ones (Prieto-Sandoval et al., 2018, Mariadoss et al., 2011; Engez et al 2021). In the CE, the value of materials and

This paper was presented at ISPIM Connects Valencia – Reconnect, Rediscover, Reimagine, on 30 November to 2 December 2021. Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-691-7. Order number in series 110.

products is maintained to reduce demand for virgin natural resources, through the main CE principles recycling, reuse and reduction (Geissdoerfer et al., 2018, Kirchherr et al. 2018). Implementation and adoption of such circular principles and practices require not only single tech companies to adapt or replace their current business models (Prieto-Sandoval et al., 2018; Urbinati et al. 2018; Centobelli et al. 2020), but whole value chains, industrial networks, and business ecosystems to transform more sustainable so that companies and other stakeholders can create and capture economic value from increased material circulation (Aarikka-Stenroos et al. 2021), as the shift to CE is a system level phenomenon. Consequently, we need both company and industry/system-level understanding on CE innovations, to solve how diverse companies and industries can develop and create value from CE innovations that change their practices and operations at micro, meso and system levels.

Furthermore, even though circularity occurs through diverse CE principles of recycling, reuse and reduction that all can be facilitated via CE innovations (Engez et al. 2021; Prieto-Sandoval et al., 2018), research and practice have, however, noted that recycling principle dominates, even though other principles, such as reuse would provide even more value to the society. One rationale for this may be that reuse disrupts the companies' business models and value chains more critically (see e.g. Ranta et al. 2018). Reuse innovations, however, are diverse and they can appear through diverse innovation types, spanning from technology and product to process and business model innovation (Engez et al. 2021; Crossan and Apaydin, 2010). Reuse innovation, by this far, has not been in the focus of examinations and the aspect of how reuse creates value through innovation is not yet studied within CE innovation research. Therefore, more specific research on reuse innovations is needed.

To summarize the research gaps above, by this far, less in known how innovations stemming from reuse principle can shape value creation and capture among the actors of circular value chains and ecosystems. Therefore, this study aims to *expand our understanding on reuse innovations and their value creation and capture in multi-actor, ecosystem setting.*

We will examine reuse innovation in particular crucial empirical setting, namely construction sector, since globally construction sector has been identified as one of the largest waste-generating industries (Solis-Guzman et al., 2009; Ajayi et al., 2015; O'Grady et al., 2021). The construction sector is also one of the largest consumers of raw materials and energy (UNEP, 2016; UNEP, 2019), as well as producers of waste (Pomponi & Moncaster, 2017; Akanbi et al., 2018a) and CO2 emissions (Baek et al., 2013; Chen et al., 2022) and is therefore pragmatically relevant context to study. Furthermore, this setting allows us to examine how a reuse innovation shapes and changes value creation of different industry actors, forming the industry system, that reuse innovation would then change. In this study, we will examine concrete element rebuilding concept as a reuse innovation: the concept means that buildings that are in the end of their lifecycle are deconstructed and the applicable building components are detached to be reused. To ensure the safe reuse of the detached building components, testing and quality assurance are performed as well as demolition planning and redesign. Thus, the use of virgin materials can be decreased by these reused building components. This concept is a fruitful reuse innovation to study as it is expected to comprise product, process, service, and business model CE innovations (Crossan and Apaydin, 2010; Engez et al. 2021), and changes involved industry actors, i.e. companies' value creation and capture.

To reach our research aim, we will examine *i) how the reuse innovation of rebuilding concept manifests and what kind of innovation types it triggers among companies ii) what is the ecosystem that reuse innovation touches and changes, and iii) how the reuse innovation shapes value creation in the system.* We conduct an extensive single case study – based on both primary interview data and observation as well as secondary sources - in Finland among diversified construction companies from a nascent concrete rebuilding ecosystem that is developing within the ReCreate project (EU Horizon 2020 project).

As the intended contribution to technology and innovation management and CE research, we generate new understanding on CE innovations by focusing on reuse innovation and by providing empirical based understanding on how tech companies in their industry system can create value from reuse innovation. Our findings display the actor ecosystem needed for innovative concrete rebuilding as a reuse innovation, and the business value of it to different ecosystem actors as well how these actors may capture value from it.

Through these contributions, the study connects the CE research stream (reuse as CE principle) with technology and innovation management research stream (reuse innovation, systemic innovation and different innovation types; value creation from innovation), and ecosystem approach (reuse innovation studied from multi-actor, industrial system setting). All in all, the study contributes to circular economy innovation, ecosystem and circular construction research.

This paper is structured as follows. After the introduction, the theoretical background section discusses the CE innovation, reuse as a specific type to create value and provides also system and ecosystem approach to circularity, innovation and value creation and explains construction sector as a context for circular economy, innovation, reuse and changing value creation. The following method section then presents the research design and explains our extensive case study. The result section reports the reuse innovation types from our case and their value potential and displays the ecosystem actors from the industry whose value creation is shaped due to reuse innovation. The final section concludes the theoretical contribution, practical implications, and future research avenues.

2 Theoretical background

2.1. Circular economy innovations

CE innovations, in general, are developed to slow and close resource loops: slowing resource loops refers to the process of decreasing the rate of material flows from production to recycling, which can happen when a product's lifespan is extended through the use of durable materials and a design that is repairable, reusable, upgradable, and suitable for disassembly and reassembly (Bocken et al., 2016; Stahel, 2016; Prieto-Sandoval et al., 2018,). Closing resource loops refers to a recycling process that utilizes materials from products that are no longer usable, the focus being in the link between post-use waste and production (Stahel, 2016) and innovativeness then addresses to solving how the resources, products and elements, instead of becoming waste, could be used again. Some theoretical understanding on CE innovations can also be driven from eco-innovation research (Mariadoss et al., 2011; Helström, 2007).

CE innovations can take diverse forms. A recent chapter on CE innovation types (Engez et al. 2021) categorizes numerous CE innovation occurrences in the innovation type

This paper was presented at ISPIM Connects Valencia – Reconnect, Rediscover, Reimagine, on 30 November to 2 December 2021. Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-691-7. Order number in series 110.

categorization by Crossan and Apaydin (2010), and identifies diverse CE innovation sub types, the major ones being 1) product innovation (e.g. recyclable products, substitute products, durable products, 2) technologies and process innovations (e.g. circular process technologies, material efficiency improvements, take-back processes and reverse logistics); service innovations (platforms or online marketplaces; monitoring, optimization, consultancy, or design; loop-closing (recycling) services) and business model innovations (two-sided business models; transferring product ownership from customer to the firm i.e. product-service systems; and deposit systems). Many of these innovation types assumingly enable and advance, not only recycling, but also reuse, and therefore this framing gives theoretical support on analyzing reuse/rebuilding innovation and its type variants in more detail. Therefore, next we discuss reuse in more detail, and value creation and innovation in it.

2.2. Reuse as a specific type to create value and link to innovation

Reuse as a circular principle has been identified as a broad concept, with different definitions prevailing in different industries (Russell & Nasr, 2019). Within circular economy frameworks, reuse is often referred to as either *direct reuse* (with minimal recovery done to the product), or reuse after some type of recovery operations, mainly *repair, refurbishing* or *remanufacturing* (Lüdeke-Freund et al., 2019). These reuse types require different levels of processing and labour inputs (Russell & Nasr, 2019), but they all retain some of the inherent value added of the product or its components. While in recycling, the product and its components are disintegrated (Hollander et al., 2017) and the product's identity is thus lost in the recycling process, reusing retains the value-added (the resources and labour used in the making of the product) from the product's original manufacturing process (Linder & Williander, 2017), allowing the already existing product (or component) to continue creating value.

Value creation from reusing existing goods can happen in various ways, extending from profitable reuse business models (Yrjölä et al., 2021; Bocken et al., 2016) to individual product recovery schemes (Alexander & Smaje, 2008). Because value can be considered as perceived by the customer (Bowman & Ambrosini), even change of product ownership may create value: a product deemed as "waste" by one individual could be valuable to another (Zacho et al., 2018). Technology innovation can be needed to enable products to achieve reuse potential and become valuable resources (Park & Chertow, 2014).

The economic value from reuse derives from exploiting and/or enhancing the residual value of the good, which can be enabled by various actors involved in the value chain: The supplier of used goods may gain revenue from the resale of products (Veleva & Bodkin, 2018), or even opt to donate products for reuse to avoid costs related to their holding or disposing (Alexander & Smaje, 2008). Direct reuse can be facilitated by "market-makers" (Lüdeke-Freund et al., 2019) who act as intermediators between the supply and demand for the used products, also taking part in the value creation process to a varying extent, for example by offering shipment and product validation services (Yrjölä et al., 2021). Reverse logistics and product recovery may be facilitated by product manufacturers (OEMs) to gain savings in materials (Lüdeke-Freund et al., 2019), but also third-party refurbishers, "gap-exploiters" (Whalen et al., 2018) may independently recover and resell existing products. The costs related to product recovery may decrease by adopting economies of scale (Whalen et al., 2018) by introducing process innovations, enabling value capture for the product recovery business. Profitability of direct reuse, refurbishing and remanufacturing on the operational level has been studied in various settings by comparing the costs related to product collection and recovery with the resale value of product outputs (Rahman et al., 2019; Geyer & Doctori Blass, 2010; Alexander & Smaje, 2008; Zacho et al., 2018). For the customers buying reused products, depending on the type of reuse, the customer may gain value by receiving products for cheaper (Veleva & Bodkin, 2018) or gaining access to products otherwise not available (Lüdeke-Freund et al., 2019). If the reused product is remanufactured, it is often "as new", thus yielding similar value to customers as linear products (Hopkinson et al., 2020). In sum, the reuse concept allows for diverse value creation and value capture to actors both in the supply and demand side for reused products, as well as to actors recovering the products for reuse and facilitating the exchange.

2.3. *Ecosystem approach to circularity and reuse innovation*

As we are interested here on reuse innovation and its value creation in its industry system context, we apply here ecosystem approach and recent work on CE ecosystems, meaning constantly evolving multi-actor networks with different system-level goals related to increased circularity and sustainability (Aarikka-Stenroos et al. 2021). CE ecosystems refer to communities of hierarchically independent, yet interdependent heterogeneous set of actors who collectively pursue a sustainable ecosystem outcome related to recycling, reuse, and reduction. Such collective actions concern the circular flow of materials, creating and capturing economic value from material flows, and knowledge development related to these two (Aarikka-Stenroos et al. 2021). Such ecosystems can be examined on micro level – looking on how individual companies collaborate with and steer other actors, in their circular business ecosystems (Kaipainen & Aarikka-Stenroos, 2021), when they create and capture economic value from circular material flows (Aarikka-Stenroos et al. 2021). Increased circularity often reshapes individual companies' business models, as they need to include resource returning loops in the supply chain, use more renewable resources, and include more service elements, such as maintenance or reverse logistics services (Kaipainen et al., 2020; Ranta et al., 2018). Increased circularity in the system level and micro level then changes also companies' and public organizations' value chains, industrial networks and regional relationships at meso level, as the companies and regional actors jointly pursue more resource efficient resource flows and operations (Aarikka-Stenroos et al. 2021, Uusikartano et al. 2020), often reflecting to sustainability development of industry norms and practices in the focal industry sector (Munaro et al., 2020).

When linking these approaches to reuse innovation, the increased need for reuse assumingly pushes individual companies to develop and implement diverse reuse-supporting innovations as a part of their business models and technology strategies, and value creation and capture, to enable and promote reuse practices, and the same need pushes also at meso level value chains and industrial practices and conventions to transform to support reuse as a part of industry norm. In this study, we are interested how rebuilding as reuse innovation reflects in individual companies' innovations and value creation at micro level as well in industrial value chains of construction at meso level, as the reuse innovations pursue more systemic impacts through increased circularity in the industry system.

2.4. *Construction sector as a context for circular economy innovation, particularly systemic reuse innovation*

This paper was presented at ISPIM Connects Valencia – Reconnect, Rediscover, Reimagine, on 30 November to 2 December 2021. Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-691-7. Order number in series 110.

We will study reuse innovation in construction sector where materials are often in the center, as the sector is renowned for its material-intensive nature (Zimmann et al. 2016; Ghaffar et al. 2020). Materials are produced a lot, consumed a lot, and as a result, there are a lot of side streams. A linear activity such as this has been characterized as an "take-make-consume-dispose" model (Nylén 2019; Benachio et al. 2020). Consequently, the CE and more circular, resource efficient operations implementing CE principles has been identified as one solution to the environmental problems of the construction sector (Pomponi & Moncaster, 2017; Hossain & Ng, 2018; Reike et al. 2018). However, on the use of CE principles, recycling is the most applied, as it is most easily applicable to the operators' own activities, and other R-imperatives such as reuse have remained less attention (Ghisellini et al. 2016; Ranta et al. 2018). Consequently, this study focused on the reuse of precast concrete at the highest utilization rate by examining the deconstruction and reuse of precast concrete elements, which is in line also with the CE R-imperatives and the EU waste hierarchy and the EU C&DW management protocol, as they prioritize dismantling reusable objects with before recycling.

By utilizing the reuse of building components, it is possible to achieve major environmental benefits (Zabek et al. 2017; Iuorio et al. 2019), such as lower CO2 emissions (Çimen 2021), but also economic value (Stahel 2016; Chileshe et al., 2018; Hopkinson et al. 2019). However, component reuse involves a variety of economic and technical challenges which have been identified in the literature, such as rising costs, low market demand, or new reuse technologies (Densley Tingley et al. 2017; Hopkinson et al. 2019), which can be considered systemic and require a supply chain approach (Densley Tingley et al. 2017). The literature has indicated these challenges could be overcome by engaging the whole value chain or ecosystem, creating collaborative joint means, such as databases to store and retrieve information from surrounding suppliers and reusable materials; creating market demand,; providing training and guidance on material reuse, government influence (Densley Tingley et al. 2017) and developing new dismantling methods (Hopkinson et al. 2019) and tools for reusability analysis that would show different reusability values based on different parts of the building (Akanbi et al. 2018b). In addition to technical and economic factors, the reuse of building components is also influenced by stakeholders' perceptions of the risks of material reuse (Rakhshan et al. 2020), recycling efficiency and transport distances (Gallego-Schmid et al. 2020). All this knowledge underlines that joint, system-level actions from development to implementation are crucial for enabling and increasing reuse in construction sector.

Although in the construction sector has been noted for its high potential for the use of CE principles and to create value by exploiting them (Smol et al., 2015; Ajayabi et al., 2019), however, it is still at an early stage in the transition to CE (Hossain & Ng, 2018). The construction sector needs to adopt new practices to replace the conventional ones and new innovations are needed, especially in order to be enabled to reuse deconstructed building components (Durmisevic, 2010; Buyle et al., 2019), and the support of the entire value chain and ecosystem is important here..

3 Methodology

3.1 Research design and case

We selected single case study research strategy for our study, as the strategy enables us to build a holistic understanding of complex phenomena that are not easily separable from their context (Yin, 2009). For this study, the case is an innovative rebuilding concept in construction sector, involving different kinds of companies and businesses as well comprising diverse innovation types.

The case selection was purposive as we followed theoretical sampling (Eisenhardt, 1989), meaning that the case is particularly suitable for illuminating the focal phenomenon, reuse innovation creating value in its industrial system. The selected case involves versatile ecosystem actors and thus allow exploring the actor diversity in the system of reuse innovation, i.e. how different actors in the system create and gain economi value from reuse innovation. The case also covers the full value chain and full industrial process of rebuilding allowing us to examine how reuse innovation creates value during the whole circular process from deconstruction to rebuilding.

We accessed the case from EU-funded ReCreate project that entails four country pilots (Finland, Sweden, The Netherlands, Germany) where regional industry actors will deconstruct and rebuild a concrete building by developing and implementing innovative technologies, processes, methods, etc. enabling concrete element reuse. We studied the Finnish pilot, Case Kyttälä from Tampere region, as it engages a majority of the relevant industry actors for concrete rebuilding already in the early phases of the project. The selected pilot case involves a rich set of tech, construction and service companies from construction sector, covering the whole rebuilding process, and representing different types of innovations. Such extensive research designs capturing the full CE ecosystem, empirically, are still rare in innovation and CE research (Aarikka-Stenroos et al. 2021).

There are seven company and building actors who get full or partial funding from the ReCreate project including companies, Tampere City, and Tampere University who form the main actor setting, which is completed with other, more external actors, such as an accredited laboratory for quality testing and owners of the buildings which are constructed with the reused building components. In the Finnish pilot one office building is demolished and these carefully detached building components are used in several sites of different building owners.

3.2 Data gathering and analysis

The primary data sources include interviews, observations, publications, and minutes (Table 1). We conducted theme interviews with a range of actors, covering themes such as the practicalities of the rebuilding project, roles of the different actors and how they relate to others, scalability of the rebuilding concept, business potential and challenges related to rebuilding in different phases of the project for different actors.

Table 1 Data on the case: Data types, sources and the role in analysis

Data types and sources	*Description of the data source*

This paper was presented at ISPIM Connects Valencia – Reconnect, Rediscover, Reimagine, on 30 November to 2 December 2021. Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-691-7. Order number in series 110.

Interviews (semi-structured) with key actors involved in the pilot case and its ecosystem	**6 individual interviews, with:**
	Business Development Manager in Construction company (5/2021)
	Chief Technology Officer in Concrete element manufacturing company (7/2021)
	Business Development Manager in (Structural) design & consulting company (8/2021)
	Site Manager in Demolition company (9/2021)
	Owner/Architect in Architectural design office (9/2021)
	Senior Research Fellow in University (10/2021)
	2 group interviews, with:
	Business Development Manager + Project Manager in Construction company (10/2021)
	Manager of Housing and Developing + Project Manager/Specialist in City organisation (10/2021)
General interviews (semi-structured) with expert actors external to the pilot and case	**2 individual interviews, with:**
	Technology Manager (Sustainable Building Design) in Construction engineering company (7/2021)
	Section Manager in Concrete industry organisation (8/2021)
Observation, ethnographic follow-up	Attending country cluster meetings involving all ecosystem actors of the Finnish pilot (4)
	Visiting the demolition pilot site in Finland
	Visiting a similar reference demolition pilot site in Sweden.
Minutes and reports	Project plans (2)
	Meeting memos (5)

In the data analysis, we pieced together understanding on the rebuilding as reuse innovation and related sub-innovations (innovative technologies, services, processes, etc. for rebuilding) and identified the actors involved and their role in the rebuilding system. This provided insights into the composition of the extensive ecosystem as well value creation and innovation in this system.

Multiple tools and tactics enhanced the analysis. Atlas.ti, excelling and tabling was employed, particularly for the analysis of interviews; and Kumu.io mapping tools was used in the ecosystem conceptualization and visualization.

By collecting different types of data and from different actors, we increased data triangulation, theoretical triangulation was pursued by using multiple theoretical schemes and conceptualizations from various research streams) and finally researcher triangulation i.e., multiple researchers gathering and analyzing data and interpreting results, in collaborative yet validating manner, was used to enhance the trustworthiness of the results. (see Flick, 2004).

4 Results: Reuse innovations by multiple ecosystem actors and value creation and capture

4.1. Overview on reuse innovation(s) of concrete rebuilding and its economic value

Our analysis of the case uncovered diverse reuse innovations stemming from cocrete rebuilding process and facilitating it further, thereby supporting implementation of reuse principle. Concrete rebuilding is a concept by which (prefabricated) concrete elements are salvaged from existing, donor buildings by deconstruction to be reassembled for use in a new building and supplemented with new components where necessary. The rebuilding process changes traditional construction, with new functions needed to enable construction “in reverse”. Deconstruction requires extensive planning to evaluate the reuse potential of the elements and to ensure their preservation intact. Logistics and storage space requirements change when elements need to be transported from donor building to be recovered and await subsequent reuse in a new site. The elements need to be checked, cleaned, tested, possibly refurbished and repaired prior to reassembly to ensure technical functionality and aesthetics. In addition, the legal framework dictates that the products may require additional testing and validation before they are allowed to be reused in new buildings.

In our case, concrete rebuilding as an umbrella reuse innovation was manifested and realized through very diverse innovation types and innovativeness by and among the industrial actors involved in rebuilding value chain and the ecosystem. From our data, we identified all archetypes of innovation from technology innovations to business model innovation, what all together enabled innovative concrete rebuilding as a systemic innovation in the construction sector and thus created value in the industrial system of actors (see Table 2)

Table 2 Innovation types in the rebuilding reuse innovation

Innovation type characteristics	*Explanation/example and link to value creation (by an actor in the system)*
Technology innovation	Software for building modelling (university/emerging actor)
Product innovation	Remanufactured concrete elements (element manufacturer)
	Circular buildings (building contractor)
Service innovation	Redesign services (architect)
	Data modelling (architect)
	Safety assessment services (emerging actor) Certification services (element manufacturer)
	Pre-deconstruction audit (consultant)
Process innovation	Work safety methods (university)
	Pre-demolition audit methods (consultant)
	Building modelling for existing building stock (architect)
	Scale production of elements (element manufacturer)
	Deconstruction methods (demolition contractor), Storage and logistics optimisation for salvaged elements (demolition contractor + element manufacturer)
Business model innovation	New business line for remanufactured elements (element manufacturer)
	Sale of salvaged components (demolition contractor)

4.2. The ecosystem and its diverse actors involved in reuse innovation and enabling the concrete rebuilding

Our case analysis allowed us to investigate and display the diverse actors involved in the reuse innovation of concrete rebuilding and who also contributed to the overall reuse innovation with their own sub-innovations from their own expertise and role in the system. Figure 1 demonstrates our findings on the ecosystem and key actors for concrete rebuilding in the case pilot. The ecosystem map demonstrates the actors and their diverse roles in the industry system, and interlinking relationships. The map also explains the functions/tasks needed by the ecosystem actors for developing and implementing systemic reuse innovation in the pilot case for concrete rebuilding. In addition, the ecosystem map links the actors to the previously categorized innovation types (see table 2). The actors are marked with blue; the functions/tasks are marked with orange and the innovation types are marked with brown. The following figure of the ecosystem of the Finnish pilot presents a snapshot of the actors and their roles and relations in the ecosystem in the beginning of the pilot project and these may change and evolve during the progress of the Finnish pilot project.

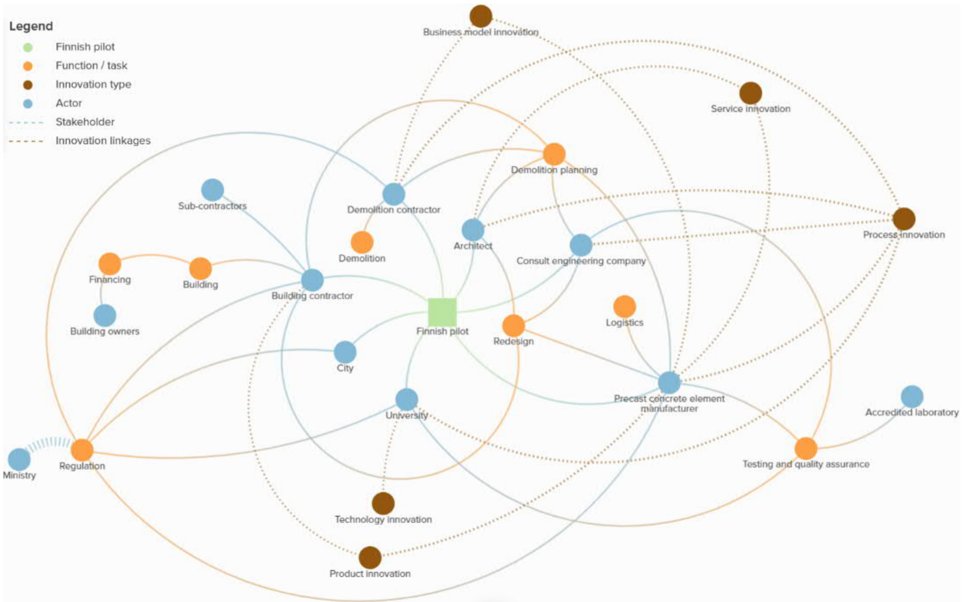

Figure 1. Key actors in the industry ecosystem enabling reuse innovation(s) and concrete rebuilding

The ecosystem of concrete rebuilding in the case comprises a building contractor, subcontractors, a demolition contractor, architect company, consultant company, a precast concrete manufacturer, a university, and a city. These actors are involved in the functions/tasks needed to enable the rebuilding pilot project in one regional setting. The concrete element rebuilding comprises of several tasks/functions (such as demolition planning, testing and quality assurance, redesign) and multiple actors can take part in these different tasks. For demolition planning five actors are needed: architect, consultant, demolition contractor, building contractor, and precast concrete element manufacturer. The university, consultant, and precast concrete manufacturer take part in testing and quality assurance as well as an accredited laboratory. The demolition contractor is in charge of the demolition in the pilot project, whereas the precast concrete element manufacturer takes care of the logistics. The city, the university, precast concrete element manufacturer, demolition and building contractors are engaged in the regulative tasks related to the pilot and a ministry is an important stakeholder for the pilot project. Redesign with the detached building components is done by the architect, consultant company, building contractor and the precast concrete element manufacturer. The building and financing of the pilot project are between the building contractor and the building owner. The building owners are linked to the pilot indirectly through taking part in the financing and building of the new sites.

4.3. Value creation and capture from concrete rebuilding innovation by ecosystem actors

The concrete rebuilding ecosystem creates both direct and indirect value to the actors involved. How this rebuilding is implemented affects how certain actors may capture value in the ecosystem. The value creation manifests as various innovation types provided by different actors.

Next, we give some exemplars on value stemming from reuse innovation: Most interviewed actors stated that the project enables them to implement the values and strategies of their organisations. Sustainability is seen as "good business", enabling brand value gains for building contractors and building owners. New, sustainably oriented customer segments can also be served. Future demand for rebuilding services and products is identified, and thus actors capture value from rebuilding by providing service and product innovations that meet this new emerging demand. Examples of different innovations provided by actors are given in Table 2.

Deconstruction planning and the deconstruction itself are important value-creating innovations in the ecosystem, because they enable identifying reusable elements from the donor building and salvaging them as intact as possible. For the consultant actor, rebuilding enables new service innovation related to "pre-deconstruction auditing" for donor building owners, and demolition contractors provide value to the ecosystem by enhanced process innovation related to the deconstruction process and safe working methods.

For precast concrete element manufacturer, a new type of product innovation emerges as it provides remanufactured concrete components to the ecosystem, recovering the elements supplied by the demolition contractor after donor building deconstruction. The elements also require logistics and storage services, which can be taken on by the element manufacturer or a new emerging actor. The recovered concrete products are considered remanufactured because they are provided to the building contractor of the receiving building in "as new" condition. Introducing a new product innovation also has potential for business model innovation for element manufacturing.

For rebuilding to take on as a scaled practice, the public actors (city/state) can facilitate value creation and capture for other actors by assigning relevant incentives towards rebuilding with reused concrete elements as well as by eliminating legislative barriers hindering element reuse. Doing so also enables public actors to capture value from rebuilding, as they may advance strategic sustainability goals and promote circular economy. Especially for building contractors and owners, this was found to be a determining factor in their value capture potential from concrete rebuilding.

Concrete rebuilding can be implemented in various ways, which determine how value creation manifests in the ecosystem and which actors are able to capture value. These are expressed here as different value creation pathways for concrete reuse. According to the first pathway, concrete elements may be salvaged with the intention of reusing them in demanding applications, which require high-value components that are as good as new. This requires that the elements are either carefully selected in donor buildings to match the quality and safety requirements dictated by the design of the receiving building, or that the products are remanufactured to the extent that they are comparable to virgin products, tested and certified. This allows the building contractor to gain brand value and possible tax incentives from reuse without the risk related to product quality.

Another value creation pathway relates to finding secondary applications for the salvaged elements. This pathway is a cost-effective solution for building contractors to gain use value from existing elements without needing to resort to product recovery or heavy testing and validation processes. The owner of the donor building may also retain the elements for use on the same site, or the demolition contractor can choose to resell or donate them for reuse.

In addition to findings regarding concrete reuse as whole elements, the actors within the case expressed interest towards upcycling of concrete in crushed form to make new concrete. Concrete upcycling, possibly paired with sustainable cement alternatives in new concrete manufacturing is a product innovation that could facilitate diverse uses of concrete in new buildings, even enabling design-for-deconstruction. Building with such upcycled concrete has already been implemented (*see* Nussholz et al., 2020).

5. Discussion and Conclusions

5.1 Key findings and contributions to theory

Finally, we conclude our key findings and discuss their contributions to theory. Our study examining rebuilding as a reuse innovation in construction sector, identified how the innovative rebuilding concept was enabled via diverse types of innovation, as the rebuilding required and enabled technological, product, service, process and business model innovations to emerge. These reuse innovations enable value creation and value capture potential for several actors in the ecosystem in various pathways from high value retaining applications to upcycling.

The rebuilding happened in the industrial ecosystem, whose diverse actors' interactions, practices and businesses the reuse innovation changed: the roles and tasks of the conventional construction industry actors changed, new tasks and interactions emerged and even new actors were needed in the system. New tasks emerging from the different phases of a rebuilding process include demolition planning and deconstruction (how to detach elements to enable reuse), possible repairing of the deconstructed elements, testing and quality assurance, marking and tracking (RFID) of the elements, safe storing of the elements before their reuse, redesigning to enable the use of deconstructed elements in new buildings as well as identifying the regulative conditions for concrete element reuse. These new tasks emerging from the reuse of elements requires closer collaboration and interaction between actors, for example, in demolition planning close collaboration between demolition and building companies, consultant, precast concrete element manufacturer, and architect is needed. In addition, new skills are needed to enable the deconstruction and reuse of concrete elements and these new skills present a possibility for new business opportunities and thus the emergence of new actors in the sector. The required new skills link to the identified innovation types, for example, new deconstruction methods as process innovation and safety assessment services as service innovations provide a fruitful basis for skill development and business opportunities. We also identified several pathways for value creation from the rebuilding concept, which affect the division of value among the ecosystem actors. Value creation from rebuilding manifests in new product innovations for remanufactured concrete products, as well as the accompanying service and process innovations creating new types of revenue to the actors facilitating the reuse. Indirect value creation takes place in the form of brand value and revenue potential from serving new customer segments interested in sustainable construction. Our insights from this study create contributions to several research streams.

Firstly, regarding CE innovation research, our study developed more focused understanding of particular reuse innovations, as the extant research has been biased to recycling oriented innovations. This contribution is addressed in the field of innovation

This paper was presented at ISPIM Connects Valencia – Reconnect, Rediscover, Reimagine, on 30 November to 2 December 2021. Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-691-7. Order number in series 110.

management, to developing field of CE innovation research (Bocken et al., 2016; de Jesus et al., 2018; Engez et al. 2021; Kaipainen & Aarikka-Stenroos, 2021) as well to eco-innovation and sustainable innovation research (Hellström, 2007). However, our study also indicates, that there is a blurred line between the CE principles and reuse innovations link closely and are partially overlapping with recycling and upcycling innovations. Furthermore, we put CE innovation into a system-level analysis: instead of examining one innovation from single company perspective, we examined what reuse innovation is to the whole industrial system and value chain, particularly on value creation and capture perspective, and ecosystem actors' technologies, processes and businesses change due to reuse innovation. system-level innovation.

Secondly, our study observes how theory on value creation and value capture in reuse innovation can be applied in a rebuilding setting. Thus, this study contributes to the research stream of circular business value (e.g. Bocken et al., 2016, Lüdeke-Freund et al., 2019, Nussholz et al., 2020), bringing needed attention on the "reuse" imperative especially. Our study agrees with the prior notions from reuse literature that the process of reusing products holds value potential to several actors involved in the process, especially in the product recovery phase.

Thirdly, our study also provides an empirical-based analysis of CE ecosystem from construction sector, displaying the interlinked actors developing and implementing reuse innovation in the industry system, and the system boundaries for reuse innovation in one industry sector, construction. Our ecosystem mapping answers to the need of more empirical understanding on CE ecosystems (Aarikka-Stenroos et al. 2021) by depicting the actors and their roles, relationships and task division to enabling concrete rebuilding. Mapping the ecosystem for concrete rebuilding visualizes the wide variety of actors needed for the different phases of rebuilding, and thus helps to understand the critical actors and tasks in this particular CE ecosystem.

Fourthly, regarding circular construction, it was identified how it is possible to take advantage of other forms of CE (reuse) than just recycling which is the most applied method of CE in construction sector (Adams et al., 2017). In the study thus identified the risks, challenges and opportunities of reusing the deconstructed elements and how they are distributed among the different project actors; who benefits the most and who incurs the most integration costs and challenges when reuse of deconstructed elements is applied to actors' own activities. The study was also able to show to what extent the process of reusing elements differs from traditional construction and how in practice the role and tasks of actors change when the principle reuse of the CE is utilized. This provided a comprehensive overview of the opportunities created by the CE principle, reuse, in terms of both value creation and environmental impact.

5.2 Implications to practice

Our research insights on reuse innovation creating value for diverse ecosystem actors in construction industry sector provides also guidance on managers from technology and innovation development to business development. Our ecosystem maps guide managers to realize actor diversity be acknowledged when developing, commercializing and implementing circular innovations. Our findings of diverse reuse innovation types (table 2) can encourage managers in realizing their own reuse innovation potential, developing their core business to allow better reuse, and (re-)designing their value propositions accordingly. Our study advices that technology managers should consider how to develop novel technologies to enable reuse and how such technological innovations may lead also to process and business model innovations, whereas business managers addressing to business model innovation allowing reuse innovation should consider how the circular innovation changes technological processes and profound material flows of their industry actors in the system, to make the novel business model profitable.

For construction sector, particularly the practical implication is the identification of digital and technical tools and methods at all different phases of the process of reusing deconstructed elements, such as in building condition survey, demolition design, demolition, marking the deconstructed elements, repairing the deconstructed elements, as well as in the redesigning the new building. Consequently, we have been able to create a comprehensive overview of reuse-oriented innovations in construction industry sector, throughout the building process. In terms of new innovations and practices, one key step is how to implement the dismantling phase, i.e., reverse construction, and how to lift the elements to be dismantled safely (it needs new innovations, for example for lifting parts; what types of lifting parts are needed and how they should be attached to the detached elements in order to make safe lifting). The second main phase of the process for new innovations and modes of action can be considered how the deconstructed elements should be stored, how they should be tested and repaired, and how existing elements monitoring systems are suitable to reusable elements. In addition to these, design tools have also been made for designing new buildings, thus designing new components and elements, so how are they suitable when some of the elements are reused elements and dimensions can vary from standard ones. Other practical implications are also that the actors involved in the project are given a comprehensive overview of the reuse process of the elements being dismantled, as well as the actors and factors that affect it, and thus it is possible for operators to identify the need for a new level of competence, as well as how a scalable business could be obtained from the reuse of deconstructed elements.

5.3 Limitations and future research

This case study focusing on rebuilding on construction sector has analyzed one systemic reuse innovation in one industry sector. Another limitation is that due to our single case strategy, we examined the phenomenon in only one regional setting in Northern European country. Further studies could analyze (systemic) reuse innovations in other sectors (such as remanufacturing in manufacturing and extend the scope of investigations to multiple case studies, where the same reuse innovation can change the ecosystem actors' businesses differently.

As our case stemmed from an EU project where several ecosystem actors were already engaged to the pilot and implement rebuilding innovations, it would be fruitful to study research settings where the industry actors are less engaged, and implementation and adoption of reuse innovation by the ecosystem actors requires more education, facilitation and persuasion. Such studies could provide crucial guidance for firms and industrial value chains on how to enhance development, implementation and adoption of valuable reuse innovation in the industry systems, in successful way that supports commercialization, adoption and diffusion of CE innovations, and thus sustainability transition of the industry.

Acknowledgements

This work is supported by European Union's Horizon 2020 research and innovation program (RECREATE) research funding (grant ID 958200). and the Academy of Finland's "Circular Economy Catalysts: From Innovation to Business Ecosystems (CICAT2025)" research funding (grant ID 320194).

References

Aarikka-Stenroos, L., Ritala, P., & Thomas, L. D. (2021). Circular economy ecosystems: A typology, definitions, and implications. In Research Handbook of Sustainability Agency (Eds. Teerikangas et al.). Edward Elgar Publishing.

Adams, K.T., Osmani, M., Thorpe, T. & Thornback, J. (2017). Circular economy in construction: current awareness, challenges and enablers. Waste and Resources Management, Vol. 170(1), pp. 15-24. https://doi.org/10.1680/jwarm.16.00011.

Ajayabi, A., Chen, H-H., Zhou, K., Hopkinson, P., Wang, Y. & Lam, D. (2019). IOP Conference Series; Earth and Environmental Science, Vol. 225.

Ajayi, S.O., Oyedele, L.O., Bilal, M., Akinade, O.O, Alaka, H.A., Owolabi, H.A. & Kadiri, K.O. (2015). Waste effectiveness of the construction industry: Understanding the impediments and requisites for improvements. Resources, Conservation and Recycling, Vol. 102, pp. 101-112. https://doi.org/10.1016/j.resconrec.2015.06.001.

Akanbi, L.A., Oyedele, L.O., Akinade, O.O., Ajayi, A.O., Davila Delgado, M., Bilal, M. & Bello, S.A. (2018a). Salvaging building materials in a circular economy: a BIM-based whole-life performance estimator. Resources, Conservation and Recycling, Vol. 129, pp. 175-186. https://doi.org/10.1016/j.resconrec.2017.10.026.

Akanbi, L., Oyedele, L., Delgado, D.J.M., Bilal, M., Akinade, O., Ajayi, A. & Mohammed-Yakub, N. (2018b). Reusability analytics tool for end-of-life assessment of building materials in a circular economy. World Journal of Science, Technology and Sustainable Development, Vol. 16(1), pp. 40-55. https://doi.org/10.1108/WJSTSD-05-2018-0041.

Alexander, C., & Smaje, C. (2008). Evaluating third sector reuse organisations in the UK: Case-studies and analysis of furniture reuse schemes. Resources, Conservation and Recycling, Vol. 52(5), pp. 719–730. DOI: 10.1016/j.resconrec.2007.09.005

Ayres, R., Ferrer, G. & Van Leynseele, T. (1997). Eco-efficiency, asset recovery and remanufacturing, European management journal, 15(5), 557-574. doi: 10.1016/S0263-2373(97)00035-2

Baek, C., Park, S-H., Suzuki, M. & Lee, S-H. (2013). Life cycle carbon dioxide assessment tool for buildings in the schematic design phase. Energy and Buildings, Vol. 61, pp. 275-287. https://doi.org/10.1016/j.enbuild.2013.01.025.

Benachio, G.L.F., Freitas, M.D.C.D. & Tavares, S.F. (2020). Circular economy in the construction industry: A systematic literature review. Journal of Cleaner Production. Vol. 260(1). https://doi.org/10.1016/j.jclepro.2020.121046.

Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering, 33(5), 308–320. doi: 10.1080/21681015.2016.1172124

Buyle, M., Galle, W., Debacker, W. & Audenaert, A. (2019). Sustainability assessment of circular building alternatives: consequential LCA and LCC for internal wall assemblies as a case study in a Belgian context. Journal of Cleaner Production, Vol. 218(1), pp. 141-156. https://doi.org/10.1016/j.jclepro.2019.01.306.

Bowman, C. & Ambrosini, V. (2000). Value Creation Versus Value Capture: Towards a Coherent Definition of Value in Strategy, British Journal of Management, Vol. 11(1), pp. 1-15. DOI: 10.1111/1467-8551.00147.

Centobelli, P., Cerchione, R., Chiaroni, D., Del Vecchio, P., & Urbinati, A. (2020). Designing business models in circular economy: A systematic literature review and research agenda. Business Strategy and the Environment, 29(4), 1734-1749.

Chen, J., Shi, Q. & Zhang, W. (2022). Structural path and sensitivity analysis of the CO2 emissions in the construction industry. Environmental Impact Assessment Review, Vol. 92. https://doi.org/10.1016/j.eiar.2021.106679.

Chileshe, N., Rameezdeen, R., Hosseini, MR., Martek, I., Li, H.X. & Panjehbashi-Aghdam, P. (2018). Factors driving the implementation of reverse logistics: A quantified model for the construction industry. Waste Management, Vol. 79, pp. 48-57. https://doi.org/10.1016/j.wasman.2018.07.013.

Crossan, M. M., & Apaydin, M. (2010). A multi-dimensional framework of organizational innovation: A systematic review of the literature. Journal of Management Studies, 47(6), 1154–1191. doi: 10.1111/j.1467-6486.2009.00880.x

Çimen, Ö. (2021). Construction and built environment in circular economy: A comprehensive literature review. Journal of Cleaner Production, Vol. 305. https://doi.org/10.1016/j.jclepro.2021.127180.

Densley Tingley, D., Cooper, S. & Cullen, J. (2017). Understanding and overcoming the barriers to structural steel reuse, a UK perspective. Journal of Cleaner Production, Vol. 148(1), pp. 642-652. https://doi.org/10.1016/j.jclepro.2017.02.006.

de Jesus, A., & Mendonça, S. (2018). Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy. Ecological Economics, 145(August 2017), 75–89. doi: 10.1016/j.ecolecon.2017.08.001.

Durmisevic, E. (2010). Green Design and Assembly of Buildings and Systems, Design for Disassembly: a Key to Life Cycle Design of Buildings and Building Products. VDM Verlag Dr. Müller, Saarbrucken, Germany.

Engez, Anil; Ranta, Valtteri; Aarikka-Stenroos, Leena (2021) How innovations catalyze the circular economy: Building a map of circular economy innovation types from a multiple-case study. In Research Handbook of Innovation for a Circular Economy. Edited by Jakobsen, Lauvås, Quatraro, Rasmussen, and Steinmo. Edward Elgar, Forthcoming.

Gallego-Schmid, A., Chen, H.-M., Sharmina, M. & Mendoza, J.M.F. (2020). Links between circular economy and climate change mitigation in the built environment. Journal of Cleaner Production, Vol. 260(1). https://doi.org/10.1016/j.jclepro.2020.121115.

Geissdoerfer, M., Morioka, S. N., de Carvalho, M. M., & Evans, S. (2018). Business models and supply chains for the circular economy. Journal of Cleaner Production, 190, 712–721. doi: 10.1016/j.jclepro.2018.04.159

Geyer, R., & Doctori Blass, V. (2010). The economics of cell phone reuse and recycling. International Journal of Advanced Manufacturing Technology, 47(5), 515–525. doi: 10.1007/s00170-009-2228-z

Ghaffar, S.H., Burman, M. & Braimah, N. (2020). Pathways to circular construction: an integrated management of construction and demolition waste for resource recovery. Journal of Cleaner Production, Vol. 244(20). https://doi.org/10.1016/j.jclepro.2019.118710.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production, 114, 11–32. doi: 10.1016/j.jclepro.2015.09.007

Flick, U. (2004). Triangulation in qualitative research. A companion to qualitative research, p. 178-183.

Hellström, T. (2007). Dimensions of environmentally sustainable innovation: the structure of eco-innovation concepts. Sustainable Development, 15(3), 148–159. doi: 10.1002/sd.309

Hollander, M. C., Bakker, C. A., & Hultink, E. J. (2017). Product Design in a Circular Economy: Development of a Typology of Key Concepts and Terms. Journal of Industrial Ecology, 21(3), 517–525. doi: 10.1111/jiec.12610

Hopkinson, P., Chen, H.M., Zhou, K., Wang, Y. & Lam, D. (2019). Recovery and reuse of structural products from end-of-life buildings. Proceedings of the Institution of Civil Engineers – Engineering Sustainability, Vol. 172(3), pp. 119–128. https://doi.org/10.1680/jensu.18.00007.

Hopkinson, P., De Angelis, R. & Zils, M. (2020). Systemic building blocks for creating and capturing value from circular economy, Resources, Conservation and Recycling, Vol. 155 pp. 104672. DOI: 10.1016/j.resconrec.2019.104672

Hossain, M.U. & Ng, S.T. (2018). Critical consideration of buildings' environmental impact assessment towards adoption of circular economy: An analytical review. Journal of Cleaner Production, Vol, 205(20), pp. 763-780. https://doi.org/10.1016/j.jclepro.2018.09.120.

Iuorio, O., Napolano, L., Fiorino, L. & Landolfo, R. (2019). The environmental impacts of an innovative modular lightweight steel system: the Elissa case. Journal of Cleaner Production, Vol. 238(20). https://doi.org/10.1016/j.jclepro.2019.117905.

Kaipainen, Jenni; Aarikka-Stenroos, Leena (2021) From vision to commercialization of a circular economy innovation: a longitudinal study of overcoming challenges throughout the full innovation process. In Research Handbook of Innovation for a Circular Economy. Edited by Jakobsen, Lauvås, Quatraro, Rasmussen, and Steinmo. Edward Elgar, Forthcoming.

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127(April), 221–232. doi: 10.1016/j.resconrec.2017.09.005

Linder, M., & Williander, M. (2017). Circular Business Model Innovation: Inherent Uncertainties: Circular Business Model Innovation. Business Strategy and the Environment, 26(2), 182–196. doi: 10.1002/bse.1906

Lüdeke-Freund, F., Gold, S. & Bocken, N.M.P. (2019). A Review and Typology of Circular Economy Business Model Patterns, Journal of Industrial Ecology, Vol. 23(1), pp. 36-61. DOI: 10.1111/jiec.12763.

Maine, E., Lubik, S., & Garnsey, E. (2012). Process-based vs. product-based innovation: Value creation by nanotech ventures. Technovation, 32(3–4), 179–192. doi: 10.1016/j.technovation.2011.10.003

Mariadoss, B. J., Tansuhaj, P. S., & Mouri, N. (2011). Marketing capabilities and innovation-based strategies for environmental sustainability: An exploratory investigation of B2B firms. Industrial Marketing Management, 40(8), 1305–1318. doi: 10.1016/j.indmarman.2011.10.006

Munaro, M.R., Tavares, S.F. & Bragança, L. (2020). Towards circular and more sustainable buildings: A systematic literature review on the circular economy in the built environment. Journal of Cleaner Production, Vol. 260(1). https://doi.org/10.1016/j.jclepro.2020.121134.

Nussholz, J.L.K., Rasmussen, F.N., Whalen, K. & Plepys, A. (2020). Material reuse in buildings: Implications of a circular business model for sustainable value creation, Journal of Cleaner Production, 245, 118546. doi: 10.1016/j.jclepro.2019.118546

Nylén, E.-J. A. (2019). Kiertotaloussiirtymä ja uudet markkinat - Kahden kiertotalousraportin argumenttianalyysi. Alue ja Ympäristö, Vol. 48(1), pp. 14–28. DOI: https://doi.org/10.30663/ay.77836.

O'Grady, T., Minunnon, R., Chong, H-H. & Morrison, G.M. (2021). Design for disassembly, deconstruction and resilience: A circular economy index for the built environment. Resources, Conservation & Recycling, Vol. 175. https://doi.org/10.1016/j.resconrec.2021.105847.

Park, J. Y., & Chertow, M. R. (2014). Establishing and testing the "reuse potential" indicator for managing wastes as resources. Journal of Environmental Management, 137, 45–53. doi: 10.1016/j.jenvman.2013.11.053

Pomponi, F. & Moncaster, A. (2017). Circular economy for the built environment: A research framework. Journal of Cleaner Production, Vol. 143(1), pp. 710-718. https://doi.org/10.1016/j.jclepro.2016.12.055.

Prieto-Sandoval, V., Jaca, C., & Ormazabal, M. (2018). Towards a consensus on the circular economy. Journal of Cleaner Production, 179, 605–615. doi: 10.1016/j.jclepro.2017.12.224

Rahman, S.M.M., Kim, J., Lerondel, G., Bouzidi, Y. & Clerget, L. (2019). Value Retention Options in Circular Economy: Issues and Challenges of LED Lamp Preprocessing, Sustainability (Basel, Switzerland), 11(17), 4723. doi: 10.3390/su11174723

Rakhshan, K., Morel, J-C., Alaka, H. & Charef, R. (2020). Components reuse in the building sector – A systematic review. Waste Management & Research, Vol. 3884), pp. 347-370. DOI: 10.1177/0734242X20910463.

Ranta, V., Aarikka-Stenroos, L., Ritala, P., & Mäkinen, S. J. (2018). Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe. Resources, Conservation and Recycling, 135, 70–82. doi: 10.1016/j.resconrec.2017.08.017

Ranta, V., Keränen, J., & Aarikka-Stenroos, L. (2020). How B2B suppliers articulate customer value propositions in the circular economy: Four innovation-driven value creation logics. Industrial Marketing Management, 87, 291–305. doi: https://doi.org/10.1016/j.indmarman.2019.10.007

Reike, D., Vermeulen, W.J.V. & Witjes, S. (2018). The circular economy: New or Refurbished as CE 3.0? — Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options. Resources, Conservation and Recycling, Vol. 135, pp. 246–264. https://doi.org/10.1016/j.resconrec.2017.08.027.

Russell, J. & Nasr, N. (2019). Value-retention processes within the circular economy, in: Remanufacturing in the Circular Economy: Operations, Engineering and Logistics, pp. 1-29. doi: 10.1002/9781119664383.ch1

Smol, M., Kulczycka, J., Henclik, A., Gorazda, K. & Wzorek, Z. (2015). The possible use of sewage sludge ash (SSA) in the construction industry as a way towards a circular economy. Journal of Cleaner Production, Vol. 95(15), pp. 45-54. https://doi.org/10.1016/j.jclepro.2015.02.051.

Solis-Guzman, J., Marreno, M., Montes-Delgado, M.V. & Ramirez-de-Arellano, A. (2009). A Spanish model for quantification and management of construction waste. Wate Management, Vol. 29(9), pp. 2542-2548. https://doi.org/10.1016/j.wasman.2009.05.009.

Stahel, W.R. (2016). The circular economy. Nature, Vol. 531, pp. 435-438. https://doi.org/10.1038/531435a.

UN Environment Programme, (UNEP). (2016). Towards zero-emission efficient and resilient buildings - GLOBAL STATUS REPORT 2016. Global Alliance for Buildings and Construction.

UN Environment Programme, (UNEP). (2019). 2019 Global status report for buildings and construction - Towards a zero-emissions, efficient and resilient buildings and construction sector. Global Alliance for Buildings and Construction.

Urbinati, A., Chiaroni, D., & Chiesa, V. (2017). Towards a new taxonomy of circular economy business models. Journal of Cleaner Production, 168, 487-498.

Uusikartano, J., Väyrynen, H., & Aarikka-Stenroos, L. (2020). Public Agency in Changing Industrial Circular Economy Ecosystems: Roles, Modes and Structures. Sustainability, 12(23), 10015.

Veleva, V., & Bodkin, G. (2018). Emerging drivers and business models for equipment reuse and remanufacturing in the US: lessons from the biotech industry. Journal of

Environmental Planning and Management, 61(9), 1631–1653. doi: 10.1080/09640568.2017.1369940

Whalen, K.A., Milios, L. & Nussholz, J. (2018). Bridging the gap: Barriers and potential for scaling reuse practices in the Swedish ICT sector, Resources, Conservation and Recycling, 135, 123-131. doi: 10.1016/j.resconrec.2017.07.029

Yrjölä, M., Hokkanen, H., & Saarijärvi, H. (2021). A typology of second-hand business models. Journal of Marketing Management, 37(7-8), 761–791. doi: 10.1080/0267257X.2021.1880465

Zabek, M., Hildebrand, L., Brell-Cokcan, S., & Wirth, M. (2017). Used building materials as secondary resources – Identification of valuable building material and automized deconstruction. Journal of Facade Design and Engineering, Vol. 5(2), pp. 25–33. https://doi.org/10.7480/jfde.2017.2.1684.

Zacho, K. O., Mosgaard, M., & Riisgaard, H. (2018). Capturing uncaptured values — A Danish case study on municipal preparation for reuse and recycling of waste. Resources, Conservation and Recycling, 136, 297–305. doi: 10.1016/j.resconrec.2018.04.031

Zimmann, R., O'Brien, H. & Hargrave, J. (2016). The Circular Economy in the Built Environment. ARUP, pp. 1-94.