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Foresights from the Swedish Kitchen: Four Circular Value Opportunities for the Built Environment

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Abstract: This paper examines the kitchen as one relevant part of the home that is highly affected by frequent replacements, renovations, and a short service life. The aim is to discern circular value opportunities for the built environment by examining stakeholder activities and the value proposition associated with Swedish kitchens. The paper answers the research question 'Which aspects in stakeholders' value proposition of kitchens might contribute to future circular housing design?'. The empirical material was collected through a workshop, interviews, and a focus group session. The data were analysed using qualitative content analysis while applying value mapping as an analytical framework. Four opportunities for circularity were identified: (1) aligning spatial and product design for a circular economy, (2) considering end-user perspectives and demands, (3) formulating regulations informed by research, and (4) developing circular products and services through collaboration. While some of these opportunities have already been emphasised in previous literature, the most distinct contribution of this paper is that it reveals the importance of spatial parameters when transitioning towards a circular housing design. The methods and results of this paper may be adapted to various building components to create a system-level circular economy in the built environment.

Keywords: circular economy; value chain; value proposition; kitchen design; spatial design; built environment

1. Introduction

There is a need for more sustainability in the building industry, which is further demanded by governmental initiatives (e.g., The European Green Deal [1], the Circular Economy Action Plan [2], or the Swedish Climate Act [3]). In contrast to these initiatives, the current linear business model of 'take-make-dispose' contributes to premature disposal of still-functioning products and building components. An alternative to this linear process is the concept of the circular economy (CE) [4], which has the potential to tackle the current linear model's flaws [5]. The CE has been promoted as a key strategy for achieving a sustainable future [6]. In this paper, the authors adopt the following definition of CE:

> ... an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes [...] with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations [7] (pp. 224–225).

The CE is studied for its potential in attaining sustainability [8]. It is shown that shifting to CE in the building industry has economic benefits [9], reduces the industry's environmental impact [10–12], and can contribute to social sustainability [13]. However, studies have also revealed that there are obstacles in achieving the necessary transition. Ownership questions, a lack of integration of sustainability strategies, and 'uncertain aftermaths' of CE implementations are primary barriers in the building sector [14]. Eberhardt [15] found that the complex and long supply chains, profit-oriented short-term goals, lack of universal methods, and unknown future circumstances also contribute to the challenges. It is further argued that engaging stakeholders in developing the value proposition is crucial to overcoming the emerging barriers and achieving a successful transition to a CE in the built environment [15]. These identified aspects imply that breaking down the complexity (e.g., by investigating single building components) and examining connected value chains to align stakeholder goals with the sustainability and circularity agenda are important.

In order to study possibilities for more sustainable housing designs, this paper focuses on the kitchen, since it is a building component with a high impact in terms of material flows and related climate impact over time [16]. Research investigating sustainability questions showed that the kitchen is a resource-intensive part of the home regarding both everyday activities [17] and alterations [18–20]. Premature replacement of kitchen furniture and appliances accounts for an estimated 57% of the overall climate impact (measured in CO_2 equivalent) of interior renovation or maintenance of owner-occupied apartments in multi-residential buildings in Sweden [16]. Additionally, in Europe, approximately 10 million tonnes of furniture (including kitchens) are discarded yearly, of which 80%–90% is incinerated or put in landfills [21]. Increased CE in the kitchen could thus contribute to sustainability from an ecological, economic, and social point of view.

To propose improvements to achieve sustainability and circularity in the built environment, this paper puts the kitchen and its value chain in focus, where rarely any discussion has taken place in previous research. This article answers the question: Which aspects of stakeholders' value proposition of kitchens might contribute to a future circular housing design? Therefore, first the value chain is mapped—using the Swedish kitchen as a case study—with the purpose of understanding the underlying relations, roles, and processes among the stakeholders. Second, this study reveals stakeholders' preferences regarding ideal contemporary kitchen designs, which are analysed to identify potentials for a future circular concept for kitchens and housing design.

The rest of the paper is structured as follows. The relevant theoretical concepts are presented in Section 2. The methods used for collecting and analysing data are introduced in Section 3. Section 4 displays the results of the analysis of the empirical material. Section 5 first discusses the results from a CE perspective, then addresses the limitations and proposes further research recommendations. Section 6 summarises the conclusions.

2. Background and Theory

Business models are used to demonstrate and evaluate how organisations carry out their business and core activities. Richardson's [22] business model framework builds on the recognition that value is a key component of business models and strategies. Three major elements of this framework are the value proposition, the value creation and delivery system, and the value capture. These three elements constitute the value creation logic. This logic is the base of the business model generation approach developed by Osterwalder [23], which consists of strategic ideas and tools for creating and implementing new business models in organisations.

Nußholz [24] summarises the three value elements through three questions (formulated based on Richardson [22] and Osterwalder [23]): (1) Value proposition—'What value is provided and to whom?'; (2) value creation and delivery—'How is value provided?'; and (3) value capture—'How does the company make profit and capture other forms of value?'. This implies that the core of the value creation logic is the value proposition, which needs to be thoroughly defined before strategies for value creation and delivery and value capture can be developed. Den Ouden [25] further stresses that

value propositions are complex systems of the product, the encircling services, their representations, and economic aspects, while the consumers' perception of this system is also an important view to consider. Peronard and Ballantyne [26] underline that, in CE transition, the consumer perspective is a strategic factor in developing value propositions.

Conventional business models are often governed by maximizing economic value while neglecting environmental and social value [27,28]. The importance of integrating all three pillars of sustainability in value propositions is increasingly recognized [27,29,30]. It has been further indicated that organizations must reconsider their value creation logic [24] and incorporate circular strategies that consider the environment and society [27,29,31,32].

The value mapping tool (VMT) [29] aims to support comprehensive development of value propositions that consider economic, environmental, and social benefits. In a multi-stakeholder, network-centric approach, the tool enables stakeholders to evaluate their value proposition and create an action plan for transitioning towards a more sustainable business model [29]. The tool organises the elements of the value proposition into three categories (value captured, value missed, destroyed, or wasted, and value opportunities) and allocates them into relevant stakeholder segments (customers, network actors, society, and environment). The VMT measures both negative and positive value propositions and assesses possibilities for improvements. Further testing of this tool also revealed that it has potential as an evaluation and screening tool for qualitative material [33].

Research in connection to CE in the built environment investigates various approaches to creating sustainable value propositions while slowing, narrowing, and closing resource flows [34]. For instance, studies exploring the potential of material and resource recovery showed environmental, economic, and social advantages [12,35]. Lifecycle-analysis-based tools are made to inform life extension possibilities [36], and design strategies—such as Design for X [37] or the circular building component generator [38]—support design processes for creating circular products and services. Nonetheless, there are barriers in applying these tools and theories in practice.

Specific CE barrier literature exists in various fields [39]. Kirchherr et al. [39] reviewed the literature and extended it with a comprehensive study involving experts on CE. They identified four main cluster categories of barriers (adopted from de Jesusa and Mendonça [40]): (1) Cultural, (2) regulatory, (3) market, and (4) technological. Their findings further reveal that cultural barriers (such as 'hesitant company culture', 'lack of consumer awareness and interest', and 'operating in a linear system') and market barriers (such as 'low virgin material prices' and 'high upfront investment costs') seem to be the most pressing issues. Hart et al. [41] further explore the barrier framework within the built environment while applying the same cluster categories with minor modifications. Their results affirm that, for the built environment, the cultural and market barriers are also the most pressing obstacles.

3. Materials and Methods

This study used a qualitative approach, where data were collected through a workshop, semi-structured interviews, and a focus group session. The workshop aimed to map the stakeholders along the value chain of the kitchen. This first mapping directed the selection of stakeholders for the in-depth interviews. Finally, a focus group with representatives from housing developers and contractors helped verify the information gathered from the interviews. The data were collected between 2018 and 2020 and were handled according to General Data Protection Regulation (GDPR) requirements [42].

3.1. The Empirical Material

This study is part of a research project (The Circular Kitchen; CIK) that aims to find pathways for more sustainable kitchens. This project involves theoretical knowledge building and developing, prototyping and testing new kitchen designs based on CE principles. This paper focuses on design processes of kitchens in condominiums (resident-owned and occupied apartments), which make up 42% of the multi-residential housing stock and 21.5% of all housing units in Sweden, a number which

is also growing [43]. The present study involves several main actors involved in the research project: A large national housing developer (which has commissioned about 32% of existing condominiums in Sweden), a significant national kitchen producer (which manufactures about 18,000 kitchens per year for the Swedish market), and major contracting enterprises that also develop condominiums and, as such, are main clients of the mentioned kitchen producer.

3.1.1. Stakeholder Mapping Workshop with the Kitchen Producer

As part of the CIK project, regular workshops have been organised with the partners. During one of these events, the research team (consisting of two senior researchers and three Ph.D. students) led a session with key actors from the kitchen producer. The main stakeholders in the kitchen value chain were mapped with the help of a power-interest grid for stakeholder prioritisation (adapted from Mendelow [44]). The participants of the workshop were selected based on their expertise, as shown in Table 1. The outcome of this workshop provided an overview of the complex value chain of the kitchen producer and created an understanding of key stakeholders. In total, six stakeholders were identified: Housing developers, architect firms, real estate agencies, kitchen producers, contractors, and end-users.

Table 1. Overview of the participants in the workshop.

Organisation	Participant	Relevance for Study
Kitchen producer	Chief executive officer (CEO)	Has knowledge on the processes and the economic situation, represents the company, makes corporate decisions, manages resources and operations
	Product responsible	Leads projects for new development, monitors existing products
	Product coordinator	Has an administrative role within the assortment department
	Technical product developer 1	Prepares production drawings and oversees furniture-assembly-related practices and processes
	Technical product developer 2	Prepares production drawings and oversees furniture-assembly-related practices and processes

3.1.2. In-Depth Interviews with Stakeholders

Ten semi-structured interviews (with eleven interviewees) were organised during 2019–2020 that focused on how kitchens are commissioned, designed, delivered, installed, and sold in multi-residential housing projects in Sweden. Furthermore, the interviewees shared their views on ideal kitchen designs. The interviews lasted between 35–70 min and were conducted in person or online in either English or Swedish. Quotes from the interviews were selected (and, if necessary, translated into English) to illustrate the results. The interviews were audio recorded and later transcribed.

After identifying key stakeholder types through the workshop (Section 3.1.1), the potential interviewees were contacted based on purposive sampling [45] to gain knowledge relevant for this study (Table 2). The housing developer and the kitchen producer were involved in the CIK project. Representatives from their businesses (A1–A2; F1–F2) were selected based on their involvement in different phases of a housing project. The architects were chosen either because they were consultants (C) for the housing developer (A) or because they have considerable experience in housing and kitchen design (B, D). A real estate broker (E) was approached for their experience in sales processes. A large contractor (G)—as a major client of the kitchen producer (F)—was also interviewed. Lastly, an end-user (H, who resides in a condominium with a kitchen delivered by the housing developer and kitchen producer of CIK) was interviewed to gain insight on their role in the process.

Almost all housing developments in Sweden are conducted as design and build contracts. This means that the contractor is responsible for the planning and realisation of a building project [46]. This type of contract engages the contractor for both design and construction tasks. The interviewed contractor's (G) main activity was building construction, but they also acted as a client for their own housing development. In Section 4, this stakeholder (G) is referred to as contractor or as housing developer based on whether their comments were stated from the perspective of a contractor or a housing developer.

Table 2. Overview of the participants of the interviews.

Case	Organisation	Participant	Relevance for Study
A	Housing developer 1	Responsible for interior finishes (A1)	Coordinates end-user choices for kitchen and bathroom
		Project developer (A2)	Leads the project development from the first stages up to construction
B	Architect firm 1	Senior architect	Has long experience in multi-residential building design
C	Architect firm 2	Architect, CEO	Works regularly for the interviewed housing developer (A) and has 20 years of experience in housing projects
D	Architect firm 3	Senior architect, director of unit at a large international architecture and engineering firm	Acts as project leader for housing projects and has significant experience in drawing newly produced multi-residential houses
E	Real estate agency	Senior real estate broker	Has knowledge on sales processes and user preferences
F	Kitchen producer	Business area manager (F1) *(construction projects)*	Oversees construction projects, develops collaboration processes for housing developer clients, and handles contract negotiations
		Sales manager (F2) *(construction projects)*	Oversees project processes and has knowledge of production drawing process
G	Contractor and housing developer 1	Sustainability specialist (G1) *(project development)*	Manages sustainability questions connected to building projects
		Customer manager (G2)	Deals with client satisfaction and selects and manages the company's assortment of kitchens
H	End-user	Resident	Has recent experiences from the sales process

3.1.3. Focus Group with Housing Developers and Contractors

A focus group session was arranged with main clients (major contracting companies which are also developers of condominiums) of the kitchen producer. The participants were responsible for sustainability management at their respective organisations (Table 3). The aim of the focus group was to verify the results of the interviews and complement the data in case additional information was mentioned by the participants.

Table 3. Overview of the participants at the focus group session.

Organisation	Participant	Relevance for the Study
Kitchen producer *(same as F in interviews)*	CEO	Has knowledge on the economic situation, takes corporate decisions, manages resources and operations
	Business area manager *(construction projects)*	Oversees construction projects, develops collaboration processes for clients, and handles contract negotiations
Contractor and housing developer 1 *(same as G in interviews)*	Sustainability specialist *(project development)*	Manages sustainability questions connected to building projects
Contractor and housing developer 2	Environmental manager	Has knowledge on construction processes and is responsible for sustainability development
	Product development responsible *(interiors)*	Coordinates the permanent furnishings in homes in terms of standard furnishings and optional choices, and participates in designing the apartments' interiors
Contractor and housing developer 3	Public relations manager	Works with communication, concepts, brand development, and sustainability

3.2. Coding of Empirical Material and Value Mapping Analysis

The empirical material (workshop, interviews, and focus group session) was analysed using qualitative content analysis [47,48]. This analysis was done to discover answers related to the research question. Hence, four themes formed the coding frame: Interest (of stakeholders), process map (of the kitchen value chain), roles (of stakeholders), and visions (for ideal kitchen). During the analysis, subcategories emerged from the data that were incorporated in the coding frame. The analysis was summarised with the help of the programme NVivo 12.

The authors of this paper applied the VMT [29] (see Section 2) as a framework for further analysis of the coded material. The tool was adopted by the researchers to evaluate the value propositions derived from the data. The network actors were defined as the main stakeholders of this study (housing developers, kitchen producer, architects, contractors, and real estate broker). The end-user was identified as the final customer, and in alignment with the arguments of Bocken et al. [29], society was included as a stakeholder segment as well. In this paper, the authors consider the environment to be an overarching objective instead of a stakeholder segment. The authors argue that environmental benefit should be a central goal of each aspect of a value proposition; values created for economic or societal reasons should be guided by environmental considerations.

The identified values were organised into the three value categories. In this paper these categories are defined as follows:

1. Value captured: Positive aspects of the value proposition that can support circularity;
2. Value missed, destroyed, or wasted: Negative aspects of the value proposition that can hinder circularity;
3. Value opportunities: Aspects of the value proposition that have the potential to support circularity, including proposals to improve these aspects.

As a result of the analyses, the values named by the network actors have been sorted into three groups: 'Furniture and appliance design', 'spatial design', and 'processes and economy'.

4. Results

This section first describes the mapped stakeholder relationships within the value chain connected to kitchens. Second, the analysis of the value proposition of the stakeholders is presented. Within this analysis, potentials and hindrances in implementing CE are pointed out. The section ends by formulating opportunities for a future circular kitchen and housing design.

4.1. The Mapped Processes among Stakeholders within the Value Chain for Kitchens

During the initial phase of a building project, the housing developer negotiates with an architect regarding the basic design features of the building, including the layouts of the apartments and the kitchen as a space. The architect designs the kitchen in connection with other rooms in the dwelling as well as the overall built-in furniture layout to ensure that the kitchen is functional and designed according to regulations. At the end of this phase, the housing developer makes a final decision regarding the layout of the apartments.

In line with Swedish building regulations, the kitchen (including the built-in furniture and basic kitchen appliances) is delivered with the condominiums and remains a part of the apartment when sold. Depending on the type of procurement and contracting, the kitchen producer is sometimes involved in the initial phase and provides consulting and advisory services. More often, the kitchen producer is only involved at a later phase where the detailed building design is prepared. The design drawings are developed in close collaboration and negotiation among the architect, kitchen producer, and housing developer before the building permit application is submitted. Once the building permit is granted, the architects are no longer involved and do not follow the construction process. In the upcoming phases, the contractor takes over responsibilities connected to architectural drawings, which are usually outsourced to external consultants. During the sales process, drawings, 3D renderings, or show rooms are available for the real estate broker. Often, the construction first starts when at least 30% of the condominiums of a building project are sold.

The housing developers (A; G) established a specific 'interior design process', providing design alternatives to the end-user. These alternatives (basic assortment) include finishes and surface materials, such as tiles, countertop material, taps, colour selection, appliances, and floor material. End-users are thus given the choice to personalise their kitchen with basic options that are included in the purchase price of the condominium or to add more exclusive alternatives for extra costs. The interviewed end-user perceived the basic options as quality solutions and stated that "I thought everything was pretty good by default, so I didn't add anything I wasn't in super need of" (H). The housing developer (G) argued that, through pre-selecting a basic assortment, they aim to ensure quality products for the end-user.

The interior design process is coordinated between the stakeholders. The housing developer defines choices based on the available offers from the kitchen producer and according to the design recommendations of the architect. The final choices of the end-user are communicated to the kitchen producer, who then prepares the production drawings. Once the kitchen furniture is produced, it is delivered to the construction site.

The kitchen producer "know[s] how much [their] clients work with time and logistics on the sites" (F2). Therefore, the kitchen producer (F) aims to provide affordable options for easy installation. For instance, the furniture is transported to the site fully mounted to ease the installation and economic burdens of the contractor. From the contractor's perspective, logistics are important, and by receiving fully mounted kitchen furniture, the onsite labour is reduced. This solution further ensures quality, minimises damages, and prevents incorrect assembly. However, this practice increases the bulk of the cargo and number of shipments.

Additionally, the interviewed contractor (G)—that is also a housing developer—puts high emphasis on internal goals for sustainability and believes it is an advantage for them to be involved in a longer segment of the construction process. In that way, the contractor has a comprehensive

oversight of the project, gains more control over their built-in and end products, secures quality, and can prioritise end-user satisfaction.

4.2. Analysis of the Value Proposition Connected to Kitchens

The analysis of the empirical material consists of four steps, which follow the brainstorming process of Bocken et al. [33]: (1) Identifying the collective purpose of the stakeholders, (2) identifying positive values, (3) identifying negative values, and (4) turning the negative values into positive ones by proposing improvements. These four steps of the analysis are presented in the following sub-sections.

4.2.1. Purpose of the Stakeholders

Despite some apparent conflicts in their interests, the stakeholders presented overlapping aspirations. The housing developer wishes to have an economically feasible project, follow regulations, operate with simple processes, satisfy the end-user, and receive a good rating on the Nöjd Kund Index ('Satisfied Customer Index'). The architect's main goal is to design liveable spaces, find functional and aesthetically appealing solutions, and design the kitchen as a space that properly accommodates the built-in furniture and follows regulations and standards. The kitchen producer aims to provide a holistic service package to the main customers (housing developers and contractors) and create a quality product for the end-user. The end-user wishes to gain the most for their money and receive a functional and aesthetically pleasing kitchen. Lastly, the contractor aims for profitability, a safe working environment, and easy logistics. The stakeholders' overall purpose can be summarised as:

- Creating kitchen furniture that is aesthetically appealing, complies with regulations, and fulfils user needs;
- Designing the kitchen as a room that is functional and liveable;
- Developing economically feasible projects with transparent processes and simple logistics.

4.2.2. Value Captured—Positive Aspects of the Value Proposition that Can Support Circularity

The housing developer (A) appreciates the well-established processes with all their partners. For instance, the offered services and easy communication were mentioned as key factors when choosing a kitchen producer. The kitchen producer (F) actively works towards developing comprehensive processes with key partners. They emphasise the importance of engaging early in a project and providing consulting and guidance services already in the design phase. To enable good collaboration and ensure quality throughout the whole process, there are partnership agreements in place, which describe the basic rules and requirements of their cooperation. This well-established collaboration could potentially facilitate the CE transition for kitchens.

> … I think we had the benefit of having responsive customers, [and] we have had nice cooperation over the last few years, so we have put in a lot of routines that help in this process. (F1)

The long tradition of modular measurements for kitchen furniture allows for the furniture size to be easily adapted to the particular dimensions of a room. Theoretically, in a smaller kitchen, fewer modules can be installed, while in a larger kitchen, the basic constellation can be extended with extra modules. This modular concept provides variation through the same design system. It was indicated (C) that the kitchen furniture has been made with the same modular measurements over the past 40 years and has been adopted by all major kitchen producers. This allows kitchen producers to deliver for any building project and carries the opportunity to develop a product that is easy to repair, refurbish, or dismantle.

The architect designs the kitchen with the intention of creating a functional living space for the end-users. The room must be spacious enough for the household, and its furniture arrangement must allow practical workflows. The architects (B; C; D) expressed that it is their responsibility to create

an apartment floorplan and kitchen that can accommodate reasonable furniture solutions. They also presented intentions to create harmony among the materials used, design features of the furniture, and the connecting rooms. One of the architects (B) added that providing proper daylight in the kitchen is also an important factor.

The housing developers (A; G) and the architects (B; C; D) regard the Swedish regulations and standards as reliable references for creating a good kitchen. They expressed that the standards create an adequate baseline for quality and eliminate inappropriate solutions. The kitchen producer (F) further underlined the importance of the standards and said that in each project, they must follow them. With respect to regulations, accessibility was mentioned as an important spatial aspect and durability of built-in materials as a crucial quality for the furniture.

Concerning the arrangement of the kitchen furniture, the different stakeholders were in consensus with one another. They agreed that the straight and L-shaped layout typologies were favourable options. The straight layout was the most preferred among the interviewees, who added that this layout is most applicable for larger kitchens, where the length of the room provides for this layout typology. The least preferred layout was the U-shaped design. One interviewee mentioned that "all corners are difficult, so the best is to avoid it" (B). The corners are troublesome because the countertop is manufactured in one piece and is therefore difficult to work with during transportation and installation. Furthermore, the U-shaped layout may feel cramped, which is not optimal when multiple people are using the kitchen at the same time. Additionally, valuable countertop surface and storage opportunities are lost or underutilised in this layout. Parallel kitchen designs were viewed as a possible alternative, but only when there is enough space designed between the parallel sides of the furniture. Choosing a built-in furniture layout that is easy to install can later facilitate effortless maintenance or refurbishment, while layout typologies favoured by the end-users could extend the product's lifespan.

Open apartment floorplans were mentioned to be the result of compact housing designs. The efficient site use and floorplan solutions enable lower environmental impact per household. The real estate agent (E) pointed out that an open floorplan with a kitchen island is a favoured solution of the end-user since it creates a space for social activities. Although the architects (B; C; D) had divided opinions about open floorplans, they acknowledged their advantages (e.g., experience of spaciousness, ideal for socialising). One of the architects (D) cited an example project where, in half of the apartments of a building project, a kitchen island was incorporated within the open floorplans and, in contradiction to the housing developers' initial fears, these apartments were sold first and fast. However, it was further noted that providing the kitchen islands was only possible because the apartment sizes were relatively bigger than average due to regulations of the local authorities.

There is an increasing interest in end-user preferences among the stakeholders. For instance, through the work of the interior design responsible (A1) and the customer manager (G2), the respective housing developers (A; G) intended to gain knowledge about user demands and to offer services that satisfy the end-user. The housing developer (A) hopes that they can incorporate these demands in the initial design of the kitchen layout and furniture. By creating solutions that prioritise end-user preferences, the expected use cycle of the product can be prolonged, the number of consumer-initiated radical renovation projects may be reduced, and resources would thereby be used in a more sustainable way.

> Basically, whoever will live there [in the apartments] is our focus. (G1)
> We also have a responsibility to ensure that the customer gets a good product. (G2)

The real estate broker (E) established knowledge about user preferences and, in rare cases, acted as an adviser to the housing developer during the design process. Both the housing developer (A) and the real estate broker (E) found that neutral colours and design solutions were preferred by end-users. The real estate broker (E) further observed that long-lasting and energy-efficient appliances are often appreciated. The housing developer (G) saw an increasing demand for more technological solutions (e.g., appliances operated through apps) among their younger clients. According to the

kitchen producer (F), popular trends include drawers with soft closing systems or countertops made of stone products. Table 4 summarises the captured circular values in the stakeholder's value proposition. These values have the possibility to support a circular kitchen and housing design.

Table 4. Summary of identified captured circular values for the Swedish kitchen.

Stakeholder Segments	Value Captured (*Positive Aspects of the Value Proposition that can Support Circularity*)	
Network actors	Furniture and appliance design	Modular design Functional furniture Practical workflows Selected base assortment Demand for durable materials Design harmony and aesthetics
	Spatial design	Open layouts enabling social engagement Extensive regulations connected to apartment design and kitchen Accessibility regulations Preferred functional layouts Daylight requirements Intention to create liveable spatial design Small, compact apartments that have less environmental impact Dimensions of room determining furniture Design harmony and aesthetics
	Processes and economy	Existing partnership agreements Well-established collaborations aiming at effective communication Rising interest in end-user wishes Increased internal sustainability ambitions Similar goals and interests among stakeholders
End-user	Demand for long-lasting and energy-efficient appliances Increased interest for technical solutions (e.g., connected apps) Preferences for neutral colours and design Options for end-user choices	
Society	Regulations and standards for good kitchen solutions	

4.2.3. Value Missed, Destroyed, or Wasted—Negative Aspects of the Value Proposition that Can Hinder Circularity

The linear business model of the stakeholders mostly ends with the installation of a kitchen. The kitchen producer (F) explains that there is a five-year warranty period while the end-users receive help with damages in the furniture. However, there is a missed circular opportunity to capture revenue from long-term, second-cycle services such as recollecting, refurbishing, and reselling kitchen furniture or recycling materials.

Furniture design examples from the 1920s and 1950s were cited as exclusive, custom made, and easy to repair. However, it was pointed out that, even if there is the possibility to refurbish older solid wood furniture, it is costly, and often, it is cheaper to replace all of it. Recent kitchen furniture is more difficult to refurbish, since fibreboards became the most common material used in the furniture industry. To enable more circularity for kitchens, it is crucial to apply materials that are easy to maintain, refurbish, and recycle. However, there is a lack of feasible, durable, and sustainable alternatives. The kitchen producer (F) also pointed out that there are risks in changing practices first on the market: There is economic uncertainty, the company might lose customers, production processes must be reorganised, and they would need to invest in new equipment, production lines, and facilities.

The housing developer aims for profitable projects, which influences what kitchen designs are realised. Firstly, extra equipment or larger kitchens than required by regulations would lead to extra costs. These extra costs could be mitigated by higher rental or selling prices, but these prices

might elicit unfavourable responses from end-users. Secondly, usually, the housing developer aims to maximise their profit for each project. Consequently, apartments built today are more compact and less flexible [48]. Thirdly, experimenting with new solutions and being innovative is a risk factor for housing developers, since untested alternatives might not sell. Architects (C; D; E) found that regulations and standards are applied too rigidly, and this leads to inflexible dwellings and a lack of innovative solutions. They also pointed out that housing developers often ask for the minimum that standards recommend. Therefore, to achieve circularity, enable long use cycles, and eliminate unnecessary renovations, it is important to balance economic gains with end-user demands.

> The developer [. . .] want[s] the kitchen to be a nice kitchen, but they don't want to make it bigger than the standards demand so they keep it for the exact [. . .] size for the purpose of the apartment. [. . .] I think I am very critical to these standards because they are today used as a model, so you can't do anything else but the standards, so that I think is wrong. (D)

Many apartments today are built with an open floorplan between the kitchen and the living room. As stated earlier, this is primarily to save space and increase profitability, but is marketed as a means to enhance sustainability by permitting dense developments, efficient heating, and opportunities for social activities. One of the interview participants from the housing developer expressed concerns regarding this practice, pointing out that " . . . the reason why we have these open kitchens and living room is [...] to minimise, to cut [. . .] square metres, or [. . .] combine the areas. So, it is a way of narrowing things, actually lowering quality in one sense" (A2). An architect (D) also remarked that the open floorplan solution was a result of more compact living spaces. It was further expressed that "if [a dwelling] has a large area, the kitchen can be large too. If it has a small area, one can, in some way, be forced into solutions for [combined] kitchens and living rooms [. . .] to save space" (B). An additional speculation was made stating that, if the end-user could choose between an open layout or a separate kitchen (for the same price), the latter solution would be more popular.

The kitchen producer (F) and housing developer (G) pointed out that the dimensions of the kitchen predominantly determine the arrangement of the built-in furniture. In a larger space, there is more opportunity for more exclusive solutions (such as a kitchen island). An interviewee (F2) reflected that, in other dwelling types (e.g., terraced houses), there is a more spacious room for a kitchen and, hence, there is more possibility for better-equipped furniture. In connection to the modular measurements of the furniture, one of the architects mentioned that, if they design something "that doesn't follow those modular [measures] at all, none of the big manufacturers can actually deliver anything, so it has to be all custom made and that's not an option. [. . .] It would be far too expensive" (C).

The infrastructure (e.g., electricity, plumbing, ventilation system) connected to the kitchen also influences the spatial design of the room. One interviewee opined (D) that the electricity was the least influential factor. The plumbing and ventilation systems play a higher impact. The age and condition of these infrastructure systems can be major reasons for fully renovating a kitchen. However, these systems are hard to modify, since they are often built into the overall building structure and are connected to larger systems.

Further difficulties can occur if this infrastructure is part of a kitchen island (e.g., sink, stove). The kitchen producer (F) also emphasised that furniture must be designed in consideration of the infrastructure. Considerations include, for instance, how to cover water and ventilation pipes. The flexibility, adaptability, and 'furnishability' of a kitchen is influenced by how the necessary infrastructure was installed in the first place. For example, the positions of the electrical sockets determine the appliances' locations, and the water and plumbing system determine the location of the sink and dishwasher. Therefore, creating more flexible ways of connecting to infrastructure can facilitate various layout solutions and would not lock in certain parts (e.g., sink, oven, dishwasher, ventilation hub) of the built-in furniture.

The kitchen furniture must also accommodate built-in appliances. These appliances are delivered through the contractor, and the kitchen producer must adjust the measurements of the furniture

accordingly. The kitchen producer (F) must be able to produce a wide range of possible furniture sizes, since the dimensions of appliances vary between producers. This is not a sustainable practice, since the wide range of measurements makes repairs and refurbishment difficult. Changing appliance trends were also mentioned. For example, today, the microwave oven is a standard, often built-in part of the kitchen, while the stove and the oven are not necessarily integrated into one device (B). The stove is commonly mounted separately in the countertop, and the oven is placed in a tall cupboard at a comfortable operation height. These changes reflect both technological advances and user preferences.

The end-user has a limited influence on the layout and equipment of the built-in furniture, which is finalised by the time the end-user is involved in the process. Furthermore, there are few projects that directly involve end-users in evaluating the final design from their perspective. The kitchen producer (F), for instance, solely follows trends, and they rely on their experience with private clients (mostly villa owners).

The real estate broker (E) and the housing developer (G) pointed out that the location of the housing project also has an impact on the kitchen. Depending on the area, the anticipated group of buyers might have different expectations regarding the quality and equipment of a kitchen.

Table 5 summarises the identified missed, destroyed, or wasted circular values. These negative aspects can hinder the CE transition; in a future kitchen and housing design they must be improved.

Table 5. Summary of missed, destroyed, or wasted circular values within the value proposition of the Swedish kitchen.

Stakeholder Segments	**Value Missed, Destroyed, or Wasted** *(Negative Aspects of the Value Proposition that Can Hinder Circularity)*	
Network actors	Furniture and appliance design	Modular dimensions of furniture: Lack of innovation opportunities Unsustainable material use, lack of alternatives Lack of correlation between standard measures for appliances and furniture Decreased flexibility for renovations due to built-in furniture and appliances Quality differences based on location of housing project and target group
	Spatial design	Lack of experimentation and innovation Hesitant company culture Lack of flexibility and adaptability Shrinking, more compact apartment sizes Strictly following the minimal requirements of regulations leading to inflexible apartments Inflexible infrastructure (electricity, plumbing, ventilation) Lack of simple separation options for open floorplans
	Processes and economy	Linear process Stakeholders are engaged in a limited part of the process, "relay run" Complex and long value and supply chain Economic pressure governs (design) decisions Furniture usually delivered fully mounted, increased transport Sustainability or circularity is not a priority Costly repair work to refresh or refurbish furniture High precision for installation—increased logistics Complex parts of furniture (e.g., long worktops)—difficult to deliver and install
End-user	Lack of direct feedback and evaluation channels Exclusion from design processes Limited options for personalisation (only final finishings) Increased number of electric devices in the kitchen Some demands result in economical or logistical conflicts(e.g., kitchen islands, long worktops without gaps)	
Society	Lack of regulations for more circularity measures Minimum requirements for design of homes (storage, m^2, etc.) being strictly applied as an upper limit	

4.2.4. Four Circularity Opportunities for the Kitchen and Housing Design

The circular value opportunities consist of propositions by the interviewed stakeholders and suggestions by the authors based on the identified missed, destroyed, or wasted values in line with CE principles. These strategies have been clustered into four circular opportunities: (1) Aligning spatial and product design for circular economy, (2) considering end-user perspectives and demands, (3) formulating regulations based on research outcomes, and (4) developing circular products and services through collaboration (Table 6).

Table 6. Summary of circular value opportunities for the kitchen and built environment.

Stakeholder Segment	Value Opportunities *(that Have the Potential to Support Circularity, Including Improvement Proposals)*		Clusters
Network actors	Furniture and appliance design	Long-lasting design [1]	Aligning spatial and product design for circular economy
		Increased standardization [1]	
		Practical, functional, aesthetically appealing furniture well-equipped with storage [1]	
		Flexible basic furniture arrangement to enable variety and adaptability [1]	
		Mobile furniture solutions [1]	
		Feasible, durable, sustainable alternative materials which are easy to refresh or renovate [1]	
		Energy-efficient and multifunctional appliances [2]	
		Lifecycle extension of kitchen products [2]	
		Attractive modular worktop solutions with sealed gaps [2]	
	Spatial design	More straight kitchens and fewer corners [1]	
		Reasonable spatial margins (e.g., enabling flexibility or kitchen islands) [1]	
		Easy and flexible separation solutions to divide open floorplans [1]	
		Spacious dimensions for number of users and functional workflow [1]	
		Adaptable and flexible layout solutions [1]	
		More flexibility in plumbing, ventilation, and electricity infrastructure and outlets [2]	
	Processes and economy	Challenging the idea of delivering kitchens fully assembled [1]	Developing circular products and services through collaboration
		Aligned standards and expand collaborations [2]	
		Understanding long-term market dynamics [2]	
		New business models [2]	
		New partnerships [2]	
		New loops and services (reuse, refurbish, recycle) [2]	
End-user	New feedback channels [1]		Considering end-user perspectives and demands
	Evaluation of user demands [1]		
	Increased user involvement [2]		
Society	New regulations demanding sustainability and circularity [1]		Formulating regulations informed by research
	Regulations possibly requiring reasonably generous dimensions to enable flexibility and adaptability [1]		

[1] Improvement proposals from stakeholders. [2] Improvement proposal from authors based on identified missed, destroyed, and wasted values in line with circular economy (CE) goals.

Circular Opportunity 1: Aligning Spatial and Product Design for Circular Economy

With respect to spatial and product design, the stakeholders had concrete suggestions for how to improve current practices. The real estate broker described that "the kitchen is a little heart of the

dwelling and people are there a lot. One sits there and studies, reads, eats, and socialises, so it is very important for people. [. . .] It should be practical, should be pretty, [have] enough [. . .] storage, and one should be able to have their guests" (E). Additionally, long-lasting design solutions were mentioned as a value, and the real estate broker (E) indicated that enabling easy refurbishment of the furniture could encourage people to keep their kitchen longer.

There was a wish for more standardised layouts and furniture design to make logistics faster and easier (A1). This interviewee added that these standardised solutions must be flexible enough to adapt to the user needs. The flexibility of a basic layout could potentially provide a wide range of variations. A modular kitchen furniture design, where the furniture sections could be bought and installed separately, was mentioned as an example of an easily adaptable furniture concept. This concept could also allow a modular worktop solution with sealed gaps.

The interior design responsible (A1) recognised that some end-users wish to separate the kitchen from the living room. The main reason for this demand was presumed to be the end-user's desire to have more privacy and hide the kitchen if it happens to be messy. However, the interviewee added that this trend mostly reflects the elderly age group's wishes. The architects (B; C; D) mentioned a few examples of how to create an open but still visually divided kitchen and living room area: Placing a kitchen island between the two areas, using movable walls, or having a bar segment to divide the two.

The dimensions (e.g., height, length, modular measurements compatible with the furniture) of the space have a direct influence on the furniture design and on the workflow. For instance, in a smaller kitchen, it is difficult to fit enough working surface between the water source (sink) and cooking surface (stove) as required by regulations. Preferences for more functional layout typologies (straight and L-kitchen) intend to avoid non-functional kitchens and increase user satisfaction. The architect's aim to create suitable living spaces contributes to social sustainability. Furthermore, the architects (B; C; D) agreed that the size, shape, and dimensions of the kitchen were influenced by the size of the apartment, "because the kitchen won't be better than the floorplan [of the dwelling], it is that simple actually, it is connected" (B). Providing various adequate solutions (with respect to room size and shape, furniture layout, storage options, and proper workflow) is easier in larger apartments. It was suggested that, during the design phase, it is wise to plan in a spatial margin in case there is a need for more space than anticipated (A2).

One of the architects (B) mentioned an example regarding the mobility of the furniture: A mobile kitchen island which, if not in use, could be placed against a wall. Another example—where the architects consciously dealt with flexibility and adaptability—was to develop several versions of the same apartment floorplan (C). By placing some walls in different positions, the design enabled five or six different floorplans. The client would then have the opportunity to choose their preferred solution for each apartment without raising the costs of production. For future end-users, the possible variations may enable easy modification of the existing floorplan.

Circular Opportunity 2: Considering End-User Perspectives and Demands

All stakeholders expressed a wish for more direct—for instance, interview-based—feedback loops with the end-users. The stakeholders must establish new channels for gaining insight into user preferences and incorporate them early in the design process, which would contribute to the life extension of the product. A more extensive evaluation of user demands or more inclusive user involvement could lead to solutions that provide flexibility and adaptability, which would enable personalisation for various user groups and individual needs.

Circular Opportunity 3: Formulating Regulations Informed by Research

Even though stakeholders showed some dissatisfaction with regulations, they mentioned only a few possible improvements. The kitchen producer (F) indicated that new regulations demanding sustainability and circularity would accelerate the CE transition by enforcing change among all stakeholders. This would eliminate risks associated with being the first ones to implement CE. Some

of the participants (A2; D) also expressed that regulations could require more generous dimensions to enable flexibility and adaptability. However, this aspiration conflicts with the economical prioritisation that the building industry is based on today.

Circular Opportunity 4: Developing Circular Products and Services through Collaboration

The participants of the study showed little ambition for transitioning towards CE. It seems that only minor changes have been considered, such as challenging the idea of delivering kitchens fully mounted or developing sustainability strategies for their respective companies. These changes are formulated and implemented on an organisational level rather than in collaboration with stakeholders along the value chain. Therefore, there is a need to align strategies and standards and to extend collaborations. Such collaborations could also enable a better understanding of long-term market dynamics.

5. Discussion

With one of the most resource-intensive functions in the home, the kitchen holds a great potential for increased sustainability by applying CE. The interview study revealed a broad scope of stakeholder views, and although the focus group participants did not express any additional information, their comments reinforced the interview data. The results show that there is a wide range of circular possibilities within the current value proposition of kitchens. For instance, the efficient processes established by the kitchen producer, which enable easy communication, steady collaboration, and manageable production, can serve as a platform for transitioning the current linear business model to a circular one. Close cooperation can facilitate the development of common circular goals and pathways to transition to CE in the industry. Furthermore, the modular furniture design may enable easy product reparation, refurbishment, reassembly, personalisation, and inter-compatibility among different manufacturers' products. By improving the already existing modularity (which currently focuses on dimensions) of the kitchen furniture, a circular product design can facilitate slowing, narrowing, and closing the loops [34].

In some cases, statements of the study participants were somewhat contradictory. For example, many stakeholders desired enhanced standardisation and modular furniture measurements, while they simultaneously criticised the lack of personalisation and innovation in design, or the end-users desired larger apartment sizes while the other stakeholders acknowledged the current economic strains on the construction industry. Additionally, more compact apartments are economically and environmentally advantageous, but they may negatively impact the quality of life of the end-users. For instance, recent research has shown that smaller apartments are less flexible in their design and their potential to adapt to various user needs [49]. These examples demonstrate that different prioritisations and design choices result in trade-offs, and there are some conflicts among stakeholder interests.

There are missed, destroyed, or wasted values that hinder the transition to CE. The linear business model of the industry is a major obstacle in the value chain. This is paired with a hesitant company culture that obstructs CE development. The dominant economic focus of organisations results in shrinking living spaces and lost opportunities to capture circular value. The stakeholders named strategies to lower in-situ installation-related economic burdens and standardised solutions to limit expenses. However, these strategies lead to environmental disadvantages (increased transportation) and products with shorter service lives. Furthermore, the lack of legislative guidance for sustainability and circularity, practical examples, and circular design solutions is a significant barrier. The stakeholders face challenges, since current practices are difficult to change as long as there is a shortage of viable circular alternatives both on a product and service level. Additionally, the stakeholders admit that their access to user feedback and knowledge on user preferences is limited.

In line with Kirchherr et al. [39] and Hart et al. [41], the results of this study suggest that cultural and market barriers are the most common with respect to the value proposition of kitchens. The regulatory and technological barriers seem to be similarly pressing issues. Encouragingly, there is possibility to turn these challenges into new circular opportunities by incorporating the fundamental

CE principles, such as maintaining, prolonging, reusing, redistributing, refurbishing, remanufacturing, and recycling [9], in the product design and business model of kitchens.

5.1. The Significance of Spatial and Product Design Alignment for Circularity

Spatial features were frequently mentioned by all stakeholders. The large number of references to spatial qualities gathered from the interviews indicate that spatial design can influence circularity. The results demonstrate that, within the value chain, there is knowledge regarding spatial qualities that can enable circularity. This knowledge needs to be further explored, and circular spatial design strategies must accompany product-level CE design. In the built environment, products are connected to space, and certain aspects (e.g., dimensions, shape, accessibility, infrastructure, daylight, etc.) influence how those products can be integrated, used, and re-circulated.

The current apartment design fails to address changing lifestyle situations [17,49]. This failure might lead to high numbers of relocations of the residents, which might be followed by high rates of renovations to adjust the dwellings to their needs. By creating more adaptable apartment floorplans (additionally designed with a reasonable spatial margin), the number of relocations and connected redundant waste generation could be reduced. Accompanying circular design strategies could further enable low-impact personalisation and renovation on both a spatial level (restructuring the floorplan, adaptable infrastructure) and a product level (furniture, appliances, fixtures, windows, doors, etc.). Ultimately, it is important to reconsider how apartments are designed and what aspects are the most important (beyond the economic) in order to prioritise circular design in the home and, thus, in the building industry.

5.2. The End-User in Focus

The end-users' perspective is a crucial aspect of CE development [26], and their perceptions of kitchens must be considered when developing the value proposition [25]. The results in this study show that consultations with end-users in multi-residential building processes are limited. For other types of building projects (e.g., villas, terraced houses), the end-user is the direct client and the building is designed according to their needs. The end-user is not the direct client in multi-residential projects, and, hence, their perspective is little considered. This lack of consideration is because economic gains are prioritised more than user demands. Even though end-users wish for more spacious dwellings, larger apartments are more costly and economically risky for housing developers, who instead focus on smaller apartment sizes that will be easier to sell.

The end-users' demands need to be further considered in order to enable sustainability and circularity in the construction sector [8,25,26]. Although this study focused on condominiums, there are many similarities in rental dwellings with respect to user experiences of kitchens. Due to urbanisation, a rising number of people live in city apartments [50]. In Sweden, 51% of the housing stock consists of (rental and owner-occupied) apartments in multi-residential buildings [43]. Therefore, user-preference-based design for these types of buildings can have significant social, environmental, and economic benefits, since it can enable long-term use and lower renovation impacts. Furthermore, more integrated user preferences can foster long-lasting designs and, therefore, extend the service lives of kitchens.

It was also suggested that real estate brokers' knowledge on user preferences could be further exploited, and that they could be involved during the design process of multi-residential building projects. However, their knowledge should be reviewed critically, since the real estate broker is often motivated by short-term economic factors, and sustainability questions are less of a priority for them. Furthermore, it is necessary to review the end-users' wishes too, and their design suggestions should be assessed by trained professionals (such as architects and product designers).

5.3. Gap between Research and Regulations

There has been a long tradition of user-focused kitchen research in Sweden that started in the 1930s [51]. Thorough full-scale experiments in model kitchens and studies of user behaviour in their private homes were part of that research. The results of that research became the basis for building regulations, which, with modifications and additions, have been used ever since [52]. The standards were loosened when Sweden entered the European Union, and in the 1990s, the building sector was deregulated while adapting to European guidelines. The stakeholders' responses show that regulations and standards are still regarded somewhat positively with respect to how they guide good kitchen designs and help to avoid inappropriate solutions. It was suggested that regulations could require larger minimum dimensions to enable more generous living spaces and greater flexibility. Nonetheless, the current development of regulations points in the opposite direction, allowing and promoting decreasing apartment sizes.

The extensive research on the home carried out from the 1930s to the 1980s produced valuable results and notably improved the design of Swedish homes [51]. The stakeholders showed trust in the regulations, which might be because the regulations stemmed from evidence-based research. This trust in the regulations could accelerate the CE transition once the regulations are formulated and enforced. However, there is a need to revisit previous research approaches and to once more perform extensive user-based investigations on the home. This is necessary since the lifestyle changes and sustainability and circularity demands have established new challenges for dwellings.

Current regulations focus little on sustainability or circularity. Environmental and social sustainability are especially disregarded, and, therefore, economic considerations drive the industry. Furthermore, there is a lack of long-term vision in the regulations, which leads to poorly designed kitchens and homes that result in more renovations and, thus, environmental impacts [16]. All three pillars of sustainability and related CE strategies need to be incorporated into governmental legislation in order to facilitate a transition in the industry and enable regulatory support for manufacturers and suppliers.

5.4. The Importance of Collaboration to Achieve Circularity

In alignment with the examined literature, there is a need for strengthened and extended collaboration [15] in the value chain related to kitchens, and organisations must rethink their value creation logic [24] to provide for more circularity. Based on the identified missed, destroyed, or wasted values, it is apparent that the business model of the building industry needs to be reorganised. The results revealed that the current conventional business model and value proposition for kitchens barely consider environmental and social impacts. Including these perspectives in a circular value proposition is an essential step for achieving sustainability [27,29,30]. The industry must shift from a purely economic focus and include environmental and social considerations to develop a sustainable kitchen and housing design.

Due to complex building processes and long supply chains [15], the different stakeholders are involved only in certain parts of the overall process and do not collaborate at each stage of a housing development, which might be one of the reasons behind the unutilized circular values. New activities combined with alternative business model archetypes [53] could provide opportunities to capture currently missed circular values.

System-level changes—which are necessary for achieving sustainability and circularity—are lacking from the stakeholders' visions. The reviewed literature shows that there is economic [9], environmental [10–12], and social [13] potential in circular business models, extended collaborations, new partnerships, and circular services (reuse, refurbish, recycle). These proposed solutions present great opportunities for the built environment. Retrieving and reutilising still-functional building components, products, and materials has significant potential for reducing the large amount of waste that the building industry currently produces [14,15]. These new services require industry-level collaboration through the design processes up until second-life repurposing.

Who the stakeholders engage with is as important as how the construction sector works. The current collaborations need to be strengthened to find and capture unexploited circular values. This study revealed that there are extensive technical barriers to CE implementation. One significant challenge is the lack of circular alternatives to current products. Value opportunities could be unlocked by establishing new collaborations with suppliers, providing circular products, or developing new businesses to create the necessary circular inventions. These partnerships can further encourage circular design solutions for building components or material innovations.

5.5. Limitations of the Study and Future Research Recommendations

This study is qualitative, which enabled the identification of different types of value and opportunities for more circular design in kitchens as well as the understanding of the underlying motivations behind stakeholder statements. A possible limitation of the study may be that the values and opportunities are not weighted for their importance; this potentially needs to be further studied. Some of the statements might also be context dependent, as a relatively small number of stakeholders were interviewed, and the study only examines the Swedish design process for kitchens.

Regarding the generalisability of the results, the authors acknowledge that their focus on kitchens might have led to specific findings. The kitchen is a room which requires certain types of equipment (e.g., infrastructure, appliances, built-in furniture) that might not be necessary in other rooms. However, results from focusing on the kitchen may be even easier to adapt to less demanding spatial contexts.

Customer needs are essential to value creation [26]. A crucial next step to complement the results of this paper is further investigation of the needs and wishes of the end-user. The suggested improvements need proof-of-concept testing, and research on CE in the home environment needs to be extended to other rooms to create a holistic solution. Furthermore, the trade-offs in CE design choices must be studied to minimise the negative impacts of their application.

6. Conclusions

In this paper, the authors explored the potential for more circular housing development, exemplified in the value chain of the kitchen as one building component. This was done by analysing the processes and value proposition of stakeholders. The research design consisted of a workshop, semi-structured interviews, and a focus group session with key stakeholders, where the questions encircled around how kitchens are commissioned, designed, delivered, installed, and sold. The outcome of this research provided a list of favoured qualities of kitchens from diverse stakeholder perspectives. This list was reviewed to assess whether different aspects support or hinder circularity. The analysis revealed possibilities, hindrances, and opportunities for developing a circular kitchen and housing design.

Positive qualities within the value proposition have been identified as a base to build on for a future circular kitchen design. The current modular design system, well-established collaborations in the industry, design intentions for proper living spaces, emphasis on spatial qualities, increased interest in end-user perspectives, and demand for energy-efficient appliances can all be viewed as strong starting points for working towards circularity in the built environment. However, the current linear processes, limited user involvement, a lack of consideration for the environment and society, more compact living spaces, a lack of product and material recovery, and strictly applied minimum requirements in housing design hinder this development. By identifying positive and negative values, the authors revealed leverage points and proposed potential circular opportunities for improvements.

Based on the results of the analysis, and in line with the findings of the examined literature, this paper formulates four circularity opportunities for the kitchen and the built environment: (1) aligning spatial and product design for circular economy, (2) considering end-user perspectives and demands, (3) formulating regulations informed by research, and (4) developing circular products and services through collaboration. The main contribution of this paper regarding the development of circularity in housing development is the importance of considering spatial factors. The identified spatial qualities

of the kitchen could be further studied with the aim of defining architectural design solutions for maximising circularity. Based on the outcomes of such a study, design strategies could be formulated for the kitchen as a space that enables CE in the home.

The authors of this paper conclude that there is a need for more circular design solutions for kitchens not only to fulfil end-user demands to reduce renovations, but also to enable sustainable retrofits to minimise material flows and waste production. Furthermore, the methods of this paper could be replicated to study various building components. In-depth investigations of value propositions connected to those components can lead to improvements that will enable a holistic, circular, and sustainable built environment.

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