

Article

Co-Creating Service Concepts for the Built Environment Based on the End-User's Daily Activities Analysis: KTH Live-in-Lab Explorative Case Study

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Abstract: The purpose of this study is to synthesize the widely used theories about co-creation from two main perspectives: co-creation as an innovation process and co-creation as a design process applied to the service concept design in the built environment context. The architecture, engineering, and construction (AEC) industry do not have much application of end-user-oriented service design in general, especially with intensive co-creation processes. To facilitate such a process, we are using a living lab environment as a laboratorial model of the real built environment, but with the opportunity to have access to the end-users and different types of stakeholders. Using the KTH Live-in-Lab explorative case study, we were able to discuss the concept of co-creation by distinguishing between co-creation as innovation and co-creation as a design process, facilitating the process of co-creation of service concepts for the proposed built environment including methods from both perspectives: innovation and design, and evaluating the process of service concepts co-creation for the built environment from the point of innovation, knowledge transfer, sustainability, and user experience.

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Keywords: co-creation; service concept; living lab environment; built environment

1. Introduction

Presently, the vast majority of the innovation projects in the building sector in the EU are related to sustainable building construction and operation. A good example of this trend is the flagship project Building Technologies Accelerator (BTA) by Climate KIC, which aims to speed up the dissemination of new products, technologies, and services contributing to climate change adaptation and mitigation in the built environment. To reach this goal, BTA provides a network of living labs for co-designing and testing new sustainable products, services, and models for energy management, indoor environmental quality control, and management of the real environment by real users [1]. Technical options to decrease energy demand are widely available and, in many cases, economically viable [2], still, further innovation is needed to unwrap their full potential, including greater end-user involvement and better adjustment and customization. Early studies of [3,4] highlighted an ignorance of end-user requirements during both: building design and operation. Little has been improved since this was written. Different examples are highlighted by [5,6], and mostly touch areas as wellbeing and overall user experience of everyday life. Authors [7] still highlight the communications gap between the end-users, designers, and building owners. Also, the building sector is one of the slowest in the adoption of innovation [8], further initiatives, tools, and platforms are needed to enhance innovation. Living labs can be used for testing and research in the building sector where inhabitants/users are engaged in product or service co-development and providing feedback to the innovating organizations. Living labs provide open-innovation environments,

which in combination with established open innovation ecosystems and respective stakeholder organizations can serve as an effective platform to foster the development and uptake of innovation in the building sector [1].

In many industries, the role of the individual customer is becoming more important and firms must form close relationships with them to understand their needs and incorporate those needs in their product and/or service offering [9]. The customers' role in the industrial system has changed from isolated to connected, from unaware to informed, from passive to active, and their great influence in value creation is supported by information access, global view, networking, experimentation, and activism [10]. According to [11], co-creation is a powerful engine for innovation: instead of limiting it to what companies can devise within their borders, pull systems through the process open to many diverse participants, whose input can take product and service offerings in unexpected directions that serve a much broader range of needs. Co-creation offers significant opportunities for innovation, as each actor offers access to new resources through a process of resource integration. However, despite the significant advantages that co-creation can offer, there is surprisingly little research providing a strategic approach for identifying the most advantageous co-creation opportunities, especially when many possible options are available. Customers' needs, experience, and knowledge are crucial for the process of joint value creation with customers and other stakeholders in the integrated value network. Organizations must develop their collaborative competence and view customers as active contributors with knowledge and skills rather than simply as sources of information [12]. Many authors suggest that successful services have a strong value proposition and are the result of properly built processes.

The main purpose of this paper is to explore and identify a process of co-creation for service concepts in the built environment based on the end-users daily activities analysis, using the case of the KTH Live-In Lab. The KTH Live-In Lab is a multiple-testbeds platform for accelerated innovation in the AEC industry, intending to facilitate the advent of the sustainable and resource-effective buildings of the future. Using this explorative case, the paper's first objective is to discuss the concept of co-creation by distinguishing between co-creation as innovation and co-creation as a design process, two different approaches in the literature. We are focusing on the theoretical overlapping between two concepts of co-creation: co-creation as an innovation process as a part of open innovation theory and co-creation as a design process as a part of participatory design theory for the service concept development as a part of new service development theory. Second, using the case of the KTH Live-In Lab, we facilitate the process of co-creation of service concepts for the proposed built environment including methods from both perspectives: innovation and design. We highlight the theoretical foundation of the living lab as an environment for acceleration and facilitation of the innovation process in the built environment. We discuss the role of co-creation service concepts through living lab environments for the built environment and suggest how this facilitates multi-stakeholder engagement between building stakeholders and end-users. Third, we evaluate the process of service concepts co-creation for the built environment from the point of innovation, knowledge transfer, sustainability, and user experience.

Hence, the main contribution of this paper is a developed process that enables strong interaction and valuable output for building stakeholders (such as building owners, facility managers, home products-services developers, interior designers, architects, construction industry representatives) and end-users (tenants). An additional outcome of the study is the identification of the success factors and challenges of the proposed process of service concept co-creation for the built environment.

2. Research Background, Method, and Process

In this study, we focused specifically on the service concept design for the built environment. That means we considered only ideas for future services, which can be applied in the built environment by the end-users. It might be more correct to use the term home environment, instead of the built environment to emphasize a user-orientation in the project, but due to the fact that this article is addressed to representatives of the architecture, engineering, and construction (AEC) industry, the term built environment was used.

In terms of building type and tenant type, our main focus is residential buildings with a defined or partially defined segment of occupants, focused on affordable and sustainable housing. In terms of the living lab environment itself, the type of building is a student dormitory with a focus on small, efficiently used spaces. Our customer segment is young international students who live alone or in pairs (young family type). Based on this type of housing and the type of occupants, similar types can be identified, such as residential buildings targeted at the younger generation, as well as hotels' property and elderly housing. It is important to add that the Living lab environment, which was used in this case study has a strong orientation on sustainability and cleantech, which might create a particular direct or indirect influence on the process itself.

The research process in our study is divided into four main parts: a theoretical foundation, methods oriented towards co-creation as innovation process, methods oriented towards co-creation as design, and the final results evaluations. This process is presented in detail in Figure 1.

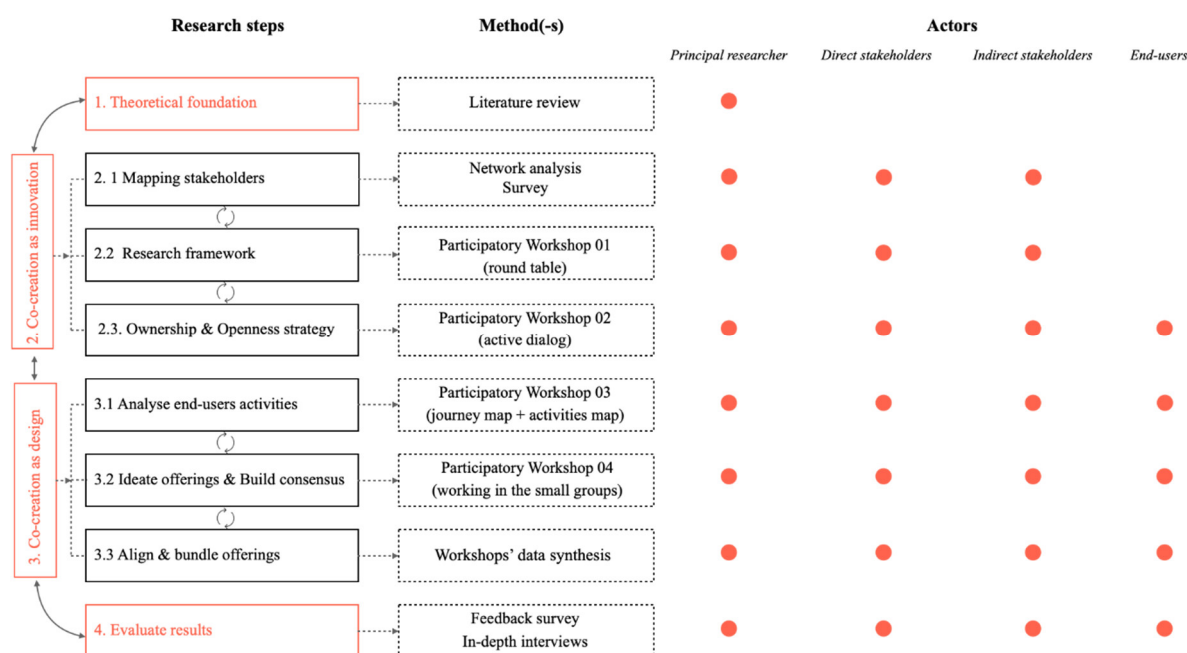


Figure 1. Research methodology and involved actors.

The theoretical part of the study highlights different theories about co-creation from both perspectives: innovation and design and proposes how this knowledge could be applicable to the domain of new service development in a built environment on the practice. In addition, the clarification about different theories related to Living Labs is highlighted as well. The practical part of this study showcases the implementation of the theory into the process of service concepts co-creation at the established Living Lab environment including both perspectives of co-creation (innovation and design). The final stage in the research process evaluates the results from two different angles: outcome-related, and process-related.

3. Theoretical Foundation

First, we begin with framing the theoretical boundaries from the point of new service development theory, since this relates to the purpose of co-creating service concepts. Johnson [13] defines new service development (NSD) as the overall process of developing new service offerings. To delimit the term NSD, the author refers to service design as specifying the detailed structure, infrastructure, and integration content of a service operations strategy. NSD addresses the overall process of developing new service offerings [13]. Looking more closely at the NSD process shows that it covers all the steps of a classical innovation process, from idea generation to market introduction. Service design (SD) on the contrary aims for a service concept and therefore overlaps only partly with the NSD process. Moreover, SD primarily contributes to service development in areas such as user orientation, contextualization, and design as a strategic instrument [14]. The initial stage of the service design process is service concept development. Edvardsson in [15] defines the service concept as a detailed description of the customer needs to be satisfied, how they are to be satisfied, what is to be done for the customer, and how this is to be achieved. The service concept clearly has a key role to play in service design and development, not only as a core element of the design process but as an important initial stage of bridging the involved actors and defining their core needs and expectations. The service concept not only defines the how and the what of service design, but also helps mediate between customer needs and the organization's strategic intent (Figure 2). This piece of theory from NSD is very much relevant for making synchronization between two co-creation theories.

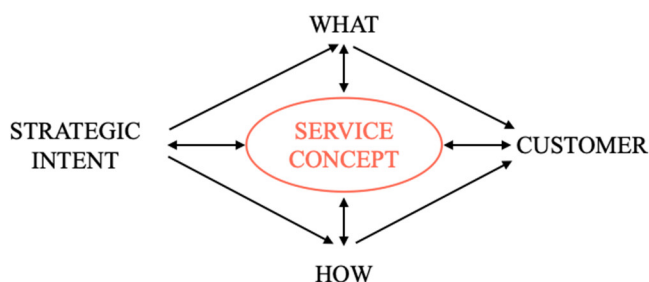


Figure 2. A model of the basic structure of the service (adapted from [14]).

There are multidisciplinary views on co-creation. The very literal meaning of co-creation is to make something together, for example, co- (together) and creation (something to exist) [16]. Co-creation, as a construct, is a problematic concept to delineate scientifically since it is a broad term with multiple ontological connotations. Recent research suggests that reaching a definitive definition remains elusive despite exponential growth in the use of the term in the literature [17]. Its applications range from material to the spiritual while also deepening in many disciplinary works, for example, evolutionary biology, physics, sociology, politics, economy, design, engineering, philosophy, and theology. For example, co-creation has been applied in design [18], participatory design [19], innovation [20–22], social innovation [23], management and marketing [24,25] among many others. Some of the studies include the concept as a method for developing new goods and services [26–32]. Whereas others have mainly observed it as an approach to change the roles between producers and consumers, in which power dynamics are challenged including notions of production-consumption, whereby various stakeholders become partakers in the process of innovation. For example, one stream of studies looks at co-creation as collaboration with users as innovators [33,34] and highlight the participatory roles of consumers, communities, and crowds [35–37]. Another looks at it as multi-firm partnerships [38,39], or as a way for open business models [40]. Further, there is also another fundamentally different approach to the notion of co-creation, which can be considered more complex in the context of philosophical underpinning of economic theory, for example, value co-creation [41–43]. In the last two decades, there has been an emerging view of how value (primarily

focused on monetary terms) is created, suggesting co-creation as its main premise. This is conceptualized as the service-dominant logic [44–46] and comes as a response to the otherwise referred goods-dominant logic (GDL), which is concerned with the division between tangible and intangible types of economic output [47]. These scholars propose that both producers and consumers work to create value [48], suggesting a third approach to value. Vargo and Lusch propose that rather than viewing value as created by a single actor, value is created as the joint integration of resources by the multiple actors associated with an exchange [49]. What we interpret from these formulations is that to co-create value with the external world, the firms' boundaries must be porous enough to facilitate the exchange of ideas, concepts, or prototypes, whether it is an outside-in or inside-out exchange. This is because human actors can also gain new opportunities of accessing and utilizing information, knowledge, competencies, and resources or other assets traditionally outside of their direct control [50]. In this paper, we draw perspectives on co-creation from the fields of design and innovation, primarily because we see the role of these increasing in the configuration of new products, services, and systems, meanwhile, both schools of thought depict distinct manifestations of the concept as well as in which phases and levels in service innovation they come best at practical uses [51].

3.1. Co-Creation as Innovation

More innovative solutions can be expected from rather open work contexts organized as collaboration ecosystems [52]. Chesbrough introduced and defined the concept of open innovation (OI) to describe an innovation paradigm shift from a closed to an open model. He suggested that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well (*ibid.*). Opening innovation processes toward more cooperative models with users and other stakeholders in the process has been shown to create better value for firms [52]. In line with such a paradigm, [53] and his colleagues examined the role of end-users as innovators, wherein these could be seen as sources of innovation, and such phenomenon was described as democratized innovation. Involving end-users during different stages of the product and service innovation process gained popularity in technology innovation particularly since the seminal work of von Hippel [54,55] in which notions of democratizing innovation and giving a more active role to users were claimed as critical for the success rate of innovative solutions, popularizing thus the idea of users as innovators, for example, lead users [56,57]. Opening innovation processes toward more cooperative models with users and other stakeholders in the process is shown to create better value for firms. Although users are a central actor within open innovation, there are also other stakeholders who can be involved in the process of service development, such as external firms and supply chains among others. [58,59] define co-creation as a particular form of open innovation and list co-creation as a category within open innovation. OI focuses on firms' R&D strategy that should be re-organized or may help organizations to find solutions to a specific problem. Co-creation represents a more holistic concept that considers a firm as part of a value creation network. Beyond firm perspective, it also covers collaborative value creation in online communities without corporate involvement (e.g., Wikipedia, Linux). Two key aspects of OI are relevant to co-creation. First, the external partners become peers with complementary and enriched internal R&D activities. Second, the centrality of an open business model emerges as a meaningful framework that enables companies to become more efficient at creating and capturing value from innovation activities [60]. Co-creation in such interpretation implies a joint collaborative activity by parties involved in direct interactions, aiming to contribute to the value that emerges for one or both parties" [61]. From such understanding we derive then the notion that co-creation as innovation is the approach for organizing multiple stakeholders to partake in the process of innovation, hence it defines the "who" and "what" of organizations. This defines the networked nature of innovation as a collaborative domain where co-creation indicates the need for the combination of ideas, knowledge, and technology distributed among a network of innovating actors

[62,63]. This is however context-dependent because a variety of forms of co-creation with various and different actors both public and private [64], which can be compounded, for example, companies, customers, users, prosumers, communities, etc., through various means and methods, for example, offline/online/both, long-term/onetime, etc., [65]. We, therefore, approach co-creation as innovation to delineate joint and mutual value creation between an actor and its related network of various entities, whose outcomes of behaviors and interactions lead to innovation [66].

3.2. Co-Creation as Design

In the fields of design, the view of co-creation, in simple terms, recognizes people as the experts of their own experience [67]. Sanders and Stappers' main argument is to acknowledge and recognize at least in the design domains, that people want to be useful and creative and not just spend their time shopping, buying, and consuming (technology). Their departure point stems from a belief that all people are creative, all people have ideas and can contribute to design processes that aim to improve their lives as well as the lives of others [68]. According to these authors, these are part of "collective creativity" which they describe as "creativity that is shared by two or more people", wherein co-creation would then refer to any act of collective creativity. This is different from the notion of co-design which indicates collective creativity applied throughout a design development process, though it is a specific instance of co-creation (*ibid*). Sanders and Stappers talk about the multidisciplinary views on co-creation which they identify as actor-actor engagement, for example, co-creation within communities, inside companies and organizations, between companies and their business partners or other companies, between companies and people the service (variously referred to as customers, consumers, users or end-users). Co-creation in design can be said to emerge from participatory design and the need to destabilize the power and control of designers over the design for which other people are/will be users of. Participatory design for example advocates for "power to the people" considering ways in which greater benefits can be obtained from new emerging relationships within a network of participants (designers, practitioners, users, and other stakeholders) through co-design [68]. This is found on a fundamental critique towards design, which in approach excludes voices of most or all users, while also ignoring other stakeholders as well [69]. As was described in [69], the notion of participatory design echoes the ambitions of designer-led control of the design process moving towards a redefinition of the designers' roles as developers, facilitators, and generators. This was motivated by the moral proposition that the people whose activity and experiences will ultimately be affected most directly by a design outcome ought to have a substantive say in what that outcome is [70]. The importance of user-actors especially is highlighted also in numerous subfields of design, particularly in human-centred design, participatory design, interaction design, product design, inclusive design, etc. A core goal of user participation in design processes for instance is that it leads to some form of change—to participants, to society, or to organizations [71]. On one hand, this ensures that the products and services being designed meet user needs, and on the other, it helps end-users to understand how a product or service works while also enabling users to have an active interest in its ongoing success [72]. Today, many scholars and practitioners question how successful design can be made without exploring people's everyday practices, and ultimately involving the people for whom designs are intended may be an imperative [73]. For example, the emerging landscape of co-design and co-creation portrayed by [62] is precisely that it emphasizes this tendency calling on collaborative idea generation and a turn towards designing for social purpose, which yet again reshapes both our notion of design and how we regard users. Design practice, they argue, must begin to nurture collective creativity, hence co-creation, in which all people are seen as active and competent participants in design practice and not just "users". This approach clearly resonates with socio-technical studies such as appropriation of technologies and understanding of technology as a pro-

cess of modifications [74]. At the same time, users being exposed to these processes enables them to reflect on current practices meanwhile articulating possible futures [75,76], as well as promoting an emancipatory view of participation where users use their voice to influence decision making [77] and bring their interests into construction in design and innovation processes [78]. From such understanding we derive that the notion of co-creation as design is the approach for *how* design is led forward through the inclusion of multiple views and voices in the process. It is not a building block process where different actors come to contribute, but a flatter ontology can be applied through the notion of co-creation where all actors participating are mutually the designers and the creators of the services they will use simultaneously [75]. Hence, we approach co-creation as design to delineate the mechanism for how actors can be engaged, involved, and design together in different contexts [79,80]. The theoretical boundaries of the study are schematically represented in Figure 3.

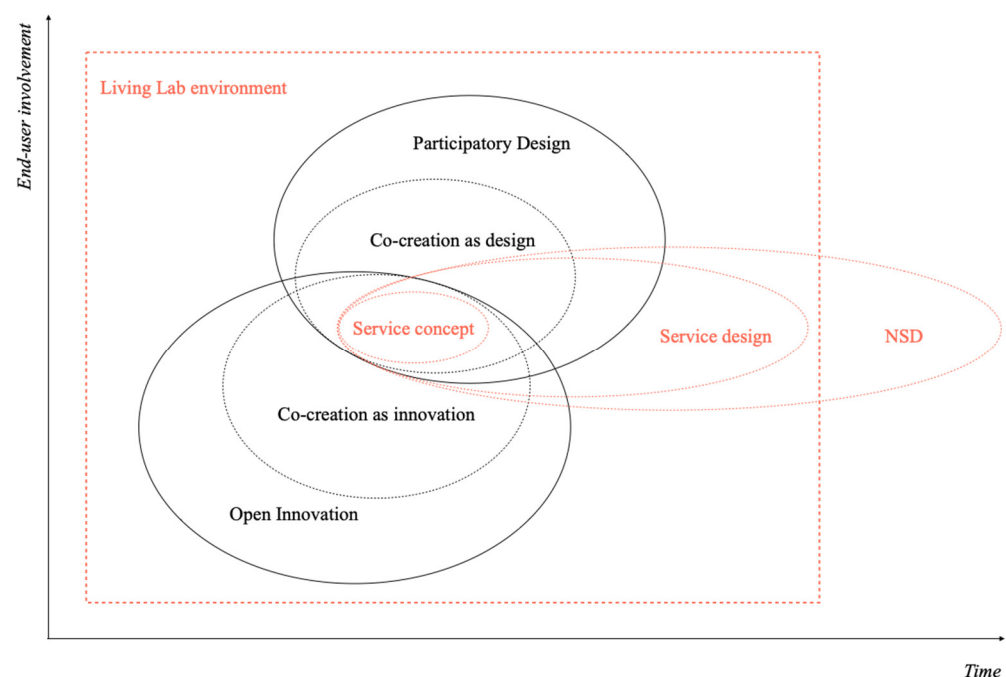


Figure 3. Theoretical boundaries of the study, which highlight the overlap of two co-existed schools of co-creation: co-creation as an innovation approach and co-creation as a design practice. In our study we consider both schools' theories working together in the context of the Living Lab as an environment.

3.3. Living Lab Environment

The concept of a living lab refers to the involvement of multiple stakeholders, including users, in the exploration, co-creation, and evaluation of innovations within a realistic setting [81–83]. However, there is often a disconnect, both in theory and practice, between those identifying living labs as environments (emphasizing, e.g., the real-life aspect of a multi-stakeholder setting) or living lab as approaches (emphasizing, e.g., co-creation activities or user-centric methods). There are many different approaches to explaining living labs as environments and living labs as approaches. Living labs environments have a main focus on the environment itself and are equipped with high-end technology and infrastructure that can support both the processes of user involvement and technology development and tests [84]. Such infrastructures are named testbeds. A testbed is a physical or virtual environment where companies, academia, and other organizations can collaborate on developing, testing, and introducing new products, services, processes, or organizational solutions [85]. It has ethical and easy access to the users and diverse partners and collaborators, but the point of the innovation is focused on improving or innovating

around the environment itself. This is driven by the notion that innovation concerns not just technology, but rather “sociotechnical” arrangements of humans and machines embedded in social contexts, and therefore should be understood, designed, and improved in vivo [86]. As indicated, this familiar context may take the shape of a controlled lab setting which mimics the day-to-day usage context. The environments are selected and managed by living lab practitioners so as to allow the involvement of different types of stakeholders in innovation activities, the introduction of new technologies in realistic circumstances, the monitoring of their acceptance, usage, and effects, and so on.

3.4. Living Labs Approaches

Living labs as approaches include experimentation and co-creation with multiple actors in order to design, try, test, or validate ideas, products, services, or stuff. Usually, activities follow an iterative process with feedback [87], over a period of time to provide a coherent base or knowledge building. Knowledge sharing among the actors is critical [88] which comes both from the actors’ own experience, but also from the collection and capture of new knowledge through the constellation. Knowledge is elicited by situating and evolving innovation projects in real-life contexts whereby the whole ecosystem of actors is involved (ibid.). Through the process of partnerships between public-private domains, an understanding of an initial idea and demand can be gained [89]. Some studies suggest that the learning process and innovation are explicitly specified [90]. and that activities are organized around the technological transfer or promotion of cities. In innovation terms, the activities have been suggested as either explorative or exploitative (ibid.). [90] suggested that these represent sensing, prototyping, validating, and refining complex solutions. Ref. [91] argue that living labs create prosperous communities. They mention trust, involvement of members in the innovation process, access to adequate knowledge regarding the problem environment, state-of-the-art ICT tools and methodologies, and good governance as critical for nurturing communities (ibid.). Not only are participating actors supported within their innovation efforts in terms of the aforementioned activities, but also in building research capabilities and a shared understanding in terms of learning and approaching complexity (ibid.). [92] ascribe living labs as “service providing organization for innovation and R&D”, where resources are offered within the areas of competency, local partners and stakeholders, ICT infrastructure, operational methodology, and administrative resources. Thus, living labs may be regarded as a platform for innovation activities to take place in a way where resources are not constrained but rather nourished by the participating actors, who share both knowledge and their competencies in order to achieve their goals of interest mutually. As an approach, these serve as a platform to combine design research with innovation praxis in which knowledge is generated through the building and deployment of designed artifacts [93]. Such methodology is based on in-situ and mixed methods “to systemize the integration of objective and subjective aspects of daily life practices at different stages of the innovation process” [94]. These methods are used to capture the technical and social aspects of practices in a qualitative and quantitative manner [95–98]. Several methods are applied in living labs, including ethnography and lead user innovation. Participants in living labs produce drawings, pictures, figures, and other representations to illustrate solutions to a particular problem [99]. A number of methods, including the collection and analysis of system logs, behavioral data, ethnographic research, questionnaires, focus groups, and observation in living labs are applied (Figure 4).

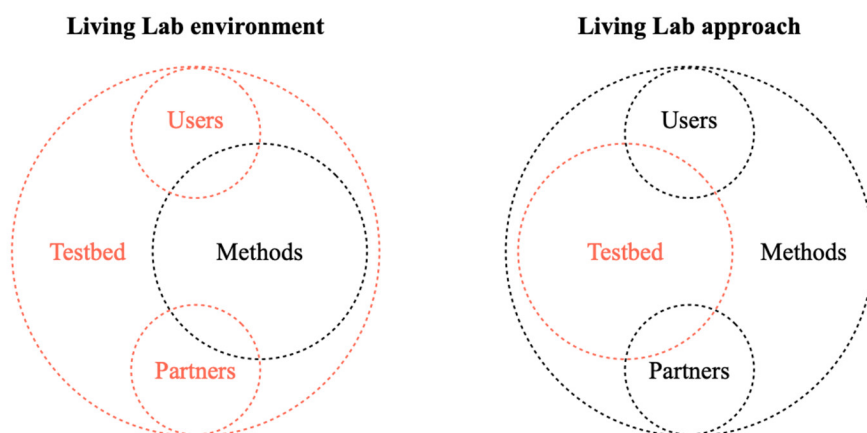


Figure 4. The living lab environment versus the living lab approach.

3.5. KTH Live-in-Lab

KTH Live-In Lab is a multiple-testbed platform for accelerated innovation in the AEC industry, and for collaboration between academia and business. Most testbeds in KTH Live-In Lab are operated in real environments for testing and researching new technologies and new methods. The purpose of the KTH Live-In Lab is to reduce the lead times between test/research results and market introduction. In this way, KTH Live-In Lab aims to facilitate the advent of the sustainable and resource-effective buildings of the future. KTH Live-In Lab enables testing of products, services, and methods in real buildings, which results in a well-founded basis for changing structures and rules, and increased use of new innovative technology. Tests in KTH Live-In Lab led to accelerated innovation.

KTH Live-In Lab encompasses a 300 sqm building permit-free innovation environment with alterable student apartments (Testbed KTH), which enables studies on the future's resource-efficient and sustainable student housing. The KTH Live-In Lab also receives property and user data from 305 common student flats owned by Einar Mattsson (Testbed EM) and from the KTH campus education building owned by Akademiska Hus (Testbed AH) (Figure 5).



Figure 5. KTH Live-in-Lab: Testbed KTH and Testbed EM.

4. Co-creation as Innovation Process

4.1. Stakeholders Involvement

The involvement of multiple stakeholders, including end-users, is crucial for the process of innovation.

At the same time, it is important to have a clear strategy of which types of actors are relevant for different types of co-creation. Most of the *Living labs environments* have a well-developed infrastructure that attracts different partners and stakeholders for different purposes. As already mentioned above, in our case we have a *Living lab environment* that is oriented on innovation related to the built environment, which is primarily represented by the AEC in addition, it is important to add that KTH Live-in-Lab has a strong orientation on sustainability and cleantech, that is why the majority of KTH Live-in-Lab's partners have a similar research orientation and interest. Despite the fact that the theme of KTH Live-in-Lab is well-established, the ways of exploring and innovating around this theme have many different approaches: from technology-oriented to human-oriented. So here you can meet engineers creating new heat pumps and philosophers studying the ethical aspects of behavior design.

Our research is primarily human-centered and organization-centered and in general, contributing to the better and faster process of NSD. At the same time, most of the NSD projects are data-intense and have a strong connection to technology and its integration into the built environment. That means that the nature of the research should be interdisciplinary and attract different types of stakeholders.

In order to identify different categories of potentially interested stakeholders in the process of service concepts co-creation, we resorted to the classification of all stakeholders of KTH Live-in-Lab according to the principle that is the most important for the subsequent development and operation of the future service: level of interaction with the end-user. This method is an adaptation of the building's shared layers approach described by Stewart Brandt [100]. We expanded the idea of considering a building as a system of different building's shared layers (site, structure, skin, space, stuff, services) [100] by defining the proximity of each building layer to the end-user and involve representative stakeholders from each building layer. This approach may become a topic for more detailed study in the future, but in this study, it is assumed as a priori method based on building's shared layers approach.

We created three main categories: high, medium, and low levels of interaction with the end-user (Figure 6). This rough classification can be useful for identifying more active and interested stakeholders and those who are interested in the topic more likely as new useful knowledge. The chart below shows schematically three groups (size of the circles does not reflect any quantitative values, but rather provides a visual representation of the structure of the participants from core to surrounding). We tried to bring an equal number of participants from each category. In the end, we had 10 representatives from each category.

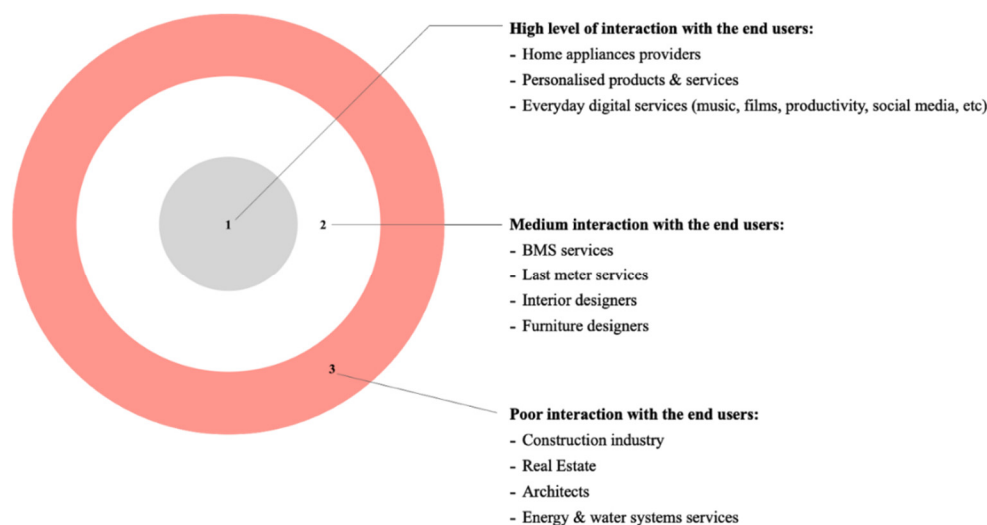


Figure 6. Mapping stakeholders for the service co-creation process.

4.2. End-Users Involvement

One of the important criteria for classifying a research laboratory as a living laboratory of any type is access to the end-user in their real-life conditions in a certain environment. Such access must be organized according to legal and ethical standards. Additionally, a living laboratory of any type must have a specific mechanism for interaction with end-users. All this creates great potential for innovation, as well as imposes a lot of obligations on the organizational structure of the living lab of any type. In this paper, we will not root into these contradictions but will only outline our social infrastructure and the mechanisms of interaction with it in general terms.

As mentioned above, we have access to two types of testbeds: Testbed KTH and Testbed EM. Testbed KTH has a legal basis to conduct a larger number of experiments and has a high level of interaction between the researcher and the end-user (tenant) in the experiment. Successfully validated hypotheses for pilots from Testbed KTH can be scaled up and continued testing in Testbed EM. Testbed KTH is home to four master's students from different EU countries. These students sign an agreement that allows researchers to invite them to participate in different types of experiments, but the student always has the full right to stop the experiment at any stage. A consent form for the experiment is signed by each student, indicating all the necessary details about the use of personal information and data. Students who agreed to live in such a research environment are generally highly motivated to participate in most experiments. This creates a definite but detectable bias. If necessary, it is always possible to involve the remaining 300 students in a pre-study or survey, which significantly improves the quality of general research related to methods, trends, and a general understanding of a particular problem or domain.

So, in our case, we created two focus groups of the end-users: one is an active group of four students from Testbed KTH who are involved in a process with a high degree of activity and interactivity and whose data on everyday activities we studied thoroughly. The second group consisted of 30 randomly selected students from 300 apartments from Testbed EM who participated in surveys and feedback. At the initial stage of the research, this is enough structure to identify the main difficulties and points of success in the service concepts co-creation process.

4.3. Openness and Ownership Strategy

There are many ways to go about co-creation, and which to choose depends on the challenge and objectives at hand. There is always one initiator, that is, the party that decides to start the initiative. This can be a company or just a single person. In our case, it is a researcher from Living Lab (KTH Live-in-Lab). One (or many) contributors will be joining along in the process, but the initiator determines who can join and under what conditions. There are two central dimensions that define types of co-creation:

- Openness: Can anyone join in or is there a selection criterion somewhere in the process?
- Ownership: Are the outcome and challenges owned by just the initiator or by the contributors as well?

These two dimensions lead to the four main types of co-creation: club of experts, crowd of people, coalition of parties, and community of kindred spirits [101]. (Figure 7).

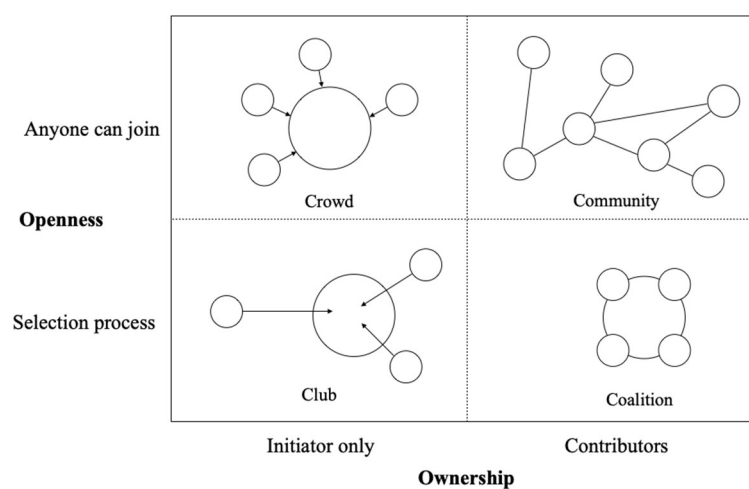


Figure 7. Types of Co-creation.

The typology proposed by [102] is useful for defining the type of cooperation, but not quite suitable for a residential laboratory. As a rule, in the process of cooperation in residential laboratories, various types of hybrid types are possible. This typology is a good framework for starting a discussion about cooperation and defining the interests of each of the participants in the process. For this part of the process, it is important to conduct first a workshop with industry representatives, then a separate workshop with residents, and then a combined workshop to discuss results and find consensus. Each participant can create a separate type of cooperation for his specific project, as well as express a general opinion about how his organization would like to see this process. Thus, at this stage, it is very important to separate the processor-oriented information gathering and working on your own concept. In our study, we see the hybrid type of co-creation, which combines community and coalition types (Figure 8).

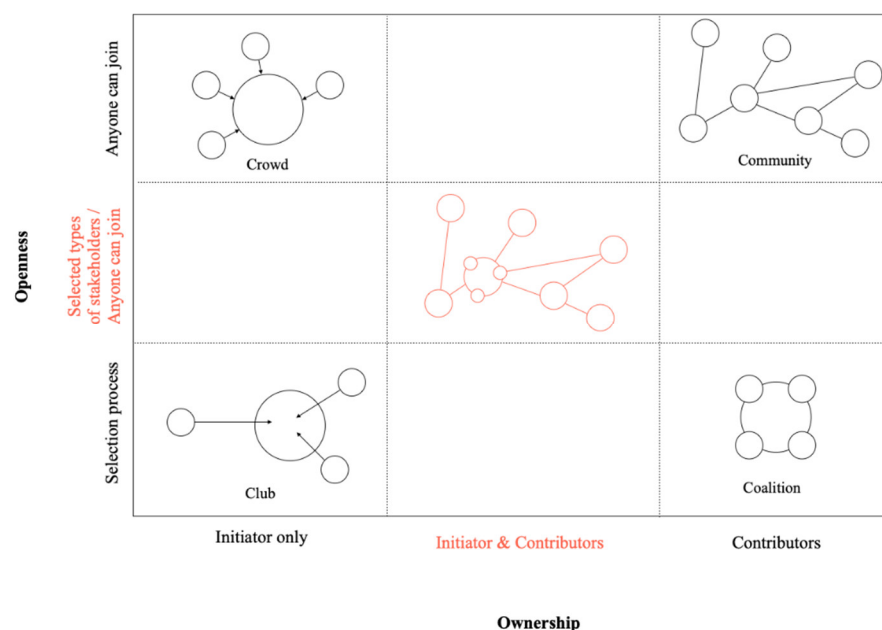


Figure 8. Types of co-creation at living lab environment.

5. Co-Creation as Design Process

5.1. Co-Analyze End-User's Daily Activities

The key role in this project is played by end-users activities context information. We will focus on the concept of a Human Activity System (HAS)—model of the daily activities of the end-users. The concept was defined by P. Checkland [103] and based on human-activities recognition (HAR) [104] and human-system interaction theories [105]. One important task of HAS is to identify the activities of a person in the built environment, such as “sleeping”, “watching TV”, “cooking”, etc.

HAS is formed from two different methods: one is well-known in-service design and called a customer journey map (CJM) that is compiled together with the end-user under investigation and data from various sensors that refine CJM compiled together with the end-user (Figure 9). Consequently, this method makes it possible to analyze and evaluate each daily activity qualitatively and quantitatively. On the basis of these CJM enriched with the sensor data, the in-depth interviews are the next step in the process. This approach makes it possible to identify those activities that the user considers less favorable (pain points) and focus on building a discussion around them. To prevent any distortion, CJMs are compiled prior to the participatory workshops and used as a starting point for discussion among all participants. In the course of the discussion, certain thematic reorientations might arise, but the process should be as independent and objective as possible. For example, often in the process of ideation, more active participants can lobby for their point of view pretty naturally, which should be recorded by the workshop facilitator and reflected later. The main goal of this stage of the process is to have as many different points of view around end-users pain points as possible. Besides the fact that this approach gives a fairly objective picture of the user's everyday life, it is also allowing to add a temporal-spatial dimension, which might be very useful in the future service development process.

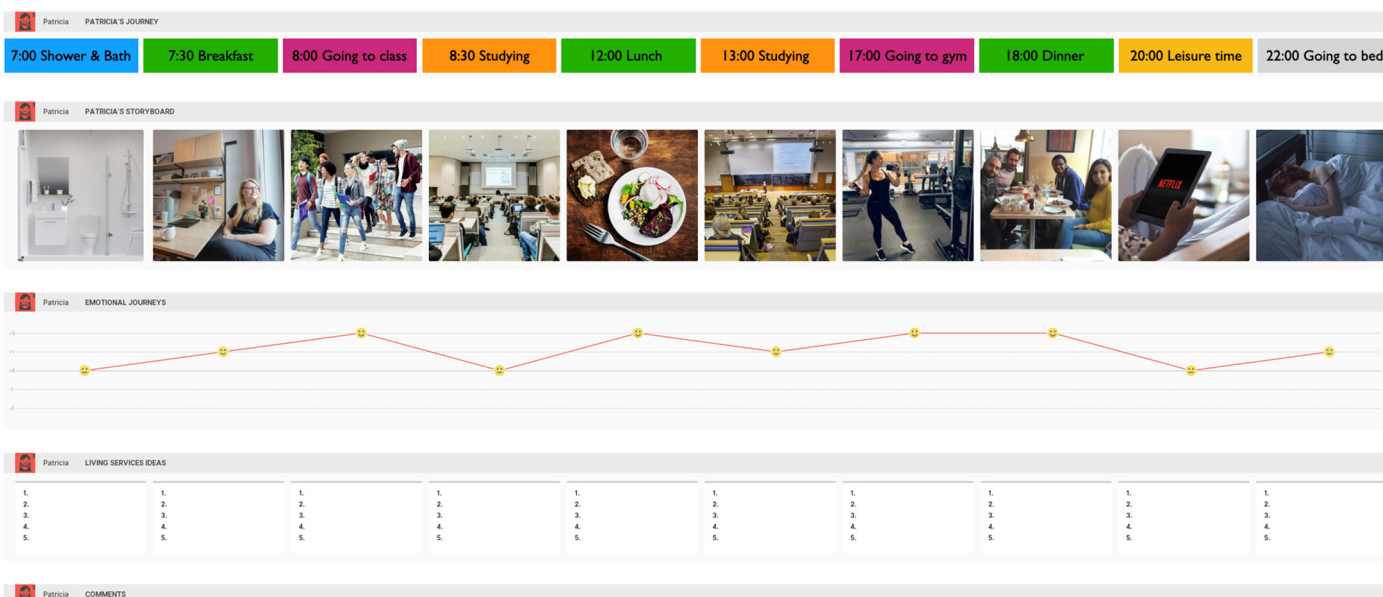


Figure 9. CJM template from participatory workshop, “end-users” daily activities analysis’.

5.2. Ideate Offerings and Build Consensus

The next stages of the co-creation process are the ideation of various proposals related to the possible improvement of a particular activity. Often, at this stage, we see different proposals depending on the professional background of the participant and here we clearly see the preliminary division of the stakeholders on the different levels of interaction with the end-users. It is important to have a diverse group of participants, not only in terms of their professional aspects, but also age, gender, nationality, and so on.

Despite all these comments, in the end, we received a fairly diverse map of ideas that cover a wide range of proposals. The results of the Participatory Workshop 04 show a polarization of the ideas, which could be classified as “end-user centric” and “building owner centric” (Figure 10). We also place each idea according to the orientation to more ‘product oriented’, and “service oriented” (Figure 11) for the future product–service system (PSS) analysis, but this topic is out of the scope of this paper.

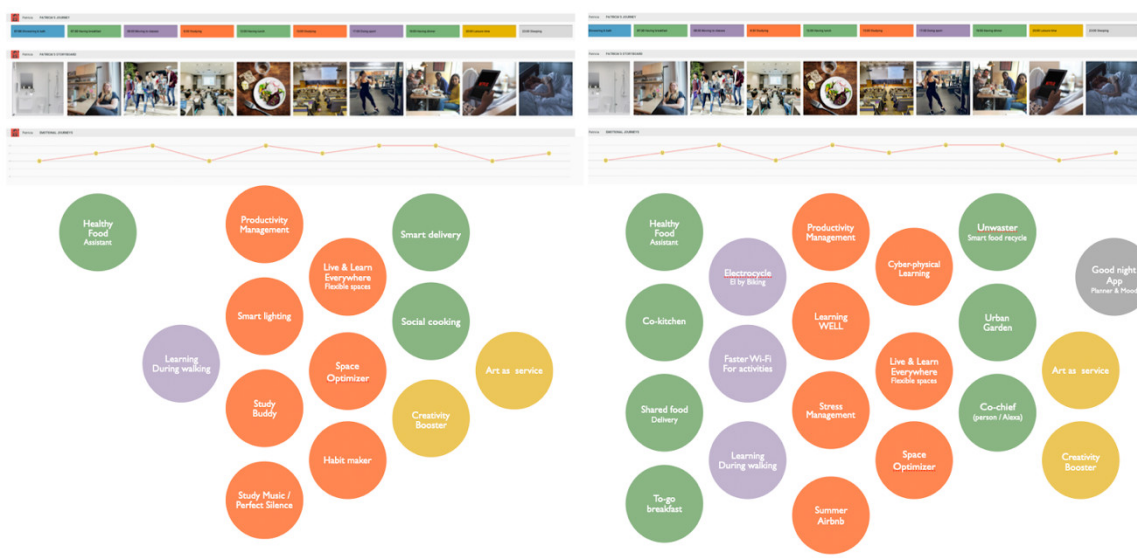


Figure 10. CJM template from participatory Workshop ‘End-users’ daily activities analysis’.

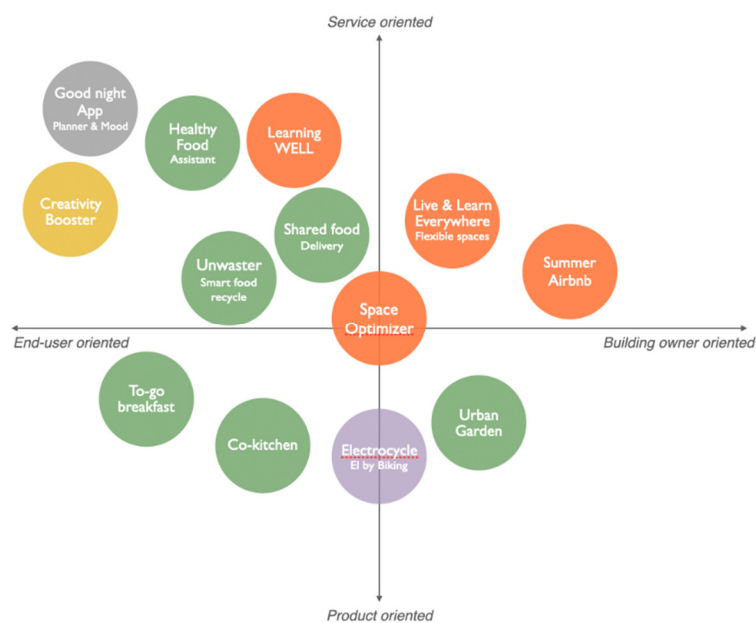


Figure 11. Service ideas orientation: from end-user centric to building owner centric.

One of the important aspects of the co-creation process is building consensus on the final outcomes of the project. In our case, we organized a two-step process for consensus building. The first step is based on the exclusion of the ideas that score least points of evaluation criteria. This step helped us to deduct the list of the proposals for future discussion. The second step is a discussion among all participants with a goal to agree on the final list of the proposals. Selected and partially modified proposals were approved for the subsequent process of forming the final service concepts’ portfolio.

5.3. Align & Bundle Offerings

The final stage of co-creation as a design is to transform the general wide ideas into solid offers. This type of work takes place in small groups with feedback sessions and a discussion of the feasibility and realism of each offering. At this stage, we return to the four main evaluation criteria that we identified as necessary for accounting: innovation, knowledge transfer, sustainability, and user experience. It is important that the selection of ideas is carried out on an equal basis and on the basis of generally recognized criteria. Below the results of three service concepts, which were co-created in a collaborative manner with the multiple stakeholders and end-users at KTH Live-in-Lab (Figure 12).

SUSTAINABLE EVERYDAY FOOD



PERSONAL WELLBEING



SPACE AS A SERVICE



Figure 12. Service concepts co-created at KTH Live-in-Lab.

6. Results

The main purpose of this paper is to explore and identify a process of co-creation for service concepts in the built environment based on the end-users daily activities analysis, using the case of the KTH Live-In Lab. The paper's first objective is to discuss the concept of co-creation by distinguishing it between co-creation as innovation and co-creation as a design process, two different approaches in the literature. Second, using the case of KTH Live-In Lab, facilitate the process of co-creation of service concepts for the proposed built environment including methods from both perspectives: innovation and design. Third, we evaluate the process of service concepts co-creation for the built environment from the point of innovation, knowledge transfer, sustainability, and user experience.

6.1. Outcome-Oriented

Outcome-oriented results are mainly focusing on evaluating the final output of the process of co-creation—service concepts. It is not an easy process to evaluate the outcome of such a complex and dynamic process. Since this project is the initial stage of a larger and longer-term project, many of the participants understood that the assessment of the first iteration of this process of evaluation would be qualitative and more prescriptive rather than numerical and precise. During Workshop 01 we identified four key criteria for outcomes evaluation: innovation, knowledge transfer, sustainability, and customer-responsibility. During the results evaluation stage, each participant was able to evaluate each service concept from four criteria perspectives from 1–5 (Figure 13). This rough evaluation only highlights which service concept might fulfill most of the interests of the group. To get into more details in-depth interviews were organized with each stakeholder and some statements are placed in the discussion part.

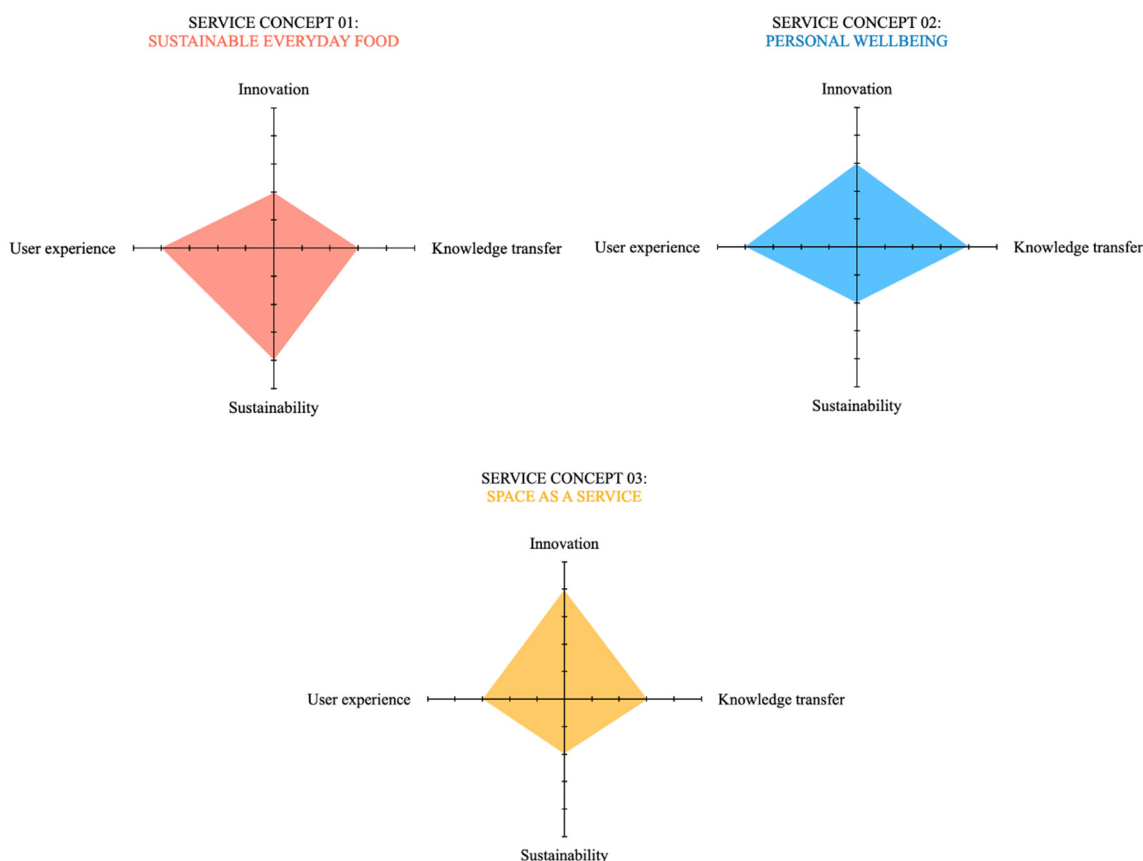


Figure 13. Service concepts evaluation.

6.2. Process Oriented

Along with outcome criteria, we also discussed process-oriented criteria, which focus on the process of co-creation itself. Among the key criteria for the process evaluation, we selected three mains: quality of the process, the equal involvement of all participants, the effectiveness of each of the exercises (a useful ratio of the result obtained to time spent on the task). Obviously, that each of such criteria has several sub-criteria (for example the quality of the process included five sub-criteria), which we would not describe in the details in this paper and only present the overall group evaluation of each process-oriented criteria from 1 to 10 (Figure 14).

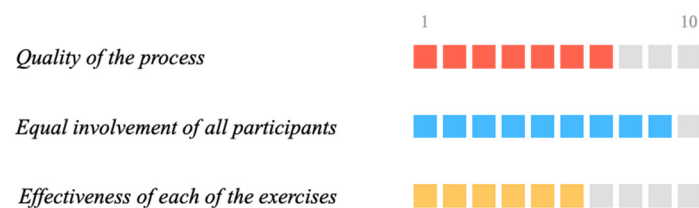


Figure 14. Service concepts co-creation process evaluation.

7. Discussion

The discussion of this paper will be presented as several success factors of the proposed process, as well as some challenges. These proposals are based on the analysis of the final workshop's results and feedback from the participants.

7.1. Success factors

1. Access to various participants from different levels of interactivity with the end-user allowed us to consider each activity from different angles. Since we had an equal distribution of the number of participants from each category of interactivity level with the end-user, we did not feel any dominant behavior of anyone.
2. The format of interactive workshops allowed not only to exchange information and opinions but to create a dialogue with an in-depth understanding of different points of view. This contributed to the expansion of knowledge not only for those participants who came exclusively to gain knowledge but also for the residents themselves, who realized that many of their desires were not realizable due to a very large number of reasons and the specifics of the industry itself, which is very standardized.
3. Organizing the process of co-creation with taking into consideration both perspectives on co-creation from the fields of design and innovation enable better navigation during the process of co-creation. Clear communication about two perspectives on co-creation also affected the fact that the participants' list in these workshops were slightly different: more people with a managerial position came to the innovation-oriented workshops call, while more designers and engineers came to design-oriented workshops, but they were all eventually gathered for the final sprint on the creation and evaluation of service concepts and this made it possible to seat people at the same table who rarely intersect in professional corridors.
4. Similar point is related to the end-users involvement. All experts highlighted that such a format gave more understanding and meaning of the 'products and services in use'. But what is more important, that particularly the end-users, were those, who brought quite a disruptive perspective into the dialog.
5. Most of the participants noted that the analysis of the end-users activities method is simple, convenient, and effective. Especially the fact of having data, which gives a more detailed perspective on each daily activity and specified a lot on the resources' usage and for each activity and some types of meta-data, which is opening a potential for better customization of the future services.

6. From the point of view of the process quality, all the participants noted the importance of the chosen criteria, which we have often relied on during various debates.
7. All participants indicated the value of networking and the possibility of collaboration both within the framework of the new project at KTH Live-in-Lab and outside the academy.

7.2. Challenges

1. The most obvious challenge is the uniqueness of the case, and in this regard, questions arise related to the subjectivity of the results (even prescriptive ones). To do this, it is necessary to repeat the methodology in several independent laboratories to ensure its effectiveness.
2. Despite the fact that the diversity of participants is an undoubted advantage of the process, it also introduces its difficulties, since the more diverse the group, the more varied the professional languages used and the particularities of communication.
3. One of the most important challenges is building consensus between multiple viewpoints. In some cases, one has to deal with diametrically opposite points of view.
4. Evaluation of the final results is still possible only at a qualitative level, and not at a quantitative level since it is almost impossible to dawn on the long-term effect on innovation and sustainability in their long-term perspective

8. Conclusions

In this paper, we explored how co-creation enables the emergence of multiple service concepts through the living lab environments using the explorative case of the KTH Live-In Lab. By describing the process and discussing the outcomes of this process, we make visible the benefits of co-creation as innovation and co-creation as design in the context of services in the built environment, more specifically “home environment”. Based on this work, several success factors and challenges for managing co-creation in living lab settings could be derived. The advantages of this method were identified such as the ability to consider each activity from different angles; enabling of dialogue with an in-depth understanding of different points of view; the intersection between various professional and non-professional actors; more understanding and meaning of the “products and services in use”, where users act as disruptors; opening a potential for better customization of the future services by focusing on users insights; and, finally the perceived value of networking and the possibility of collaboration from all the participants. However, there are also challenges with managing such processes and these are the uniqueness of the case, hence the replicability of the method; second, is the diversity of languages concerning points of views and building consensus around them; and finally, the unpredictability of the effects and their quantification. In conclusion, meanwhile co-creative approaches to service and product development show to be demanding and challenging, we believe that they are also fruitful in expanding the ability to innovate by bridging the needs and capacities of multi-stakeholders. With further methodological improvements, co-creating with multiple actors and by departing from user’s everyday life shows to be a valid method to enable the emergence of innovative service concepts in the built environment.

The future studies in this project will aim at improving the proposed co-creation process and implement all comments from each stakeholder. In addition, we plan to analyze deeper the stakeholders’ network and quantitatively represent and describe the group dynamic with the use of graph theory.

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