Human-centred Research and Open Innovation (OI)

How to Implement and Facilitate Crosscutting Collaborations in the Built Environment

Fróes, Isabel; Bolbroe, Cameline

Document Version
Final published version

Published in:
Business Meets the Humanities

DOI:
10.4324/9781003195658-7

Publication date:
2022

License
CC BY-NC-ND

Citation for published version (APA):
Fróes, I., & Bolbroe, C. (2022). Human-centred Research and Open Innovation (OI): How to Implement and Facilitate Crosscutting Collaborations in the Built Environment. In M. S. Mahnke, M. Nielsen, M. L. Petersen, & L. Tjørring (Eds.), *Business Meets the Humanities: The Human Perspective in University-industry Collaboration* (pp. 97-116). Routledge. https://doi.org/10.4324/9781003195658-7

7 Human-centred research and open innovation (OI): How to implement and facilitate crosscutting collaborations in the built environment

Isabel Fróes and Cameline Bolbroe

Introduction

Humanities-driven research represents a valuable knowledge resource for architects, helping develop robust frameworks for user-involvement processes. Nonetheless, despite the general recognition that human aspects are important for good architectural design, humanities-based knowledge is underrepresented in the architectural industry. Additionally, research and industry collaborations often meet the challenge that the two domains function within, sometimes, very different time frames. Research processes can be viewed as time consuming with longer timeframes requiring extensive preparation while, businesses, tighter deadlines tied up to economic constraints. This scenario, present in various fields, is no different in the architectural sector, with many architectural design approaches relying on static architectural principles. Here, both architecture and inhabitant are conceptualised as predominantly static and figurative in contrast to engaged and active (McDougall-Weil, A., 2015). In contrast, an architecture that aims for change and transformation substantially challenges basic architectural premises of the static and pre-determinate (ibid.). Thus, architectural design processes need alternative design strategies and methods to further explore the new design opportunities that specifically result from properties of change and transformation offered by possible research collaborations (Radion, I.-E., 2017).

Recently, the relevance of human and social values for good architecture has gained attention in the architectural design sector (Cuff, 1992; Vardouli, 2016; Van der Linden & Heylighen, 2018), prompting some architectural firms to integrate user involvement processes into their design development. Yet, current business models in this sector often neglect human and social perspectives, leaving the voice of the end users – the inhabitants – unheard (McDougall-Weil, A., 2015). Incidentally, the prospects of user involvement processes as a business opportunity is only at its beginning while the demand for innovative business models in the architectural sector is high (Bos-De Vos, 2014).

DOI: 10.4324/9781003195658-7

Design solutions based on well-researched user preferences and needs can have several beneficial impacts on the quality of architecture. For inhabitants and society the value of human factors is apparent and associated with socio-economic growth, resilience, health, well-being, safety, accessibility, equality, diversity, etc. The relevance of such values has been identified in several studies across the fields of architectural design, engineering, and business (Bos-de Vos et al., 2016).[1] However, how can businesses integrate human aspects of architecture research as a commercial design parameter? An answer to this research question might be the promotion of human-centred research, through the integration of open innovation (hereafter OI) approaches, as an added product to the architectural design process.

This chapter contributes to elicit how a human-centred research and industry partnership can contribute to architectural design practices towards new business potentials. Through a pilot case based on an industry–research collaboration, it is presented how an architecture firm might engage in developing services through direct exploration of architectural designs with end-users (future inhabitants). This chapter starts by introducing key concepts, OI, and human-centred research in relation to architecture. In the following, these concepts are bridged through a research-industry collaboration pilot case. The final sections of this chapter suggest guidelines towards humanities–business collaborations grounded on the preliminary research analysis and results.

Open innovation (OI)

The concept of OI, which deals with connecting internal research to ideas and resources outside of the organisation (Chesbrough, 2004; Helfat, 2011; Marcet, 2008), is decentralised and heterarchical (Pitt et al., 2006). Some of the OI principles include "integrated collaboration, co-created shared value, cultivated innovation ecosystems, unleashed exponential technologies and extraordinarily rapid adoption" (Curley and Salmelin, 2013, p. 2). As a principle, it highlights that product and service ideas are to be co-created with outside groups, who do not work in the company or organisation that will develop or provide them. Such an approach allows for pushing boundaries beyond a known framework, allowing initial concepts to be deconstructed, critically assessed, and creatively developed by *non*-biased participants.

An outcome of OI deals with companies having to increase their access to knowledge as dynamic instead of static (Helfat, 2011), and require services to maintain a continuous adaptive process to keep up with emerging demands and needs for a customer defined product (Freudmann, 2020). As a response to these needs, human-focused methodologies have gained ground, exploited in the fields of participatory design, co-design, interaction design, service design, and transformation design (Sanders and Stappers, 2008).

In recent history, two technological leaps have particularly influenced and shaped foundational premises for architectural practice. One regards the industrialisation of fabrication and building processes in architecture and, the other, the digitisation of fabrication and building processes. Yet, relatively little concern has been given to architectural innovation based on our interaction, engagement, and relationship with this industrialised and digitised architecture (Costa Maia, 2016; Costa Maia and Meyboom, 2015) and which kind of business models could emerge from integrating this approach.

Business models, early developed as a direct product exchange (Teece, D. J. 2010), have been further advanced in recent years to consider various aspects of products and services. Value propositions, direct and indirect customers, channels, etc., help businesses analyse their service offering through a specific set of lens (Osterwalder, A., and Pigneur, Y. 2010, 2013). In architecture practice, business models are mostly business to business (B2B), such as developing building designs for a business client and, sometimes, business to consumer (B2C), where architecture firms develop the designs for an end customer. In the architectural sector, these business models rely on principles developed prior to the recent digitally enabled opportunities and tend to still focus on economical values, while human-centred social value is often neglected (Teece, D. J. 2010). Concomitantly, within the domains of responsive and interactive architecture (and related), there has been several recent calls for more research into new design methods and perspectives that focus on design potentials related to human engagement and participation (Costa Maia and Meyboom, 2015; Loftness and Hartkopf, 1988; Schmidt & Austin, 2016; Senagala, 2005; Till, 2009). Consequently, such conditions challenge traditional architectural design approaches and emphasise the need for adapting to other models, which position human-centred qualities as a key value proposition at the core of architectural innovation and development.

Bridging open innovation (OI) and human-centred research

While there is an increasing interest in human-centred design approaches within the field of architecture, design processes directly involving inhabitants still do not play a significant role in architectural design processes (Spurr, 2007; Till, 2009; Vardouli, 2012). Architectural practice still relies to some extent on a hierarchical structure, where architects more often than not have the last word and predefine the bone structure of how others might live. Such hierarchies are evident in both architectural design as culture with the architect as the genius designer (Imrie, 2003), and embedded in architectural media, drawings, and visualisations, which literally favours the architects' point of view (Bloomer and Moore, 1977; Marble, 1988; Vidler, 1999).

Aiming to develop and offer a business and design perspective that encompasses such concerns, it is fruitful to reinvigorate the dynamic potential

of architecture as something that is continuously becoming and being shaped – and, not only by the architect. Considering architecture through the lens of a broader landscape of post human theory, architecture may be considered as ongoing processes of action, exchange, and engagement between the material, meaning, human, and non-human (Barad, 2007; Braidotti, 2013; Haraway, 2003; Hayles, 1999; Hekman, 2010; Manning, 2012; Puig de la Bellacasa, 2017). In this perspective, architecture is an ever-provisional result of intertwined action, exchange, and engagement between inhabitants, building, environment(s), and various stakeholders. Thus, architecture is fundamentally subject to change and adaptation.

Accordingly, buildings do not only have one function, or few functions, but many functions, of different kinds and with different often-overlapping purposes. The expression of architecture is a complex patchwork of different qualities: material, spatial, aesthetic, kinaesthetic, temporal, situated, transitory, etc. Meanwhile, the character of architectural processes and design strategies often reflect static architectural conceptualisations. Therefore, architects and architectural businesses may benefit from a move towards a more situated and dynamic approach to architectural design.

Such frameworks and their aligned business models must take into consideration that transformation occurs because of exchange and interaction across buildings, beings, and processes, instead of the conceiving of the building alone as a final design delivery (Bolbroe, 2019; Grosz, 2001). While OI typically focuses on technological aspects, such as product and production by means of digital fabrication, OI in architecture can also enable a focus on innovation through social and relational aspects.

When people experience architecture, they enter physically into its volumes, they move around, they feel its material textures, and perceive the sounds and light – to mention just a few relevant aspects (Bloomer and Moore, 1977; Rasmussen and Wendt, 2005; Zumthor, 2006). An attention and sensibility towards both physical and experiential aspects of architecture is therefore relevant for the development and improvement of our built environment (Bolbroe, 2019; Imrie, 2003; Vardouli, 2012). Acknowledged approaches, challenging a hierarchical relationship between the architect and the user (inhabitant), are user-centred and participatory design in architecture (McDougall-Weil, A., 2015). Participatory design in architecture discussions have their early roots in the mid-60s and has gained some more attention in recent years through the user-centred design and human-centred architecture concepts (McDougall-Weil, 2015; Luck, 2018; Petermans and Vanrie, 2019). Despite its history, making participatory design actionable within architecture practice is described and perceived to be time consuming and consequently costly, not yet becoming a general standard practice (McDougall-Weil, A., 2015). Furthermore, the economic models in architecture have only recently begun to include broader value streams related to the operational phase, usage, societal benefits, and sustainability aspects (i.e., Social Life Cycle Analysis – S-LCA, Post Occupancy

Studies – POS, Building Performance Evaluation – BPE). According to Sanders and Stappers (2008), "… domains of architecture and planning are the last of the traditional design disciplines to become interested in exploring the new design spaces that focus on designing for a purpose".

While human-centred research within architecture can bring a valuable contribution to the field, such as the suggested concept of Design for Human Flourishing (Stevens et al., 2019), it seldom permeates actively in commercial project developments (McDougall-Weil, A., 2015). Moreover, even when participatory design is the method of choice, situated and embodied perspectives are rarely applied, such as allowing participants to experience architectural design solutions at full scale. Nevertheless, it has been demonstrated that "designers can better understand latent, specific impacts of design choices" (Bukovszki et al., 2021, p. 18) when involving directly impacted users.

OI may be a strategy within an architectural design process to serve the goal of designing for human-centred innovation with uses of co-creation towards social impact (Irwin, 2015). Considering architectural design practice as a means for developing a product and looking at this product as part of a larger service, it becomes relevant to assess the possibilities that lie within such a service. Such consideration invites key questions: How can architects' current practice can be enhanced with more human-centred processes towards designing for unpredictability and more flexible designs? Moreover, how to best facilitate the transmission of end users' (future inhabitants) knowledge into the co-designing experience during the designing process? These initial questions can guide a collaboration strategy for how to tackle the challenges outlined in this chapter, contributing to a baseline for innovative service development and implementation.

When discussing user-centred design and human-centred architecture (McDougall-Weil, 2015; Radion, 2017; Stevens et al., 2019) in the context of large projects and competitions, it is relevant to note that the architectural design service ecology is composed of a wide variety of stakeholders. They influence and guide a number of aspects during the process, which are far from allowing actual future inhabitants to have a say towards their future living experience. Thus, bringing knowledge from humanities research through OI frameworks may help minimise the existing gap of human-centred approaches in architectural design processes.

A pilot research case

From the fall of 2020, Copenhagen-based architecture firm, KHR Architecture, has been working strategically with the integration of research-based user-processes into live building projects. The purpose is twofold: to increase the quality of architectural solutions as well as to contribute strategically to KHR's business models.

Graabroedre Appartments (GA hereafter) is the winning proposal for a public tender from the city of Roskilde (Roskilde Municipality), by KHR Architecture and private-sector developer CORE Property A/S. The tender regards the transformation of the buildings of a former public school, Graabroedre Skole, into apartments as well as a new adjacent building with additional apartments. The pilot study is part of the sustainability strategy for the overall project proposal by KHR Architecture and CORE PropertyA/S. In this context, the architectural project GA provided a fitting framework to demonstrate the use of human-centred research towards business development.

Short methodology overview

The pilot case is presented in a concise format – the research structure, the process carried out, and a summarised overview of the analysis and results – to illustrate how research in the context of architecture practice can aid business development. The study presented in this chapter was conducted as an integrated part of a commercial architectural project and the lead researcher collaborated with the architectural design team on a daily basis. In commercial architecture, project timelines are often very volatile and subject to change. For this reason, a very flexible research design is needed in order to counter changing circumstances. In this case, the primary study was conducted directly in a building, on a construction site, in an idle period between the partial demolition, and the construction phases. As a central part of the study, a full-scale modular prototyping system was developed and set up on location in the building. Engaging in this situated architectural framework, the purpose has been to look into how practices and experiences of prospective inhabitants may be utilised as a source and driver of architectural design opportunities.

The study used a mixed method research design utilising a design thinking approach following a divergent and convergent pattern in several iterations, in combination with qualitative interviews, performative workshops, and participatory observation (Brown, 2008; Creswell, 2014; Rowe, 1994; Buchanan, 1992; Cross 2008; Kvale and Brinkmann 2018; Pink, 2015). Prior to the design development phase, the research and design team established and assessed a series of design requirements in order to mitigate safety and handling issues necessary for full-scale interventions on a construction site with invited participants (Cross, 2008).

The overall research process was structured around two phases: (a) design-development of a 1:1 modular building system and (b) a qualitative experiment conducted on location in a building. The first phase involved the design development of the 1:1 modular building system, consisting of approximately 110 individual elements that in combination makes up a reconfigurable spatial test environment. This phase combines brainstorming, ideation, and prototyping over several iterations in order to arrive at the final design of the

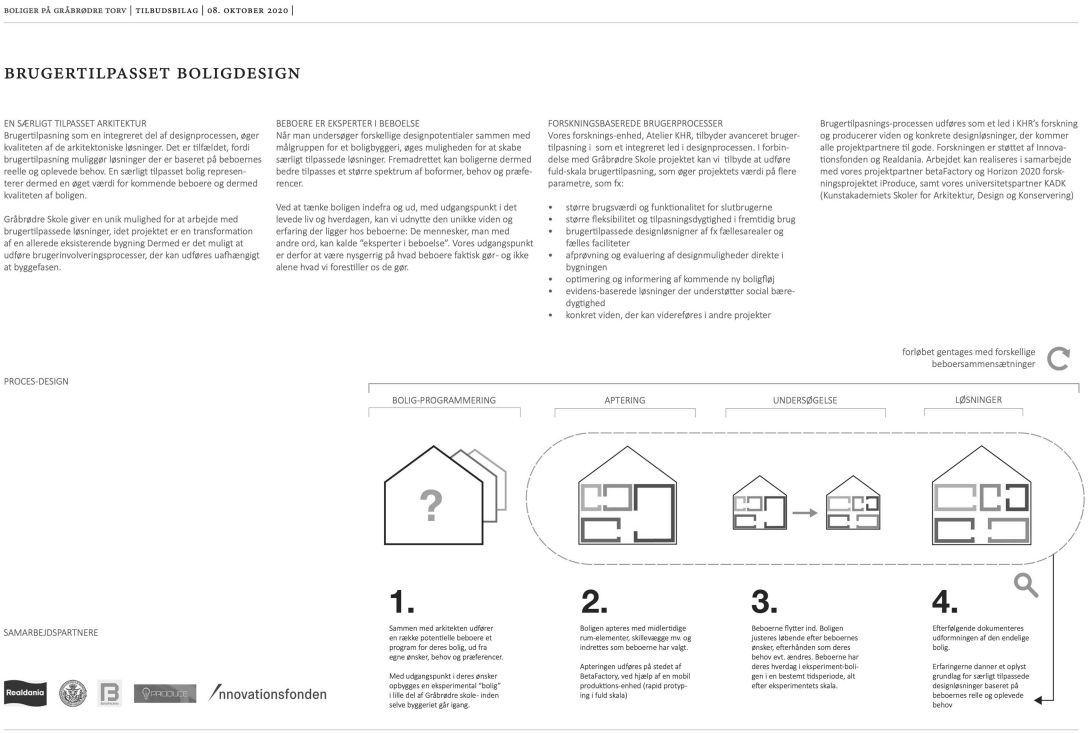
system. The second phase involved a series of performative workshops consisting of qualitative explorations on site, with invited participants, and drawing upon participatory and performative methodological elements. In the following, each phase is briefly presented.

Prior to the first phase, an architectural design team from KHR Architecture developed a project proposal for a competition entry in response to a public tender. Being a transformation of an existing building, this particular architectural project offered a unique opportunity to exploit the idle period between the demolition phase and the construction for research involving full-scale experiments. Adding further to the project proposal, the research project contributed to the overall quality of the project proposal with regard to social sustainability aspects, as called for in the public tender (Figure 7.1).

Following the tender results and following an OI approach, phase one started by setting up a cross-disciplinary design team and space consisting of researchers, architects, an engineer, and an interaction designer, located at an industrial maker space facility in Copenhagen. The overall prototype development and production involved five iterations during a four-month period: 1. Workshop, 2. Concept, 3. Design, 4. Production, and 5. Assembly. Given the condition of doing research during a live construction process, a central requirement was ease of handling and safety of modular building system. The design task was to conceptualise and produce a building system prototype with the capacity to facilitate the exploration of many different apartment layouts and interior solutions (Figure 7.2). Moreover, the building system should be able to be easily assembled and configured by two people. To fulfil this goal, a number of design aspects were considered such as size, weight, materials, joints, surfaces, assembly, transport, etc. These aspects were widely explored and converged into a final solution for a modular building system designed for full-scale architectural user interaction. As a result, the building system was designed as a modular building set consisting of 110 "building blocks" that can be combined in various spatial configurations in collaboration with invited participants.

The second phase focused on exploring the prototypes with the end users (future inhabitants) in situ across a two-month period. The researchers chose a purposeful sampling of participants, who represented the target customer group, to understand the actual value of the service in a business model proposition (Osterwalder and Pigneur, 2010). The participants were sampled amongst a number of people who had actively expressed an interest in the prospective apartments to the client. From the list received, all listed households were invited to participate in the pilot user study. Initial contact was made via email, requesting acceptance to send detailed information about participation in the workshops. Thirteen households were contacted and 11 households, totalling 18 people, participated in the workshops.

The workshops were designed around (1) a semi-structured interview supported by an interview guide (Kvale and Brinkmann, 2018), (2) a



BOLIGER PÅ GRÅBRØDRE TORV | TILBUDSBILAG | 08. OKTOBER 2020 |

BRUGERTILPASSET BOLIGDESIGN

EN SÆRLIGT TILPASSET ARKITEKTUR
Brugertilpasning som en integreret del af designprocessen, øger kvaliteten af de arkitektoniske løsninger. Det er tilfældet, fordi brugertilpasning muliggør løsninger der er baseret på beboernes reelle og oplevede behov. En særligt tilpasset bolig repræsenterer dermed en øget værdi for kommende beboere og dermed kvaliteten af boligen.

Gråbrødre Skole giver en unik mulighed for at arbejde med brugertilpassede løsninger, idet projektet er en transformation af en allerede eksisterende bygning Dermed er det muligt at udføre brugerinvolveringsprocesser, der kan udføres uafhængigt at byggefasen.

BEBOERE ER EKSPERTER I BEBOELSE
Når man undersøger forskellige designpotentialer sammen med målgruppen for et boligbyggeri, øges muligheden for at skabe særligt tilpassede løsninger. Fremadrettet kan boligerne dermed bedre tilpasses et større spektrum af boformer, behov og præferencer.

Ved at tænke boligen indefra og ud, med udgangspunkt i det levede liv og hverdagen, kan vi udnytte den unikke viden og erfaring der ligger hos beboerne: De mennesker, man med andre ord, kan kalde "eksperter i beboelse". Vores udgangspunkt er derfor at være nysgerrig på hvad beboere faktisk gør- og ikke alene hvad vi forestiller os de gør.

FORSKNINGSBASEREDE BRUGERPROCESSER
Vores forsknings-enhed, Atelier KHR, tilbyder avanceret brugertilpasning i som et integreret led i designprocessen. I forbindelse med Gråbrødre Skole projektet kan vi tilbyde at udføre fuld-skala brugertilpasning, som øger projektets værdi på flere parametre, som fx:

- større brugsværdi og funktionalitet for slutbrugerne
- større fleksibilitet og tilpasningsdygtighed i fremtidig brug
- brugertilpassede designløsninger af fx fællesarealer og fælles faciliteter
- afprøvning og evaluering af designmuligheder direkte i bygningen
- optimering og informering af kommende ny boligfløj
- evidens-baserede løsninger der understøtter social bæredygtighed
- konkret viden, der kan videreføres i andre projekter

Brugertilpasnings-processen udføres som et led i KHR's forskning og producerer viden og konkrete designløsninger, der kommer alle projektpartnere til gode. Forskningen er støttet af Innovationsfonden og Realdania. Arbejdet kan realiseres i samarbejde med vores projektpartner betaFactory og Horizon 2020 forskningsprojektet iProduce, samt vores universitetspartner KADK (Kunstakademiets Skoler for Arkitektur, Design og Konservering)

PROCES-DESIGN

forløbet gentages med forskellige beboersammensætninger

BOLIG-PROGRAMMERING | APTERING | UNDERSØGELSE | LØSNINGER

1.
Sammen med arkitekten udfører en række potentielle beboere et program for deres bolig, ud fra egne ønsker, behov og præferencer.

Med udgangspunkt i deres ønsker opbygges en eksperimental "bolig" i lille del af Gråbrødre skole- inden selve byggeriet går igang.

2.
Boligen apteres med midlertidige rum-elementer, skillevægge mv. og indrettes som beboerne har valgt.

Apteringen udføres på stedet af BetaFactory, ved hjælp af en mobil produktions-enhed (rapid prototyping i fuld skala)

3.
Beboerne flytter ind. Boligen justeres løbende efter beboernes ønsker, efterhånden som deres behov evt. ændres. Beboerne har deres hverdag i eksperiment-boligen i en bestemt tidsperiode, alt efter eksperimentets skala.

4.
Efterfølgende dokumenteres udformningen af den endelige bolig.

Erfaringerne danner et oplyst grundlag for særligt tilpassede designløsninger baseret på beboernes reile og oplevede behov

SAMARBEJDSPARTNERE

Realdania | /nnovationsfonden

2 | KHR ARCHITECTURE | CORE PROPERTY MANAGEMENT A/S | JÖNSSON ENTREPRISE A/S

Figure 7.1 Page from the competition entry for an open public tender, where the research concept was explained.

Figure 7.2 Full-scale modular prototyping system.

performative participatory event supported by an action guide, and (3) a follow-up interview and debriefing (Figures 7.3 and 7.4). Eleven workshops of three hours each took place between June and August 2021, where the end users explored and experimented with alternative apartment layouts, based on their needs and preferences. The workshops created unique opportunities to bring key people close to their possible near-future living spaces, interact, and adapt them to their needs and tastes.

Central to the workshop was the participatory aspect, since the objective was to understand how the participants' engagement with the prototypes might inform the architectural design. This form of participatory event was adapted from performance techniques with the purpose to explore the experiential and relational aspects of a specific spatial environment performed through bodily engagement (Bolbroe, 2019). Combined with a semi-structured interview guide (Kvale and Brinkmann, 2018), the researcher also developed an *action guide*, similar to a score (Schechner, 2013), a set of instructions for actions and behaviour to structure and organise participation

Figure 7.3 Participants engaging with the modular building system during performative workshops.

Figure 7.4 Scenes from the workshops. Both participants and researchers made use of hand sketches and plan drawings as reference material.

through bodily engagement, structured according to the basic principles of a performative model*: warm-up, performance*, and *cool-down* (Schechter, 2013).

The semi-structured interviews took place upon arrival of the participants. The interviews were followed up by the action guide *warm-up*, setting the scene and it served the purpose of acquainting themselves with the prototypes, the space, and the overall environment to be explored. The *performance* focused on engaging directly with the prototypes, moving them around, and positioning them originally in the locations indicating the apartment divisions initially planned for that part of the building, followed by an exploration of creating new spaces by repositioning the prototypes into new layouts (Figure 7.3). During this time, the participants talked aloud while engaging with the prototypes as guided by the researchers, to encourage the participants' initial oral elaboration (Ericsson and Simon, 1993). The *cool-down* served as a moment of contemplation and reflection to allow participants to comment and further elaborate about the embodied experience. The final part of the prototype exploration dealt with a post-interview session with the participants to gather impressions, opinions, reflections, and perceptions of the overall experience (Figure 7.4). The goal of this post-interview was to identify the value that similar services might have for the participants and to help uncover how such services can be integrated into the architectural design and building sectors.

Research insights

By exploring architectural solutions based on actual future inhabitants' experiences, the authors wish to explore and integrate the unique knowledge and expertise that lies within the inhabitants – as "experts in habitation". Our starting point was therefore an interest towards learning about

what future inhabitants actually might do, think, and experience – not only what is anticipated to be what they do, think, and experience. In this context, the building system acted as a motor for dialogue and open-ended enquiry, involving direct bodily experience (Bolbroe, 2019).

The analysis was carried out using the full interview transcripts, field notes as well as sound and video recordings. All collected data was compiled, clustered, and coded using content analysis to generate a set of themes (Charmaz, 2014). The role of the visual material and field notes together with the researchers' active and direct participation was valuable for the analysis, as these combined resources were vital for the interpretation of the field data. Contextual knowledge is crucial to decipher and understand otherwise-implicit aspects such as gestures, verbal references to space across different moment in time, movement, actions and interactions between participants, and the physical environment. For the purpose of this paper, the authors delimited the scope of the results to indicate the most relevant insights that ground our discussion and contribution.

Through the preliminary coding, three themes have been identified, which uniquely describe and nuance a range of values that emerged as result of the participants' engagement with the prototypes and the environment. The themes are "design understanding", "tangible validation", and "customisation value"; each signifies a form of value in relation to the overarching research focus and initial research questions. Given the early stage and scope of this chapter, each theme is proposed as a pointer of direction for further research.

Design understanding

When participants get the opportunity to engage physically in a full-scale prototype environment, their awareness and assessment of their own needs and preferences regarding the design parameters increases. Participants reported similar experiences in this regard, as one participant expressed:

> (IM) *It [the prototype environment] provides something to respond to physically, instead of looking at a drawing. It provides a better spatial understanding, because you can move these modules around. It triggers many more thoughts when you can move around and are able to use your body.*

Another participant describes the experience as *"architectural therapy",* and explains that the process itself helps her to gain a better and more nuanced understanding. Similarly, one participant clearly describes the experience as increasing her awareness: (E) "*when I leave today, I will be more aware of it* [about her own needs in terms of interior design]". In addition to obtaining an increased awareness, the participants' needs and preferences seemed to change over time, as the exercises progressed. Typically, participants' expressed particular needs and preferences during the interview prior to the

performance session, such as m2-requirements, number of rooms and relationships between rooms, storage, and so on. On many occasions, their initial preference changed. For example, the required m2 was reduced or the preferred number of rooms changed. Often quite small changes in the spatial configuration made the difference between an attractive plan solution and an unattractive one. Another participant explained how needs and preferences change in accordance to the practical experience of them: (E) *"When you change something [the spatial configuration] it affects other things. One need creates another one. Slowly you start to realise, oh, it can be like this too!"*

These initial observations led to a preliminary suggestion that engaging physically with a prototype space gives a deeper understanding of the needs to be accommodated into architecture design parameters.

Tangible validation

Related to awareness and assessment ability is validation of design proposals, which in this case was made tangible through the participants' opportunity to engage with a physical environment. All participants, to varying degrees, actively used their body to engage and assess various design opportunities. They moved around in characteristic patterns, such as back and forth while looking from side to side, as to physically use their body as a measuring tool to gauge the design of the space. As one participant pointed out, (LL) *"one thing is to say 75 square metres, but how 75 square metre actually appears is very different"*. They also actively used their hands, arms, and legs as bodily "measuring sticks". Meanwhile, most participants expressed their immediate thoughts and opinions, and after a while arrived at a conclusion. As one participant expressed in the follow-up interview,

> (M) *The closest I have been [to a related experience] was to measure all of my furniture, cut them out and place them on a plan drawing. This … being able to stand up inside [physical space] and make a living plan drawing … can we move this [wall] … yes, because there is still enough room for the bed.*

Similar to this participant, other participants expressed that they had a hard time only imagining spatial design solutions: *"It is hard to imagine how large an entrance hall should be [in order to be functional and feel good]"*. In comparison to looking at architectural plan drawings and engaging with a reconfigurable full-scale environment, one participant (OB) expressed that *"it [engaging in a full-scale environment] comes back tenfold!"* Unfolding his explanation, he described how engaging in the situation with his senses helped him to obtain a clearer impression of specific spatial properties and how sound and light conditions played a role. Additionally, the possibility to try out different possibilities, such as making a room smaller or bigger was helpful, because his body and movement became a means to validate if a particular design proposal fits his needs and preferences. Similarly, he expressed that it is

attractive to be able to influence architectural design solutions. He concludes, (HG) "*that thing [the opportunity], to be able to choose [between different scenarios and solutions]*".

When participants are presented with physical design proposals and an opportunity to augment them, they are generally very good at expressing how and why the proposal suits their needs – or not. A participant (MG) explained that experiencing and participating in an architectural design process at full-scale *"makes it more realistic"* and she got a better sensation of dimensions and space in terms of size, position and spatial relationships. Similarly, another participant compared the experience to a plan drawing, and concluded (L) *"I think this is much better. With a drawing … it is very hard to imagine how you can change the design"*.

Not only did they validated design proposals in accordance to their needs and preferences, they also spontaneously began to suggest alternative solutions on several occasions initially validating the value of such tangible experiences.

Customisation value

During the workshops, it was observed on several occasions that some of the participants spontaneously expressed a wish and willingness to pay for specific design solutions. Wishes fell within the two categories: customised solutions and to pay for choice. Yet a third may be identified, although not expressed directly, an option to purchase a design service similar to the workshop, to obtain the opportunity to influence architectural design. Among the solutions that the participants suggested and wished to buy as custom options, were design elements directly derived from the modular prototyping system, such as sliding doors and mobile partition walls. Among other design suggestions were mobile kitchen elements and rather extensive built-in storage designs. Moreover, lighting design and the location and design of the kitchen/bathroom amenities were among the candidates for custom-design options. One participant said, "I *would prefer that the kitchen sink is placed in front of the windows so I can look outside when I do the dishes. I don't like looking into a wall when I do the dishes*". To her, this feature was important enough to decline an apartment without this design.

These results indicate an untapped opportunity to monetise research-led physical prototyping experiences as a product within architectural design practice.

Discussion

While the general recognition that the considerations of the inhabitants' needs and preferences are important for good architecture, architects typically have limited direct access to inhabitants' perspectives (Sleeswijk

Visser, 2009). This study suggests the depth and quality of the inhabitant's perspective has important design implications for the architect. To propose relevant design solutions, architects may benefit from access and means of enquiry that help provide accurate and rich accounts of the inhabitants' perspectives, aggregating research in the design process can be one way to address such limitation.

These three themes can be embedded into business practice in various ways. For example, some structural design aspects participants mentioned, such as "window over the sink" or "bathroom with a window" can be fed straight into architectural designs, helping create more desirable layouts, fitting future residents' existing expectations and requirements.

As can be gathered from preliminary results, there was a clear interest in participating in this kind of study, demonstrating an untapped opportunity that can be further explored in future projects as participants were keen and saw value in experiencing future residential spaces before committing to a pre-set layout. Furthermore, the participants' indication that they would be willing to pay to take part in similar workshops suggests that infrastructure user-customisation in the building sector has a value and could be an add-on product or even a stand-alone service to the architectural business. This finding still needs to be validated in the market; nevertheless, it uncovered a possible market opportunity, which currently is not a mainstream offer in the large-scale architecture and building sector for residential living.

Besides the increased design potential, the customisation aspects indicate a novel set of value propositions to both companies and end users. The process and results also open up for the exploration of a new formulation regarding business models in the architectural design industry (Teece, 2010). Currently, these services have been mostly B2B and B2C, as earlier presented in this article. Within these models, valuable business proposition aspects from both the client (developer) and end-user (prospective residents) sides are suggested:

User side (Business to customer – B2C)

- Increased sense of ownership and relatability.
- Clarification of own needs and preferences (expected vs. actual).
- Accommodation of needs and preferences in design solutions.
- Increased interest and well-being due to being listened to.
- Willingness to "pay for choice".

Client side (Business to business – B2B)

- High-resolution evidence-based design may increase value through robustness of solutions.
- Greater flexibility provides a greater variation of use scenarios.
- Deeper knowledge about user segments and target groups.

- Potentially better sustainability profile due to increased life cycle of building.
- Awarded points in assessment of project (Roskilde Municipality).

However, the presented case does not exactly fit with either B2B or B2C; instead, it opens up to an opportunity, that of business to consumer to business (B2C2B), a model already applied among digital services (Hsiao, 2001; López-López and Giusti, 2020) but not yet widespread within architectural practice.

In addition, mitigating current building constraints through OI and research can positively impact architectural practice, capitalising on inertial steps in the design and building process. Currently, these processes are very long due to the complexity of stakeholders, financial requirements, building regulations, and it is not uncommon in renovation projects to have the space in standstill (and mostly unused) due to regulatory permits that need to land at the building site before the construction can start. Only having the knowledge of these idle times through a close collaboration with the industry, could the research take place exploiting the opportunity to test full-scale models in situ. In this case, it has been a prerequisite the researchers were able to carry out the pilot study without knowing the specific time intervals in advance and with the condition that the building might need to be vacant within very short notice.

As a result, for the residential building project "GA", KHR Architecture explored the potential of relational architecture as a design potential through an industry–university collaboration. In this process, the stakeholders committed to developing a new modular building system to facilitate human-centred design development of residential architecture, at the scale 1:1.

Some of the challenges initially identified:

- The innovation pipeline in the built industry is very long due to complexity of stakeholders, financial requirements, building regulations, etc. How can researchers exploit this situation in order to democratise architecture and the making of architecture?
- Deeper engagement enhances the human perspective allowing for higher empowerment and more robust and relevant design solutions. However, due to the infancy of this field, services building upon human perspectives may requires new business strategies to monetise within the industry. More research and market validation might be needed to incorporate this into architectural design practice.
- Development and innovation at full scale may be less feasible with conventional technologies due to financial barriers and time constraints in building projects.

Preliminary results indicate that, through research, a novel business model can bridge digitalisation opportunities from technology and service sectors

towards industrial practice and demonstrates its value across key stakeholders. While it is widely recognised that architecture's core value proposition lies in the form of a physically manifest building, it is less recognised how human factors such as *social processes, systems, structures, and relationships* in the built environment represent business value in the architectural industry and for the contractor, respectively.

Taking a human-centred approach and engaging with future inhabitants in 1:1 scale environment, this project has exposed the untapped opportunity of learning from needs and preferences that can guide architectural design processes. Human-centred research allows for informed decisions, which might challenge some technical perspectives commonly applied in the field, and offer a paradigm change in the way architectural practice might be practised and perceived. For architecture, the quality of *social processes, systems, structures, and relationships* is closely connected with the physically built environment, and thus need to be studied at the actual order of magnitude, namely at full scale. Combining an OI approach with a human-centred research can improve the feasibility of full-scale development and innovation.

For the architectural industry, a novel business model can highlight and operationalise how social processes, systems, structures, and relationships can continuously inform, develop, and enhance architectural design, in the form of a new architecture service product. Furthermore, it can facilitate the inclusion of experiential and relational architectural aspects emerging from the humanities towards a valuable and yet unexploited business perspective.

For the contractor, the increasing sustainability demands and requirements emphasise the need for architectural products that not only meet requirements related to the economic and environmental aspects of sustainability but also social ones.

For the building sector, even though the prospect of a research in the development process might not be initially regarded as highly valuable, it is the opportunity to build towards more sustainable solutions facilitated through the research that can help the sector achieve a more proactive practice through such collaborations. Finally, end users or future inhabitants are included in the business model, which is a clear paradigm change within real-estate development, providing original perspectives and approaches for the sector.

Conclusion

Combining the industry and research collaboration with the OI approach was key towards a fast and thorough process in co-exploring and co-developing ideas and prototypes for this case. Moreover, the research-industry-based OI approach enabled the integration of a human-centred research, directly in a live design and building process. This allowed the

exploration of the potential of research in situ and in full scale, which is otherwise less approachable with conventional construction means. For the architecture studio, there were valuable insights to be gained from exploring various use scenarios and the exploration of inhabitants' needs and preferences. Knowledge derived from such studies reveals a large untapped space of opportunities, based on identified and validated needs and preferences. Such knowledge has the potential to improve architectural solutions not only in the specific project but also across projects, and secure more relevant and robust designs. Moreover, applying aspects of OI allied to research in the architectural practice, suggests the field of humanities is a valuable pillar in research and industry collaborations. Such opportunities become available through challenging the standardisation of design and building processes, creating novel product, service, and business offerings through focused industry and user-driven research collaborations.

Acknowledgements

The authors would like to thank all the project partners, CBS, and our colleagues, who provided valuable feedback towards this article. This article reflects only the authors' view. The European Agency is not responsible for any use that may be made of the information it contains.

The authors would like to thank CORE Property A/S for making it possible to conduct full-scale architectural experiments at their property, and also thank Jönsson Entreprise A/S for their collaborative efforts towards safety and logistics at the construction site.

The current article has been made possible through the collaboration of KHR with the iPRODUCE project. The iPRODUCE project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 870037.

This project has also received funding from Innovation Fund Denmark, grant number 8054-00035B, and Realdania, grant number 2019–002122.

Note

1 To some extent, validated through tools and standards as the Social Return on Investment (SROI), Social Lifecycle Assessment (S-LCA), and sustainability certifications with a social profile in the building sector (i.e., DGNB, WELL, and Active House).

References

Barad, K. (2007). *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. North Carolina: Duke University Press.

Bloomer, K. C. and Moore, C. W. (1977). *Body, Memory, and Architecture*. In A Yale paperbound CN - NA2542.4.B57. New Haven: Yale University Press.

Bolbroe, C. (2019). *Making Architecture Become: A Performative Approach to Engaged Encounters between Inhabitants, Architecture and Technology*. PhD Thesis, IT University of Copenhagen.

Bos-De Vos, M., Lieftink, B., Volker, L. and Wamelink, H. (2014). *Business Model Design of Architectural Service Firms*.

Bos-De Vos, M., Wamelink, H. and Volker, L. (2016). Trade-offs in the value capture of architectural firms: The significance of professional value. *Construction Management and Economics*, *34*, 21–34. 10.1080/01446193.2016.1177192.

Braidotti, R. (2013). *The Posthuman*. Oxford: Polity Press.

Brown, T. (2008, June). Design thinking. *Harvard Business Review*, *86*(6), 84–92. 10.1002/med

Buchanan, R. (1992). *Wicked problems* in design thinking. *Design Issues*, *8*(2), 5–21.

Bukovszki, V., Dóci, G. and Reith, A. (2021). Coding engines in participatory social housing design—a case to revisit pattern languages. *Sustainability (Switzerland)*, *13*(6), 3367. 10.3390/su13063367

Charmaz, K. (2014). *Constructing Grounded Theory: Second Edition*. Constructing Grounded Theory. London: SAGE Publications Ltd.

Chesbrough, H. W. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, MA: Harvard Business School Press.

Costa Maia, S. (2016). *Testing Inhabitant Agency in Interactive Architecture: A User Centered Design and Research Approach*. Vancouver: The University of British Columbia.

Costa Maia, S. and Meyboom, A. (2015). Interrogating interactive and responsive architecture: The quest of a technological solution looking for an architectural Problem. In G. Celani, D. M. Sperling and J. M. S. Franco (Eds.), *Computer-Aided Architectural Design Futures. The Next City - New Technologies and the Future of the Built Environment* (Vol. 527, pp. 93–112). Berlin, Heidelberg: Springer. http://link.springer.com/10.1007/978-3-662-47386-3_6

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed). Los Angeles, London, New Delhi, Singapore: SAGE Publications.

Cross, N. and Wiley, J. (2008). *Engineering Design Methods: Strategies for Product Design* (4th ed). Portland: Ringgold, Inc.

Cuff, D. (1992). *Architecture: The Story of Practice*. Cambridge, MA: MIT Press.

Curley, M. and Salmelin, B. (2013). *Open Innovation 2.O: A New Paradigm*. https://ec.europa.eu/futurium/en/system/files/ged/24-oispgopeninnovation20anewparadigm-whitepaper.pdf

Ericsson, K. A. and Simon, H. A. (1993). *Protocol Analysis: Verbal Reports as Data*. Cambridge, MA: MIT Press.

Freudmann, A. (2020). Customers Want Customization, and Companies Are Giving It to Them - The New York Times. *New York Times*. https://www.nytimes.com/2020/03/18/business/customization-personalized-products.html

Grosz, E. A. (2001). Architecture from the outside: Essays on virtual and real space. In *Writing Architecture Series CN - NA2500.G76 2001*. MIT Press.

Haraway, D. J. (2003). The companion species manifesto: Dogs, people, and significant otherness. In *Paradigm CN - SF422.86.H37 2003*. Prickly Paradigm Press.

Hayles, N. K. (1999). *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. Chicago and London: University of Chicago Press.

Hekman, S. J. (2010). *The Material of Knowledge: Feminist Disclosures*. Bloomington: Indiana University Press.

Helfat, C. E. (2011). Open innovation: The new imperative for creating and profiting from technology. In *Academy of Management Perspectives* (Vol. 20, Issue 2). Harvard Business School Press. 10.5465/amp.2006.20591014

Hsiao, R. (2001). Technology fears: Barriers to the adoption of business-to-business e-commerce. ICIS 2001 Proceedings. http://aisel.aisnet.org/icis2001/22

Imrie, R. (2003). Architects' conceptions of the human body: 10.1068/D271t, *21*(1), 47–65. 10.1068/D271T

Irwin, T. (2015). Transition design: A proposal for a new area of design practice, study, and research. *Design and Culture*, 7(2), 229–246. 10.1080/17547075.2015.1051829

Kvale, S. and Brinkmann, S. (2018). *Interview: det kvalitative forskningsinterview som håndværk*. København: Hans Reitzels Forlag.

Loftness, V. and Hartkopf, V. (1988). The need: Intelligent buildings for building intelligence. In *Brian Atkin, ed., Intelligent Buildings: Applications of IT and Building Automation to High Technology Construction Projects*. New York: Wiley.

López-López, D. and Giusti, G. (2020). Comparing digital strategies and social media usage in B2B and B2C industries in Spain. 10.1080/1051712X.2020.1748377

Luck, R. (2018). Participatory design in architectural practice: Changing practices in future making in uncertain times. *Design Studies*, *59*, 139–157. 10.1016/j.destud.2018.10.003

Manning, E. (2012). Relationscapes: Movement, art, philosophy. In *Technologies of Lived Abstraction* (1. MIT pap). MIT Press.

Marble, S. (1988). *Architecture and Body*. New York: Rizzoli.

Marcet, X. (2008). Open innovation: A new paradigm. *Proceedings–8th International Conference on Hybrid Intelligent Systems, HIS 2008*, 959–960. 10.1109/HIS.2008.172

McDougall-Weil, A. (2015). A design anthropology of contemporary architecture: Proposing mainstream, contemporary, process-focussed inquiry for future user-centred design. In*Design Anthropological Futures*. Copenhagen, Denmark: The Research Network for Design Anthropology.

Osterwalder, A. and Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers and Challengers*. New Jersey: Wiley.

Osterwalder, A. and Pigneur, Y. (2013). Designing business models and similar strategic objects: The contribution of IS. In *Journal of the Association for Information Systems*, *14*(5), 10.17705/1jais.00333

Pink, S. (2015) *Doing Sensory Ethnography*. London: Sage Publications.

Pitt, L.F., Watson, R.T., Berthon, P., Wynn, D., and Zinkhan, G. (2006). The penguin's window: Corporate brands from an open-source perspective. *Journal of the Academy of Marketing Science*, *34*(2), 115–127.

Puig de la Bellacasa, M. (2017). Matters of care: Speculative ethics in more than human worlds. In *Posthumanities CN - BJ1475.P85 2017*. Minneapolis: University of Minnesota Press.

Radion, I.-E. (2017). *Approaching the Virtual - A Human Centred Architecture*. Aalto: Aalto University. http://urn.fi/URN:NBN:fi:aalto-201712208280

Rasmussen, S. E. and Wendt, E. M. (2005). *Experiencing Architecture* (33rd ed.). Cambridge, Massachusetts: MIT Press.

Rowe, P. G. (1994). *Design Thinking* (5th print). Cambridge, Massachusetts: MIT Press.

Sanders, E. B.-N. and Stappers, P. J. (2008). *Co-creation and the New Landscapes of Design*. 10.1080/15710880701875068, 799–809.

Schechner, R. and Brady, S. (2013). *Performance Studies: An Introduction* (3. ed). London & New York: Routledge. http://external.dandelon.com/download/attachments/dandelon/ids/DE006D98DD9826E3029AAC1257B63003B287C.pdf

Schmidt, R., and Austin, S.A. (2016). *Adaptable Architecture: Theory and Practice*. London; New York: Routledge: Taylor & Francis Group.

Senagala, M. (2005). *Kinetic and Responsive: A Complex-adaptive Approach to Smart Architecture*.

Sleeswijk Visser, F. (2009). *Bringing the Everyday Life of People into Design*, Doctoral Dissertation, TU Delft.

Spurr, S. (2007). *Performative Architecture Design Strategies for Living Bodies*. Sydney: The University of New South Wales.

Stevens, R., Petermans, A. and Vanrie, J. (2019). Design for human flourishing: A novel design approach for a more 'humane' architecture. *The Design Journal*, *22*(4), 391–412. 10.1080/14606925.2019.1612574

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

Till, J. (2009). *Architecture Depends*. Cambridge, Massachusetts: MIT Press.

Van der Linden, V., Dong, H. and Heylighen, A. (2018) *Architects' Attitudes Towards Users: A Spectrum of Advocating and Envisioning Future Use(rs)* in Design, Ardeth, 2 | 2018, 196-216.

Vardouli, T. (2012). *Design-for-Empowerment-for-Design: Computational Structures for Design Democratization*. Cambridge, Massachusetts: MIT.

Vidler, A. (1999). *The Architectural Uncanny: Essays in the Modern Unhomely* (5. print). Cambridge, Massachusetts: MIT Press.

Vardouli, T. (2016). User design : Constructions of the 'user' in the history of design research, in Lloyd, P. and Bohemia, E. (Eds.), *Future Focused Thinking–DRS International Conference 2016, 27–30 June*, Brighton, United Kingdom. 10.21606/drs.2016.262

Zumthor, P. (2006). *Atmospheres: Architectural Environments - Surrounding Objects*. Basel: Birkhäuser.