

Living in a Historic Neighborhood in the Technology-Era: Understanding Residents' Expectations from Domestic Spaces

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ABSTRACT

Our use of everyday spaces continually transforms with the domestic technologies entering our homes. However, accommodating these technologies is especially challenging in historic neighborhoods as these spaces were built in eras suitable for different lifestyles. Understanding users' expectations living in this context could provide valuable opportunities to support occupants' everyday comfort and increase the built environments' lifecycle. Therefore, we conducted in-depth semi-structured interviews with 12 early-adopter residents in two historic neighborhoods to explore expectations towards future domestic spaces. Findings reveal four themes that cover individual values and neighborhood identity in shaping residents' expectations. We uncover three design directions for the field: (1) integration of location-specific multisensory experiences, (2) consideration of bodily interacted flexible and adaptable spaces, and (3) imagination of human-like interactions with domestic spaces. We further unveil the potential for design fiction studies and discuss for how Human-Building interaction researchers/practitioners, and architects could respond to these future directions.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); Empirical studies in HCI.

KEYWORDS

Domestic spaces, Architectural change, Historic neighborhood, Home, Human-Building interaction (HBI)

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1 INTRODUCTION

In recent years, a growing number of studies in the field of HCI have been conducted to understand and shape human experiences with and within built environments [3]. Since the velocity of technologies entering our everyday domestic spaces increased, architecture has progressively been a site of inquiry for the HCI community. Even though there is a rapid increase in the advancements of these technologies, previous research shows that architectural spaces remain more rigid for the adaptation of these technologies into our domestic physical environments [41]. As the famous architect and educator Kas Oosterhuis [75] noted, the field of architecture needs to transform with the new digital technologies entering our everyday lives. Consequently, we expect to have a different level of interactivity with our architectural spaces in the future [5]. The architectural transformations of workspaces due to the increased use of technologies are stated to be slower than anticipated [28]. We believe this applies to domestic architectural spaces as well.

Integrating technologies into domestic architectural spaces has been a site of interest among many researchers and practitioners for many years [39, 74, 77]. In the field of architecture, these interests could be traced to the development of smart neighborhood approaches in cities. Smart environments which accommodate smart devices in physical spaces (e.g., using smart thermostats at home) make residents' lives more comfortable, as previously described [32]. Even though they have positive intentions for their residents, these approaches have been criticized for being top-down and neglecting users' needs and expectations in their developmental phase [98]. Further, there are recent involving famous architects in planning new neighborhoods that contain the transformation of domestic architectural spaces such as Brainport Smart District by UN Studio [36] or Sidewalk Lab's vision for a smart neighborhood in Toronto [91]. Yet, these plans significantly focus on developing new neighborhoods and rule out understanding user expectations towards the transformations of domestic spaces within the historic neighborhoods of the cities. Historic neighborhoods are important aspects of cities where many tangible and intangible heritage co-exist [35]. Therefore, in the focus of our study, we value learning about the expectations of the residents towards future domestic spaces in the historical neighborhood context. We aim to positively influence residents' life quality and the lifecycle of the built environment in terms of the sustainability of such neighborhoods [14, 46].

Our work analyzes the experiences of early adopter residents of domestic technologies in two historic neighborhoods by examining the residents' relationship with their neighborhoods, their behavior with technologies at home, and the troubles they have experienced with these current architectural spaces Among various architectural typologies for domestic spaces (e.g. detached houses, high-rise buildings, etc.), our study focuses on attached urban apartments at the two historic neighborhoods in Istanbul [79]. Our scope for



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domestic technologies includes smart technologies (e.g., smart lighting and security systems) that are used at home [84]. However, the technologies we inquired about are not limited to these, it includes a wide range of technologies that are used in our everyday spaces (e.g., regular kitchen appliances) [9]. This was preferred due to expanding our research inquiry and adopting an explorative approach to our everyday domestic spaces.

Our research contribution is three-fold: (1) revealing *residents' expectations* towards future architectural needs and interactivity desires in domestic spaces, (2) uncovering users' personal relationship with a historic neighborhood scale, and finally, (3) providing design directions for future studies. We conducted in-depth interviews with 12 early adopter participants. We complied four themes from the user data that manifest in a cross-scale relationship from individual values to neighborhood identity, identifying a sequence of an inside-out spatial flow. Following that, we discuss our findings and provide three design directions to the field. We also discuss the value of a design fiction approach in prospective research for eliciting further insights. Our work informs how HBI researchers, practitioners, and architects could respond to these directions arising from historical neighborhoods in the future to support the users in these under-explored settings.

2 RELATED WORK

2.1 Studying Technology in Domestic Spaces

Home indeed cannot be defined by any of its functions and can only survive if it addresses the needs of its members [62]. A wide span of different fields and disciplines from social sciences to architecture investigated the concept of 'home' [59]. While their aims differentiate, their common belief is that the home is a multifaceted, rich, and complex setting for everyday life [1, 82]. Several researchers focused on understanding residents' alternative notions of home for developing potential domestic technologies in the future. Prior research investigated how collective and mobile living conditions may lead to novel domestic technologies [71]. Another research explored how technology could be understood and reconstructed through alternative domestic concepts or frameworks [18]. Other studies examined do-it-yourself placemaking activities of the residents where rural eco-home conditions [89] and turning a van into home experiences [24] could result in the development of future domestic technologies.

Since the 1990s, the HCI community has been increasingly centered on understanding the evolving and complex directions of interactive technologies that are placed and impact our domestic spaces [23, 69]. These studies cover various perspectives of technologies at home. For example, one research examined how autonomous, mobile service robots might fit into domestic spaces [31]. Meanwhile, another study investigated user configurations of ubiquitous domestic environments [37]. Crabtree et al. researched to consider how these ubiquitous computing technologies might relate to and support everyday activities at home [21]. Researchers also studied the placement of technologies in these domestic spaces to sensitize designers of both artifacts and physical spaces in that focus [7]. Previous research aimed at understanding the evolution of buildings with the use of technologies and provided implications for the design of these ubiquitous domestic spaces [78]. Researchers also created purpose-built living lab environments to explore how inhabitants might experience the future of home [4, 42].

Studies that aimed at exploring domestic spaces also cover the barriers and motivations for residents' adoption of domestic technologies. One study examined the adoption of home automation technologies and presented residents' important values for technologies in a home setting [88]. Another research revealed that consumers' technological innovativeness is a motivation, whereas a lack of facilitating conditions is a barrier to residents' smart home technology adoption [10]. Previous research identified that domestic technologies need to fit into residents' lifestyles to overcome the social barriers to smart home adoption [8].

Even though these prior studies of technology at home have been researched in the field to produce essential contributions on how technology can be designed and appropriated to better support the tasks, routines, and experiences of home life; they remain scarce in terms of contributing to the design of future domestic spaces to facilitate these conditions in the historic neighborhood context.

2.2 Understanding Architectural Change

As previously stated by Rodden et al. "Domestic environments evolve. They are open to continual change and the need to understand and support this change will be important to ensure the successful uptake and management of digital devices in domestic spaces" [78]. Researchers in the past have considered the change in domestic architectural spaces with technologies in terms of evolution. Brand created a framework of different layers of change in our built environments (e.g., stuff, space, services, skin, structure, and site) [13]. The framework highlights different temporal levels for the architectural change of each layer. For example, as space plan changes are indicated to occur around 3-30 years, the structure of our buildings is stated to change around 30-300 years.

A recent study also explained that the HCI field turned the focus from the realm of artefacts into the realm of environments [2]. These studies were mainly addressed under the evolving field of Human-Building interaction (HBI) [3]. One prior study investigated the change in the HBI context via speculating with students about new university smart building interactions [65]. By contributing to Brand's model of building change, another research explained the temporal constraints in HBI and stated that architecture and interaction design are likely to produce outcomes with different lifetime expectancies [55]. Manovich described that the increasing use of social media influences a change in how people experience physical spaces [60]. Another research explored the changing patterns in the domestic architectural context that resulted from the increasing f-commerce activities of the residents [64]. Desmet described the term "affective architecture" that triggers the change in architectural spaces depending on the residents' needs and stated that such opportunities are under-utilized in design activities [100]. Therefore, examining future domestic spaces in a historic neighborhood context is valuable to understand what architectural change means at its physical and temporal levels while increasing the residents' well-being.

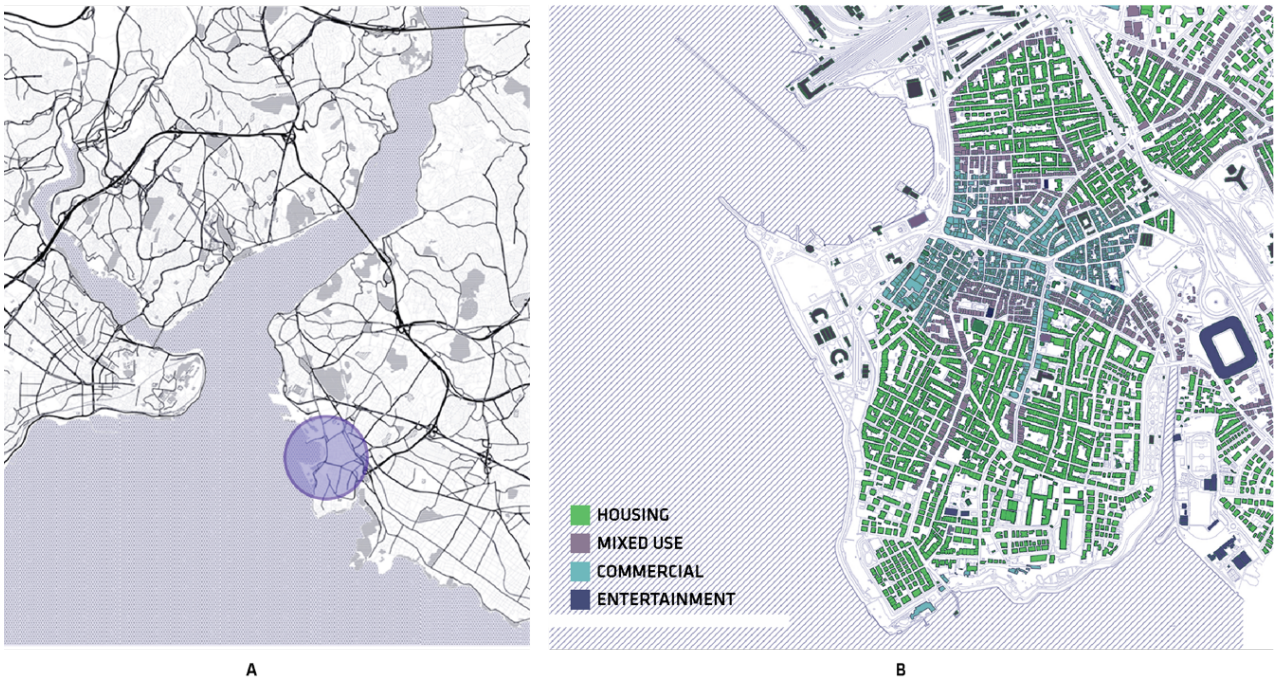


Figure 1: Location (A) and Land use map (B) of Moda and Yeldeğirmeni neighborhoods in Istanbul

3 METHOD

Applying HCI methods and approaches for architectural studies has gained traction in recent years. [50, 93]. These studies highlight the importance of focusing on user-centric efforts such as conducting observations, interviews, and creating personas for understanding architectural expectations to increase functional values and occupants' comforts. Previous research also highlights the importance of diagrammatic representation of the space to build up a meaningful dialogue between architects and users [12, 54]. Conversations around the ongoing routines [94], and the technology usage [53] are used for understanding spatial experiences and addressing users' needs and expectations within the domestic architectural spaces. Based on the earlier studies we encountered using similar approaches [48, 68], in this study, we conducted qualitative research with early adopter residents in two historic neighborhoods of a metropolitan city to elicit residents' experiences and expectations towards the future of their domestic spaces. We started our research by selecting our location, and then, deployed a survey measuring the Innovativeness Scale (IS) [38, 43] to recruit participants. Next, using Zoom and Miro software, we conducted in-depth semi-structured interviews with 12 recruited early adopter residents in two centrally located historic neighborhoods in Istanbul.

3.1 Selecting Location

The study locations are selected as Moda and Yeldeğirmeni neighborhoods in Kadıköy district in Istanbul, Turkey (see Figure 1A). The history of Kadıköy dates back to the Neolithic era, but the permanent inhabitation of the neighborhood could be traced to early Byzantine times as a small village consisting of dwellings [30]. As transportation facilities advanced in the city by the end of the nineteenth century, the district started growing rapidly and became a constituent of a western lifestyle among its residents [30]. Both neighborhoods of the study were selected according to several criteria that could be beneficial for our research focus. First, both neighborhoods consist of various historical layers as mentioned earlier, and host different morphological shifts of the urban fabric throughout the years (e.g., transforming from single detached houses to urban apartments) [92], whereas the current urban fabric is a mix of many functions co-located within the neighborhood (see Figure 1B). In the socio-spatial context, both locations have strong neighborhood identities and different demographic backgrounds of their residents [83]. Lastly, one of the neighborhoods contains the earliest example of an apartment quarter in the city, showing their potential of adopting new habitation styles [34]. For all features mentioned above, we selected these two neighborhoods as valuable locations to examine as case studies for understanding our research curiosity (see Figure 2).

3.2 Recruiting Participants

We recruited residents who live in these two historic neighborhoods by deploying a survey to our institution's participant pool. Our survey consisted of questions asking demographic information, the duration of being a resident in the neighborhood, and providing a short list of technologies (from smart domestic devices to kitchen appliances) to select for which they currently use at home. It also included the questionnaire for the innovativeness scale [38, 43]. We preferred to use IS for identifying early adopter residents, and since



Figure 2: Photos from Moda and Yeldeğirmeni neighborhoods

Table 1: Interview participants

Participants	Age	Gender	Household type
P1	53	female	Couple with a child
P2	27	female	Lives alone
P3	28	male	Lives with a partner
P4	26	female	Lives with a friend
P5	25	female	Lives with a friend
P6	37	male	Lives alone
P7	32	female	Lives with a partner
P8	37	male	Lives with a partner
P9	27	female	Lives alone
P10	50	male	Lives alone
P11	34	male	Lives with a partner
P12	27	male	Lives with a friend

individuals with higher scores of innovativeness are more likely to adapt to new technologies and lifestyles earlier [20].

In return, we received 33 responses to our survey. We selected 12 of the participants fulfilling the criteria of (1) scored as an early adopter or above from the scale, (2) residing at least for six months in one of the selected neighborhoods, and (3) containing at least four domestic technologies we listed in the questionnaire, lastly, (4) willing to participate in the interview process. In our research focus, residents, who scored as early adopters or above, were the ones who had experiences and intentions of integrating smart devices into their current homes to participate in our study. Fulfilling these recruitment criteria was essential for maximizing the data we expected to receive from the interview phase of our study.

Recruited participants are detailed in Table 1. There were six female and six male participants ranging from 25-53 years old. Each of the participants represented one household. Eight of them shared their home with partners or friends who were not willing to participate, and one out of these eight participants lived as a family with a child. The remaining four participants were single living residents.

3.3 Interview Procedure and Analysis

Due to Covid-19 restrictions, we had to manage our research using online tools. Before the start of our interview process, we conducted five pilot studies for refining our interview procedure. Our interview procedure included four consecutive phases which lasted approximately one hour in total (see the supplementary material).

The first phase was to understand the resident's relationship with the neighborhood as previous research also highlights the importance of understanding this relationship for designing the future of domestic spaces [22]. Our procedure includes a think-aloud session to examine participants' experiences, pain points, and motivations for living in that neighborhood [47]. Following that, we asked participants to sketch the floor plan of their homes and place their domestic technologies into those floor plans. This phase was to understand the current situation and architectural inadequacies and to immerse participants in the next stage. The sketches also served as reference points for discussion during and after the interviews (see Figure 3). During the interviews, participants showed around the house where possible and walked around the spaces we discussed if needed. We provided a list of domestic technologies on the Miro board and asked participants to talk about the ones they owned on the floor plans. Other domestic technologies that participants did not own but wanted to use in the list were also

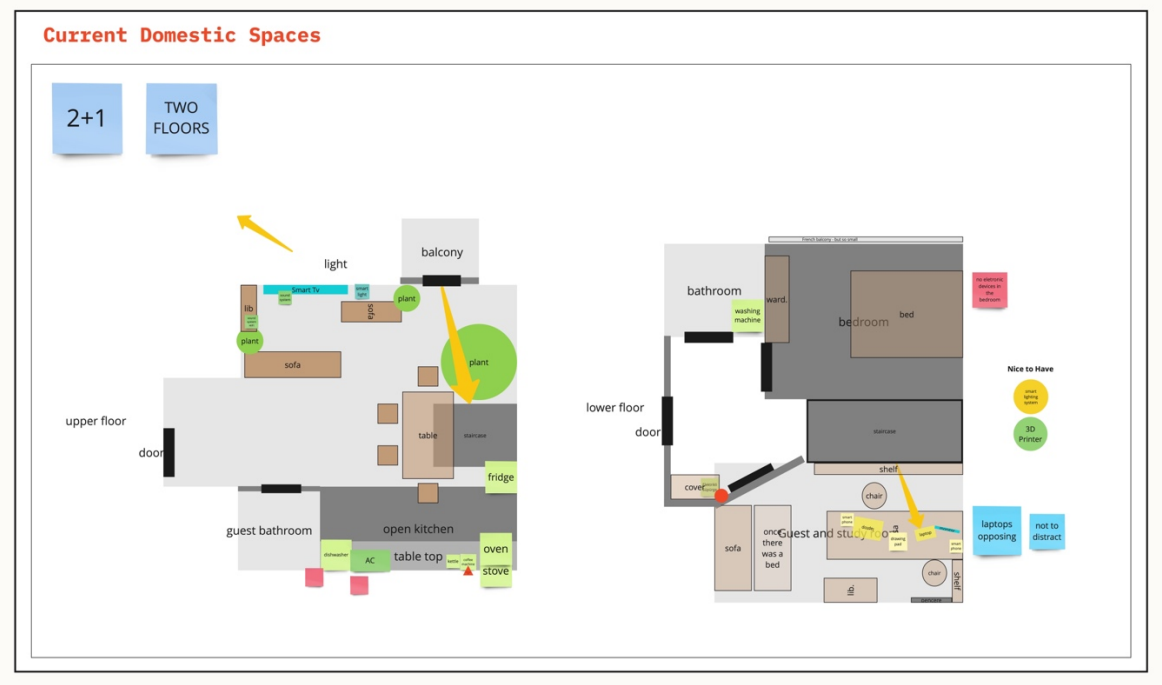


Figure 3: One participant's floor plan sketch on Miro

discussed to grasp their adequacies and shortcomings in their current domestic spaces. Lastly, we provided three questions to reveal participants' expectations from future domestic spaces.

After the interviews were completed, we transcribed our recordings for analysis. The analysis involved examining Miro boards, transcribed interviews, and interview notes. The coding process was conducted in an iterative-inductive process [29], and the themes emerged using a reflexive thematic analysis approach [15, 16]. The reflexive thematic analysis, as Bryne [17] suggested, includes six phases: (1) familiarization with the data, (2) generating initial codes, (3) generating themes, (4) reviewing potential themes, (5) defining and naming themes, and lastly (6) producing the report. Throughout the process, the outcomes have been discussed with four other researchers, who work in HCI and design research, in two meetings (which lasted approximately 6 hours in total). During the meetings, along with four other researchers, potential disagreements such as coding procedure, emerging themes, and the ambiguity associated with interpreting respondents' statements were reconsidered and reconciled according to the discussions.

4 FINDINGS

In this section, we identify how early adopter residents of two historic neighborhoods during the interviews described their experiences of living in the neighborhood, the inadequacies of their current living environments, their behavior with technology within these spaces, and their expectations from their future domestic spaces. The stated expectations from the participants in this study were reviewed under the framework of Olsson [73] which helps better reflect the data during the analysis process by examining different expectation layers (desires, experience-based assumptions, social and societal norms, must-be expectations). The overall presentation of the themes (see Figure 4, adapted from [97]) shows a cross-scale relationship from individual values to neighborhood identity and defines a sequence of inside-out spatial flow. Throughout the remainder of the paper, quotes from participants are presented verbatim.

4.1 Theme 1: Appreciating social and spontaneous interactions

Most participants described having a strong attachment and identity to their neighborhood community during the interviews. One of the participants (P10) even cited other community members, as not other residents, but described them as "more like a family". It was significantly valuable for the participants to have like-minded people with whom they could feel connected.

Another prominent statement from the participants was that they highly valued the spontaneous, casual, and serendipitous interaction they experienced with other neighborhood residents. The single-living participants especially attached high importance to small talks with other neighborhood members. P9 described the situation as *"I know most of the people in the community, and occasionally, drop by to have small talk with them... It is an essential thing for me because I live alone"*. Also, these casual interactions amongst other neighborhood residents are perceived as a factor for the safety of both the neighborhood and their home.

Following this insight, how participants described their technology use behavior at home was similar to the above-mentioned

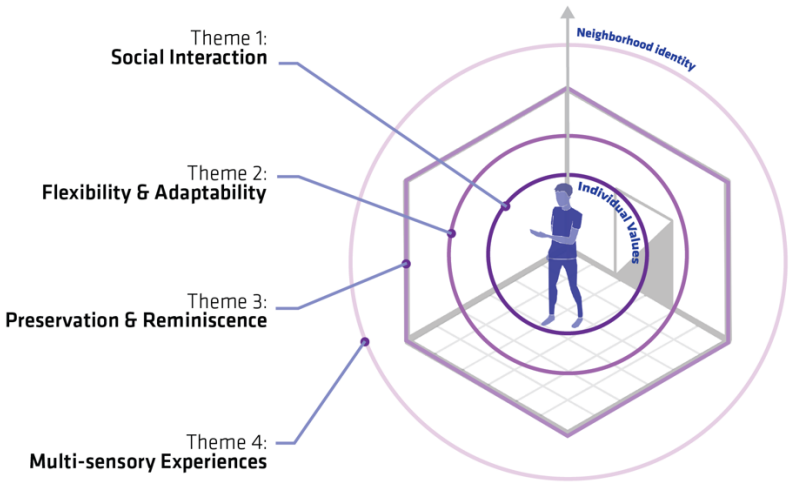


Figure 4: Cross-scale relationship of themes

interactions. One of the residents expressed the importance of keeping face-to-face interaction with his wife when he worked remotely from home. *"My wife also works from home two days a week, and we work face to face alongside each other, we chat meanwhile."* As P11 described, the placement of their personal computers in the room was based on supporting this interaction.

This also extends into the residents' personal values attributed to a specific part of their domestic spaces. Many of them stated the most frequently used spaces of their homes are the socializing spaces such as living rooms, even sometimes kitchens. P1 noted that the living room has a special meaning for her family because it is the family's union space in their daily routine. The personal values attributed to these spaces also occur as motivational factors depicted by the residents. P4 described the significance of having another room for her remote working hours as being separated from the sleeping area, which creates a motivational feeling for her.

Concerning the above-mentioned, participants stated their expectations from their domestic architectural spaces using such keywords as *'encourage,' 'motivate,' 'cooperate,' 'help,' 'learn and adapt over time for their everyday living experiences'*. One participant even used the metaphor 'like a friend' to describe the level of interaction in a future domestic space.

"Rather than I control and command things to do, that space should know me and adapt accordingly. Like a friend. . . A friend also interacts with you and learns over time. This is an important detail for me." (P11)

Another participant stated that rather than the domestic spaces automatizing chores for her, the space should encourage and motivate her towards achieving these everyday practices such as cooking, watering plants, etc.

So overall, this theme indicates that early adopter residents of these two historic neighborhoods significantly valued the human-to-human and spontaneous interactions they have with their neighborhood community and expect to integrate these human-like interactions into their future domestic spaces.

4.2 Theme 2: Seeking flexibility and adaptability in spatial arrangements

Most of the participants talked about their expectations of adaptable architectural spaces throughout the interview sessions. These codes from the interview data were identified when participants specifically mentioned the word *"to adapt"* or regarding the adaptation of a particular space depending on factors that are spatial, infrastructural, things at home, or personal needs. P2 described adaptable aspects as that these spaces at home could be designed in a more modular way and could adapt to her when she needs them accordingly. For example, she expected to change these spaces while living according to her long-term needs. From our interview data, it was remarkable that adaptability is determined as a spatial change that occurs over time at home.

On the other hand, residents' expectations of the flexibility of future domestic spaces were also at a considerable level. These codes from the interview data were extracted when the participants mentioned a spatial change at an immediate temporal level. P8 quoted that for all his domestic technologies, he expects mobility when he needs shifting places, regardless of the infrastructural constraints of his home.

Another example of the immediate change could be described as P9 stated that she expects her rooms to have more flexible features when she feels like changing them for her instant privacy needs.

The adaptability and flexibility aspects of the domestic spaces were also observed through the needs of the participants' control of these domestic spaces. Two of the participants especially indicated the importance of flexible and adaptable spaces via bodily interaction and control.

P1 noted the adaptability of the future domestic spaces *"For example, if your child is an infant, his room may be smaller. When the child grows up, I would like that living space to be reshaped with transformable materials as well."*

While P11 expressed his expectations of flexibility, such as *"In other words, these places should be in acquaintance and harmony. They should be able to move with me, just like my shadow... The fact that these places should even be like extensions of my body. Maybe I won't even need to transform these places from my phone in the future. Maybe my fingers will be enough to control."*

Overall, this theme indicates user expectations of flexible and adaptable spaces with considerations of bodily control and interaction aspects.

4.3 Theme 3: Valuing preservation and reminiscence of spatial memory

Both neighborhoods in the study were selected in terms of their historical qualities. Regardless of inhabitants' duration of residency, participants shared many lived or heard experiences from the past of their domestic architectural spaces. These homes in the neighborhood context became sites of memory through relationships, past experiences, and storytelling aspects for most of the residents.

This data also complements the previously mentioned strong attachment with the place conditions of the residents with their neighborhood and domestic spaces. For example, during the interview, P1 described that their home was initially built by a local famous architect/sculptor and was once used as an atelier, and now served as the participants' home. These participants (P1, P2, P10) highly valued the past of their architectural spaces with respect and stated that they feel special for living in such places.

Participants also explained that they traced the spatial memories of their homes when attributing new uses to these spaces. P2 noted how past occupants used the space in the apartment's entrance hall and how she considered assigning functions to the same space from the traces of this previous usage.

P1, P2, and P10 narrated these stories by answering questions to anticipate their strong connection to their neighborhood and home. Meanwhile, participants commonly stated the issues of *"inability to experience these memories fully"* or *"these memories vanish over time"*. One participant noted:

"...No, I could not see the wooden version (describing the past version of the building). I only know from black and white photos. My brother is luckier than me in that regard; he lived in it. The building was already changed when I was born." (P10)

Interdependently, participants stated their expectations towards spatially preserving, reminiscing, and re-experiencing their domestic spaces' memories. P10 described that if he had a magic wand, he would want to experience how it was in the past. Also, for P2, she wanted to occasionally experience the history to understand how these spaces once felt.

So overall, this theme identifies a strong connection between the residents and their architectural spaces from a historical perspective. The participants highly value preserving, remembering, and re-experiencing their spatial memory.

4.4 Theme 4: Exploring multi-sensory experiences

During the think-aloud session of the interviews, participants described their neighborhood-scale experiences through their multi-sensory perceptions. According to participants in both neighborhoods, these environments were perceived as highly dense, causing proximity issues in the urban settlement. For most of the residents, the proximity induced noise, sight, air quality, and thermal comfort issues. However, participants also noted that some of their sensory experiences with their neighborhoods created pleasant moments in their daily routines.

While participants shared their experiences with domestic spaces, they described their domestic spaces' spatial and infrastructural inadequacies (lack of space and/or water piping system) due to the historic context. These inadequacies result in users being obligated to place their domestic technologies in particular and/or unwanted areas at home. These obligations also create some sensory discomforts, as explained by the participants. For example, P1 stated that due to the infrastructural inadequacy, she had to place her washing machine in the kitchen. This caused her to adapt her cooking routines to avoid the unpleasant sounds of the washing machine in the kitchen.

In contrast, participants also mentioned that some of their sensory experiences with their neighborhoods created pleasurable moments in their everyday spaces. Residents noted that the presence of auditory, olfactory, and tactile experiences in these everyday living environments (the scent from the coffee machine or the smell from the sea nearby) increased the usage frequency of space within their homes. To illustrate, participants explained their tendency of integrating more functions into these sensorily pleasant domestic spaces. Another participant stated that they place their domestic technologies depending on their spaces' sensory quality architecturally provided. For example, (because they live on the top floor of their apartment) they preferred to place their TV by the side of their living room so that the sound could be amplified through the slope of their roof.

During the interview session, P12 significantly noted a memorable tactile experience he recently had at one home: "In fact, I was very impressed with a historic house I went to the other day... For example, they completely covered the floor of the house with sand. You are stepping on the sand with your bare feet. It was an extraordinary experience for me."

So, it was prominent in the interview process that residents expected to integrate pleasant olfactory, auditory and tactile sensory experiences that they experience in their historic neighborhood into future domestic spaces.

5 DISCUSSION

As mentioned earlier, our overall aim in this study is to interpret early adopter residents' expectations for the future of domestic spaces in two historic neighborhoods in Istanbul. In the next section, we demonstrate three new design directions as follows: (1) integration of location-specific multi-sensory experiences, (2) consideration of bodily interacted flexible and adaptable spaces, and (3) imagination of human-like interactions with domestic spaces. These

design directions offer new insights to HCI, based on user data collected from historic neighborhoods. Lastly, we provide prospective directions embodying these design directions in the form of design fiction studies to further explore the future of domestic spaces in historic neighborhoods.

5.1 Design direction 1: Integration of location-specific multi-sensory experiences

As previously presented, our findings suggest that residents are affected by the sensory qualities both within and outside of their homes. Participants described that they eliminate unpleasant sensory outputs (e.g., the sound of a washing machine in the kitchen) while further integrating pleasant sensory experiences that they regularly encounter in their neighborhood routines (e.g., the smell of the sea). These pleasant sensory experiences also contribute to residents' emotional attachment to their neighborhoods and domestic spaces [86].

Multi-sensory experiments in the realm of architectural spaces have been previously considered by the HCI community [61, 70]. Previous research also acknowledges the importance of studying domestic spaces in their multi-sensory dimensions for progressive technological interventions [51]. However, the architecture discipline is criticized for its ocular-centrism (sight-dominance) which causes considerations of mainly visual aspects of architectural spaces [27]. Other researchers highlight that incorporating a multi-sensory approach in architectural practice will develop our built environments and their occupants' well-being [52, 85]. Pallasmaa, the famous Finnish architect, also highlights this issue, stating that architecture involves seven realms of sensory experiences (e.g., the space of scent, the shape of touch, etc.) which interact and infuse with each other [76]. Therefore, it is prominent that incorporating neighborly triggered multi-sensory experiences into our future domestic spaces may increase the well-being of the residents.

Another essential data in our findings was one resident's expectation for integrating different tactile experiences into future domestic spaces. This insight directs us into providing a new aspect of exploring new material approaches in our future homes.

Prior research investigates different material approaches in architectural spaces [74], such as Nabil et al.'s study of the potential of organic user interfaces (OUI) for future domestic environments [66]. The research shows that designing with OUIs may provide more flexible and adaptable spaces in the future while highlighting the importance of collaboration in the process with many related disciplines [67]. We believe this approach may also integrate a more user-centered approach in further studies for designing domestic environments with OUIs that provide various tactile experiences.

5.2 Design direction 2: Consideration of bodily-interacted flexible and adaptable spaces

During the interviews, residents remarked on their expectations of more flexible and adaptable domestic spaces. Flexible domestic spaces were described as changing spacing at an immediate temporal level (e.g., transforming spatial layout for immediate privacy needs at home), whereas adaptable spaces indicated a space change over time (e.g., extending home as the child grows) by our participants.

Previously architects have responded to the issues mentioned above by creating various design strategies for flexible and adaptable spaces. The famous architect Mies van der Rohe designed versatile spaces under open-plan architecture [6]. This approach created spaces in a multifunctional approach with flexible and adaptable interior elements. Schröder House by Gerrit Rietveld is another well-known example of flexible and adaptable spaces of housing design [56]. However, prior research shows that open-plan architectural design strategies result in dissatisfaction with their occupants in workspaces [44]. Even though we can trace affordance-based approaches to architectural design [58], we believe that integrating more neighborhood-related user studies toward designing flexible and adaptable domestic spaces may also uncover new affordance-based approaches for exploring longer building life cycles in historic neighborhoods

It was also salient in our user data that participants expected to have bodily control and interactions with flexible and adaptable domestic spaces. Previous research by Jager et al. highlights the importance of bodily interactions between inhabitants and their adaptive environments [40]. These adaptive environments may enhance the flexible and adaptable aspects of our built spaces. Understanding various bodily interactions and control aspects of occupants with flexible and adaptable environments may provide more valuable insights for creating more user-centered future domestic spaces in historic neighborhoods.

Rooted on our interview analysis, as one participant stated his expectations of domestic spaces as extensions of our bodies, such implication may also hold great potential when integrated with OUIs in the designing process. With the advancements of new material explorations for the future domestic spaces, we may even consider architectural spaces as artifacts, and take a step into promising design possibilities in the future of habitation in the transformation of historic neighborhoods.

5.3 Design direction 3: Imagination of human-like interactions with domestic spaces

As described in the findings, the analysis of our user data reveals that residents of the two historic neighborhoods attach high importance to the historical aspect of their neighborhood and domestic spaces. Some participants, during the interview, stated their expectations from future domestic spaces to preserve and reminisce the spatial memory. Previous research by Dinh et al. shows that the addition of tactile, olfactory, and auditory cues into the environments remarkably increased the user's sense of presence and memory of the environment [25]. So, in this perspective, the multi-sensory design implication presented earlier may also contribute to residents' expectations for reminiscence of their spatial memories.

Previous research by Odom et al. studied why we preserve some things and discard others in the perspective of interaction design and revealed that the strength of attachment is a significant factor in preserving the individuals' belonging [72]. Another study conducted an ethnographic study in the collective home context and identified that shared memory is a fundamental aspect of forming

a community [81]. Our findings build upon this previous finding and suggest that preservation and reminiscence are also essential in the interactivity level of future domestic architectural spaces. We believe this is even more valuable in the context of historic neighborhoods.

On the other hand, our participants also stated their expectations from the future domestic spaces to embrace human-like and spontaneous interactions with their architectural environments. Previous research examines this under the term responsive environments [63]. One prior study examines the potential of responsive interactions in spaces using different architectural elements such as walls, ceilings, and floors [96]. Dong et al. investigate how people trace the past of domestic spaces and reveal concepts for more responsive building elements to collaborate with residents' spatial memory [26]. Another research conducted by Stals et al. indicates that the emotional attachment of individuals to places could potentially inform future technologies [87]. Our research identifies the residents' attachment to the community routines in their neighborhoods, such as the value given to the small talks with other members. Therefore, we contribute to this previous study by uncovering a new interactivity level of integrating the potential for human-like interactions into those future domestic spaces.

Overall, this implication describes our future living environments with their potential historical aspects and highlights the presence within our everyday routines.

5.4 Future directions featuring design fiction studies

Our design implications highlighted the importance of understanding (1) location-specific multi-sensory experiences, (2) potential bodily interactions for flexible and adaptable spaces, and (3) integration of human-like everyday interactions into a spatial scale for challenging the ways we inhabit our homes in the future. It is important to highlight that these points are not stating must-have recommendations, but rather design directions that aim to generate new ways for further studies. As a step toward this understanding can be design fiction sessions.

Design fictions are according to Sterling *"the deliberate use of diegetic prototypes to suspend disbelief about change."* Speculations and design fictions are stated previously as valuable research outputs when studying the future domestic environments [49, 80]. For many years, architects, designers, and authors have used fictions and utopias as techniques for experimenting with an alternative model of the possible futures [45]. The novice thing is that fictional practices are now taken into more consideration for producing valid knowledge in design research and science [33]. They could be in many forms of research such as narratives of pastiche scenarios [19, 90], or the form of short movies [11, 95]. The design fictions can involve different stakeholders in a participatory design approach such as including decision-makers, architects, residents, and other individuals from the relevant research fields [57].

By using our implications and user insights as a base, these design fiction studies could reflect state-of-art technological innovations regarding user-oriented future architectural innovations and could help relevant industries for future technologies.

6 LIMITATIONS

We acknowledge that our in-depth semi-structured interviews contain a limited number of residents, as is a common practice in previous research [99]. However, our participants' responses identify common points as well as unique insights for revealing the expectations for future domestic spaces of these two historic neighborhoods. We aim to provide an exemplar case study that could be iterated with other residents of different historic neighborhoods worldwide. We believe this may enhance the outcomes when repeated in other urban contexts.

7 CONCLUSION

Understanding residents' expectations for the future of domestic spaces in historic neighborhoods is crucial for enhancing occupants' everyday life quality and the built environments' lifecycle. Our research conducted in-depth semi-structured interviews with 12 early adopter residents in two historic neighborhoods in Istanbul. We framed our findings by interrelating participants' neighborly relations, behavior with technology at home, and inadequacies of the current domestic spaces into revealing their expectations towards their future homes. In that sense, our findings contribute to a more cross-scale thinking approach for further studies of the HBI field.

The findings from our study are described in four themes that are identified from the user data in a cross-scale relationship from individual values to neighborhood identity, identifying an order of an inside-out flow "spatially." Moreover, discussing these four identified themes, we contribute to the field with three design directions: (1) integration of location-specific multi-sensory experiences, (2) consideration of bodily interacted flexible and adaptable spaces, and (3) envisioning human-like interactions with domestic spaces.

In addition, we believe that with these new design implications, future studies could adopt design fiction studies for prospective domestic spaces in historic neighborhoods. These design fiction studies could further reflect state-of-art technologies and user expectations related to future conditions as well as could trigger related industries to develop more adoptable technologies that have not been considered yet.

Lastly, we strongly advocate that HCI/HBI researchers, practitioners, and architects should consider understanding residents' expectations in the historic neighborhoods for developing more livable domestic environments and long-surviving technologies in the future.

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