buildings

MDPI

Article

Methodological Approach of *Environmental Experience Design* to Enhancing Occupants' Well-Being, Bangladesh

Sajal Chowdhury [1,*], Masa Noguchi [1] and Hemanta Doloi [2]

[1] ZEMCH EXD Lab, Faculty of Architecture, Building and Planning, The University of Melbourne, Melbourne, VIC 3010, Australia
[2] Smart Villages Lab, Faculty of Architecture, Building and Planning, The University of Melbourne, Melbourne, VIC 3010, Australia
* Correspondence: sajalc@student.unimelb.edu.au; Tel.: +61-401543154

Abstract: Bangladesh is an emerging nation that is urbanizing the fastest. Generally, middle-income families (as the main economic contributors) reside in high-density urban housing due to their socioeconomic disparities in Dhaka, Bangladesh, where physical design aspects focus on current housing sectors. The congested living situation worsens indoor environmental quality and has a negative impact on occupants' mental well-being in their dwellings, resulting in a direct or indirect adverse effect on their productivity. Occupants' living conditions can be improved by adjusting individual perceptions and experiences in their domestic environments. This study has developed an "Environmental Experience Design (EXD)" methodological approach that reflects a user-centered design theoretical framework. A field study on dwelling units (±1000 sq ft) conducted throughout the selected housings in Dhaka, Bangladesh, was carried out to examine occupants' domestic experiences using semi-structured and structured interviews. After binary and thematic coding with significance, "Association Rules and Cluster Analysis" were used to ascertain relationships between three aspects (spatial, environmental, and user context) to explore and customize outcomes. This EXD methodological approach can be utilized to create an environmental (architectural) design solution that will enhance mental well-being by considering occupants' needs and demands in household settings locally and worldwide.

Keywords: occupants' experience; environmental design; well-being; middle income; Bangladesh

Citation: Chowdhury, S.; Noguchi, M.; Doloi, H. Methodological Approach of *Environmental Experience Design* to Enhancing Occupants' Well-Being, Bangladesh. *Buildings* **2023**, *13*, 542. https://doi.org/10.3390/buildings13020542

Academic Editors: Chi-Ming Lai and Ricardo M. S. F. Almeida

Received: 5 January 2023
Revised: 1 February 2023
Accepted: 14 February 2023
Published: 16 February 2023

1. Introduction

Since 2000, middle-income households have gradually increased in urban areas worldwide. According to UN world population projections and Brookings 2021, by 2030, the number of people living in middle-income families will be close to 50% [1]. Most of the world's socioeconomic development depends on middle-income families [1]. They are acknowledged as the primary force behind socioeconomic development on a global scale. Asia's growth rate for middle-income families is higher than that of other parts of the world [2,3]. The consensus is that middle-income families are the primary engine behind the nation's sustainable development. Bangladesh, the second-largest economy in South Asia, is one of the emerging nations that is urbanizing the fastest, with a population of roughly 168 million. This nation's youth is the main economic and socioeconomic driver [4]. Its economy will rank as the 24th largest in the world by 2030 [2–4]. In Bangladesh, young communities are those under 35 years old and account for about 29% of the total population [3]. Bangladesh's government is implementing several strategies to advance the younger generation. Middle-income families are this generation's primary grouping in Bangladesh. The community's average monthly income ranges from US$160 to $1220 [2–4]. The portion of the population with the highest qualifications now belongs to this income bracket. Members of this community mostly reside in high-density urban housing environments. They struggle with well-being issues such as mental illnesses, anxiety, depression,

and frustration that are, to some extent, linked to their living environments and surroundings [3,4]. These circumstances may have a direct or indirect adverse effect on their productivity as well. Without improved housing options for those who face socioeconomic limitations, achieving SDG goals (such as good health and well-being and sustainable cities and communities) for a country such as Bangladesh may not be possible.

By changing individual views in their household contexts, middle-income occupants' domestic living situations can be enhanced. Without a comprehensive understanding of the occupants' living situations, it may be difficult to define environmental design solutions in architecture that improve occupant well-being. This study aims to investigate a user-centered design theoretical framework-based methodological approach of Environmental Experience Design (EXD) to increase inhabitants' well-being in Dhaka, Bangladesh. Three crucial aspects—namely, spatial, environmental, and user contextual factors—have been taken into consideration in this study from a hypothetical perspective to explore the idea of the EXD methodological approach.

2. Occupants' (as Middle-Income) Well-Being in Bangladesh

Mental health issues are now viewed as crucial global issues, whereas physical health conditions used to receive special attention. A survey report indicates that in Bangladesh, 16.8% of the young population experiences different mental well-being issues (i.e., depression and stress). More than 6 million people in Bangladesh are depressed, and nearly 7 million are anxious [2,5]. The report points out that young urban communities are more affected by mental health issues than rural ones. This young community, primarily concentrated in Bangladesh, lives in extremely crowded urban areas with high levels of air pollution, a dense population, socioeconomic constraints, and unaffordable housing. The main factors affecting the mental health of the younger generation are lack of rest, the natural environment, indoor environmental quality (IEQ), and socialization. Based on reports to international health organizations, middle-income families who live in high-rent amenities experience various health issues [1,3,5–7]. Bangladesh's capital and central urban commercial hub is Dhaka. The population of this city, which occupies a territory of 1528 sq km, is about 21 million, making it the 11th fastest-growing megacity in the world. From 1970 to 2020, Dhaka's population increased, and by 2030, the city will be home to about 28 million people. In addition, Dhaka is the world's densest urban area, with 49,182 people living there per square kilometer in the city's central area [8–10]. Due to the city's rapid urbanization, Dhaka faces immensely challenging housing difficulties due to rising housing demand. Every day, between 2000 and 2500 people from various regions move to Dhaka in search of work and financial opportunities. Dhaka has a higher-than-average percentage of middle-income residents compared to other income groups—more than 50%. They are the most knowledgeable and skilled people in this country [3]. Due to socioeconomic limitations, the size of urban households gradually shrank in Bangladesh. In Dhaka, between 70 and 80 percent of middle-income families rent their housing.

On the other hand, the housing needs of middle-income families are driving up house prices excessively. According to an article entitled "State of Cities 2017: Housing in Dhaka" by the Bangladesh Rural Advancement Committee (BRAC), approximately 61 percent of homeowners from middle-income families depend on their family funds to purchase apartments in urban areas. As a result, roughly 70 to 78 percent of middle-income families cannot afford their apartments at the current housing market price in Dhaka, Bangladesh. Due to disproportionately high rental and apartment values, middle-income families need to adjust their daily spending to afford a place to live. These income dwellers spend less on necessities such as clothing, entertainment, and food due to the high cost of housing [6]. Most of Dhaka City's housing comes from public and private sources. Approximately 10% of all housing is provided by the public sector, primarily for government employees. In contrast, roughly 70% of private real estate developers concentrate on middle- and upper-income demographics, and the average apartment size is over 1000 square feet (92 sq m). However, there is not enough housing available, and

by 2035, there should be about 0.7 million private-sector housing units. Moreover, it is predicted that there will be a deficiency of about 0.5 million housing units by 2020, as opposed to the 25,000 units the private sector provides each year. As a result, it is getting harder for middle-income communities to afford adequate domestic space in a city such as Dhaka, especially when single earners support families [3,6,11]. To address the issue, the housing sector is now building high-density apartments, shifting its focus from higher-income households to middle-income households. High-density housing is in high demand in Dhaka as horizontal growth is difficult due to a lack of available land in urban areas [3,6].

Physical design aspects are the main components in today's built environmental design practice. Middle-income families in Dhaka typically reside in tiny homes due to insufficient economic limitations and comparatively high rents. Lower and middle-income families reside in overcrowded or compact households in high-density apartment buildings. These crowded areas with poor environmental qualities and privacy lead to unfavorable living conditions, directly or indirectly affecting residents' well-being. More than 60–65 percent of people living in Dhaka experience various mental health issues [12]. Middle-income families in high-density urban accommodations are particularly affected by these problems. Due to socioeconomic constraints, middle-income families have limited options to alter their current domestic living conditions, making them more susceptible to mental health issues [13]. The problems with occupants' well-being in high-density urban dwellings may not be sufficiently addressed by such insufficient architectural design attention on a local level to achieve the SDGs. Residents' quality of life is influenced by their living environment, which affects their well-being, feelings, emotions, moods, and productivity. Therefore, in a highly dense domestic setting, the architectural design and decision-making process should consider and incorporate the domestic experiences of the occupants [3,14].

3. Study Context and Location

The psychological needs and demands of occupants are taken into account in the user-centered design process as they correspond to occupants' living situations, resulting in an impact on both local and global users' well-being. Since user context varies depending on locations (e.g., socio-cultural factors and restrictions), it is essential to comprehend the particular study setting in order to construct the EXD methodological framework. The EXD framework can be used in diverse user contexts globally depending on various environmental components, even though the study's primary focus was on the urban domestic living situations of middle-income families in Dhaka, Bangladesh.

Bangladesh has a tropical, humid climate. High temperatures, copious amounts of rain, and high humidity are the defining features of its atmosphere. According to weather forecasting, Bangladesh has four distinct seasons: the winter is cool and dry, and the other three are hot and wet [15]. In Bangladesh, the reversal of the wind flow is a notable aspect of the summer and winter climates. The city of Dhaka is located between the latitudes of 23°40′ N and 23°55′ N in the north and the longitudes of 90°20′ E and 90°30′ E in the east. The Buriganga, Tongikhal, and Turag rivers surround the city on three sides [15]. For the initial phase of this study, high-density multistory urban housing units in dense areas of Dhaka were chosen (i.e., Uttara, Nilkhet, Mohammadpur, Mirpur, Khilkhet, Dhanmondi, Lalmatia, Green Road, Maghbazar, Shantibag, Mugda, Khilgaon, Kalyanpur, Malibagh, Tejgaon, Rampura, Old Dhaka, Kalabagan, and Elephant Road). In Dhaka, high-density, compact housing projects are being built, particularly for middle-income families with socioeconomic constraints. The congested domestic living scenario was the primary factor in choosing these dwellings as a case study. At first, it appeared that middle-income groups were accommodated in flat sizes that ranged from less than 1000 sq ft to 1200 sq ft.

4. Experiencing Occupants: Field Observation

To explore occupants' domestic living experiences through semi-structured and structured interviews, a field study (May–Dec 2021) was conducted (by the 1st author) on approximately ±90 dwelling units (area ± 1000 sq ft) spread across the selected housings

in Dhaka, Bangladesh. The locations of the dwellings were varied, considering orientations such as North, South, East, and West, as well as floor levels such as Lower, Middle, and Upper (Table 1 and Figure 1).

Table 1. Information of field data collection.

Housing System	Income Group	Housing Characteristics	Housing Storied	Useable Space (Area)	Tentative Case Study Locations	Sample Size (Unit)	Data Collection	Key Informants
Formal Settlement	Middle income group	Public housing Private Housing	Multi storied	(600–1200) sq ft	Urban Areas Dhaka, Bangladesh	±90	Different locations of the dwellings considering: orientations (e.g., North, South, East and West) and floor levels (e.g., Lower, Middle and Upper)	Occupants (Male/Female) Age (+18 years)

Figure 1. Example of compact domestic living scenarios in Dhaka, Bangladesh. (Source: illustrated from the filed study).

According to field observation, the absence of a ventilator during the summer causes the domestic indoor environment to feel excessively hot. Furthermore, the air cannot flow appropriately inside a room because of sliding windows. In addition, floor height and level affect the indoor environmental quality of a room. Based on room orientation, the indoor air quality of that space is managed. There is commonly an air conditioner (AC) on the balcony. Hot air from an AC system raises the indoor temperature of a room and increases noise, making it difficult for its occupants to sleep comfortably. This situation poses a serious issue and affects the residents' mental health. When tenants call their landlords to address this issue, there is typically no solution. The windows need to be kept closed in those conditions, and artificial lighting must be kept on throughout the day. The room becomes

unbearably hot for the occupants if it receives direct sunlight. It feels uncomfortable if the windows are not shut during the day or the curtains are not drawn.

On the other hand, rooms that are not surrounded by a large building have enough light and airflow. However, in many instances, too much sunlight can result in glare issues and raise the indoor room temperature. Even though windows are a means of ventilation and even the varied experiences of their occupants are seen, this location occasionally causes privacy issues. The occupants' privacy is frequently violated if seen directly from one room to another. Additionally, it is clear from the residents' statements that, as a consequence of living in a congested space, they do not prioritize privacy. Most of the time, they maintain their privacy issues using various screens (curtains). However, the inhabitants of the buildings use curtains at different times while also securing their privacy with plants because the distance between buildings is very close. When a window in a room is open to a domestic indoor space, the window serves as a channel for social interaction with other family members. However, the field study revealed some privacy concerns. In the opinion of middle-income occupants, functional identity and space usability are crucial spatial factors. Most of those stated that if the room or area were a little bit larger, it would be easier to arrange the furniture. The dimensions of the rooms (Figure 1) are such that if occupants want to create a closet, they must move the bed or other furniture to the other side of the door. In their rooms, they can arrange just one piece of furniture. Even if they keep more necessary furniture in the room that restricts their movement, they have not set another piece of furniture there. If the room is on the west side, the inhabitants position various pieces of furniture on the west wall to prevent additional heat from the west wall from raising the temperature inside.

As a result of the size and functionality of their room, occupants use furniture as needed. In that situation, they consider how to organize everything in that constrained area. Inside the room, there are occasionally exposed columns. The position of the columns makes the room appear smaller than other rooms. It is not the ideal space to keep any furniture. The columns make it impossible to arrange furniture correctly, and once it is in place, there is no space for movement or a way to access a balcony. Whether the room is small or large, the occupants believe that the best use of freedom depends on how the room's furniture can be arranged. Most middle-income families have few pieces of furniture in their bedrooms. After placing a piece of furniture, there is no more space, especially if the room is relatively small. The usability of space is also diminished by the placement of the room's windows and doors or by a pillar in the middle. In that situation, the occupant's choice is a rectangular-shaped room where furniture can be decorated appropriately.

On the other hand, a window (usually up to 2.5 to 7 ft), especially one that is full height (up to the ceiling), improves the functionality of the space. Additionally, the occupants' connection to the outside natural environment has psychological benefits. The statement mentioned above refers to the occupants' requirements for aesthetics in their living spaces. A room's large window connects the interior to the exterior, impacting the occupants' minds. Nevertheless, in that scenario, occupants must be aware of the type of environment observed inside the residence through the windows. Psychological benefits are stimulated if the external environment is open. One of the essential elements for occupants using the rooms to improve their mental well-being is outdoor connectivity. In addition to the abovementioned claims, it has been established that interaction between the interior and exterior environments impacts physical and psychological health. This statement is particularly true for those who reside in crowded housing. In some instances, the opposite picture is apparent. From field observation, it has been noticed that the young generation spends nearly the entire day using electronic devices such as laptops and phones. In that situation, the relationship with the outside world is generally not prioritized.

According to observations made on the ground, upstairs residents have an easier time connecting to the outside community through their windows than downstairs residents. In particular, during the current pandemic (COVID-19), there has been a significant increase in the use of computers or laptops at home, and such instances stand out. Figure 2 illustrates

an example of the circulation structure of middle-income domestic living scenarios in Dhaka, Bangladesh.

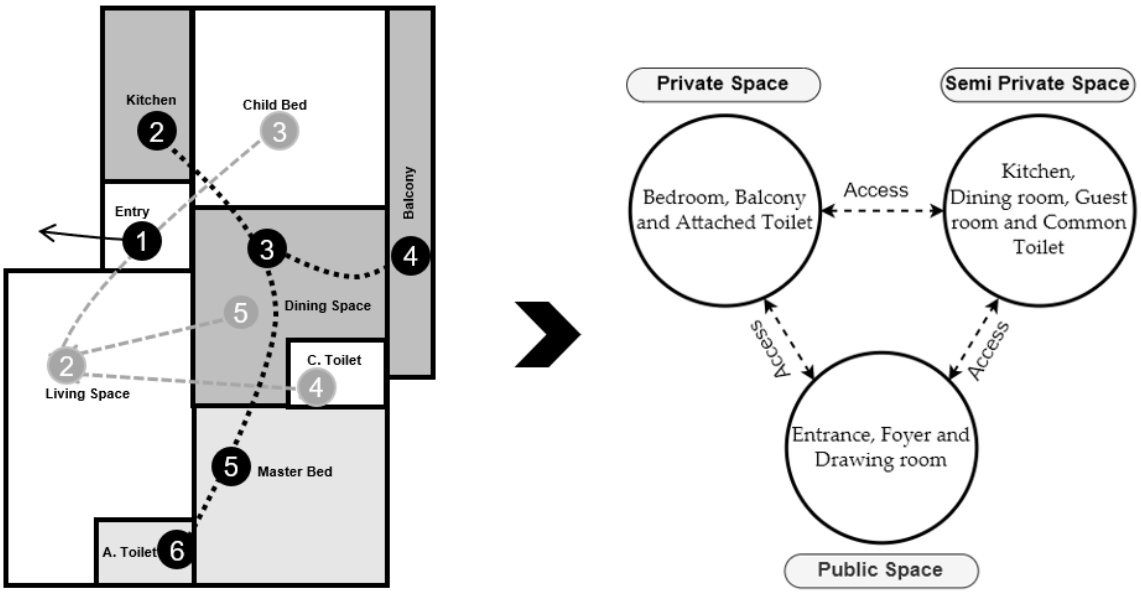

Figure 2. Circulation structure of middle-income domestic living scenarios in Dhaka, Bangladesh. (Source: author, from field observation).

When the interviewer asked about their future needs, most residents wanted to have their rooms a little bigger (more than 10 ft × 12 ft). In that case, many occupants prefer the balcony (normally 3 ft wide) that is usually attached to the bedroom. If the balcony is constructed correctly, it can also be used as an indoor space. Homemakers prefer to decorate their dwellings, typically following their personal preferences. Starting with the furniture of their choice, they begin to decorate the household with artwork. Men usually want to set up a room where they can read books or work on computers. The residents' statements make it clear that most prioritize ventilation and daylight in their rooms. However, there are many instances where the space cannot receive enough light and air. The relationship between windows and room size, outside obstruction, the quality of the colors and materials used in the walls, and the furniture arrangement are some of the main characteristics of indoor quality. The color of the interior walls or any artwork or paintings on the walls can frequently have a positive psychological impact on the residents. Sometimes occupants adjust their present situation to solve indoor environmental problems.

In the kitchen (usually 6–10 ft in length and 6–7 ft wide), functionality is a big problem. Problems arise in households when functionality is insufficient, especially for women. For instance, most women from middle-income families in Bangladesh perform household duties while seated on the kitchen floor. It is difficult to perform those tasks in a kitchen that is too small. There is a problem if there are no separate kitchen areas for cutting, preparing, and cooking food.

Concerning other environmental factors, kitchen ventilation is essential. Assume, for instance, that inadequate ventilation in the kitchen causes the interior temperature to increase. The excessive heat created by cooking makes it difficult for the occupants to remain there for an extended period. Sufficient ventilation is impeded because the distance between the two buildings is much closer. Even so, proper daylight entry is impossible. Additionally, harmful insects may enter through the pipe if the gas pipe is attached to the inside of a window.

Furthermore, a foul odor may find its way into the kitchen if a bathroom is nearby. However, many users prefer to keep their kitchen enclosed for privacy if the kitchen hood and functional layout are suitable. Position, orientation, and window size are critical factors

in this regard. Most kitchens have exhaust fans over the windows to allow smoke to escape while cooking. The residents claim that issues such as dampness can arise if the tile or water drainage quality is poor. Even if the furniture is made of the proper materials, cleaning it becomes challenging. In that case, most residents favor tiling walls throughout the kitchen, even on the exterior walls. They claimed that the vibrant tiles were uncomfortable to look at. Women prefer kitchens where all the cooking utensils are organized and used promptly. They frequently use various types of cabinets or steel racks for that purpose, and their needs are met if the kitchen space is appropriately arranged and is more significantly attached to a balcony. In bathrooms, space utility and functional identity are closely related. Most occupants believe a toilet's dry and wet areas should be separated. The functionality and spatial requirements of all toilet fixtures and fittings are closely related. Space is frequently reduced, but if used effectively, the toilet is more functional and can accommodate all types of occupants. Color, texture, and issues with moisture and mold improve residents' perceptions of material quality. The vibrant bathroom tiles, in their opinion, are unsettling. The ventilation in the toilet is typically the issue. According to the occupants' recollections, the toilet's windows were too small for ventilation. Air circulation and odor removal might be better after using the bathroom if the windows were more oversized or the grills were not there. Proper ventilation is greatly influenced by orientation.

Moreover, residents prefer single-colored (light or dark) tiles since colorful tiles are uncomfortable. There might be a privacy issue if a ventilator wall separates two toilets. There is also a privacy issue, even though there is not enough shading in the ventilation area. The residents typically cover the ventilation area with net curtains or frosted paper so they can see nothing outside. It has been determined that this issue frequently occurs in almost all domestic settings in Dhaka. In rooms that aid in children's psychological development, access to daylight is essential.

Additionally, the residents claim a connection between indoor wall color and sunlight. Moreover, keep in mind that indoor plants are uplifting. However, keeping natural elements where the sun can appear is best. Otherwise, it might have adverse effects. In that case, furniture should be positioned so it does not obstruct the light or ventilation. The residents can be seen using their balconies to dry their clothes. They choose to keep green plants on the patio but do not have enough room, light, or air to do it properly. Most residents want their balconies to be more significant. However, dust quickly enters the house if the balcony faces the road. Mosquitoes infest the area at various times of the year. Additionally, installing AC outlets on the balcony reduces the amount of space used, which is problematic for the occupants. Figure 3 depicts an example of a typical domestic scenario of high-density urban housing in Dhaka, Bangladesh.

Finally, from this field survey and observation, twelve environmental design factors (e.g., daylighting, artificial lighting, natural ventilation, air quality, acoustic quality, smells/odors, texture and color, materials, outdoor connectivity, indoor natural elements, indoor temperature, and microbe and mold control) and ten spatial factors (e.g., privacy, functional identity, safety and security, space order and usability, changeability and variety, aesthetics quality, flexibility of choice, interaction and sociability, indoor climate control, and cleanliness) have been identified and prioritized for data demonstration and interpretation (in Section 12) for this study (Table 2). These factors may differ according to different socio-cultural and regional aspects of the occupants.

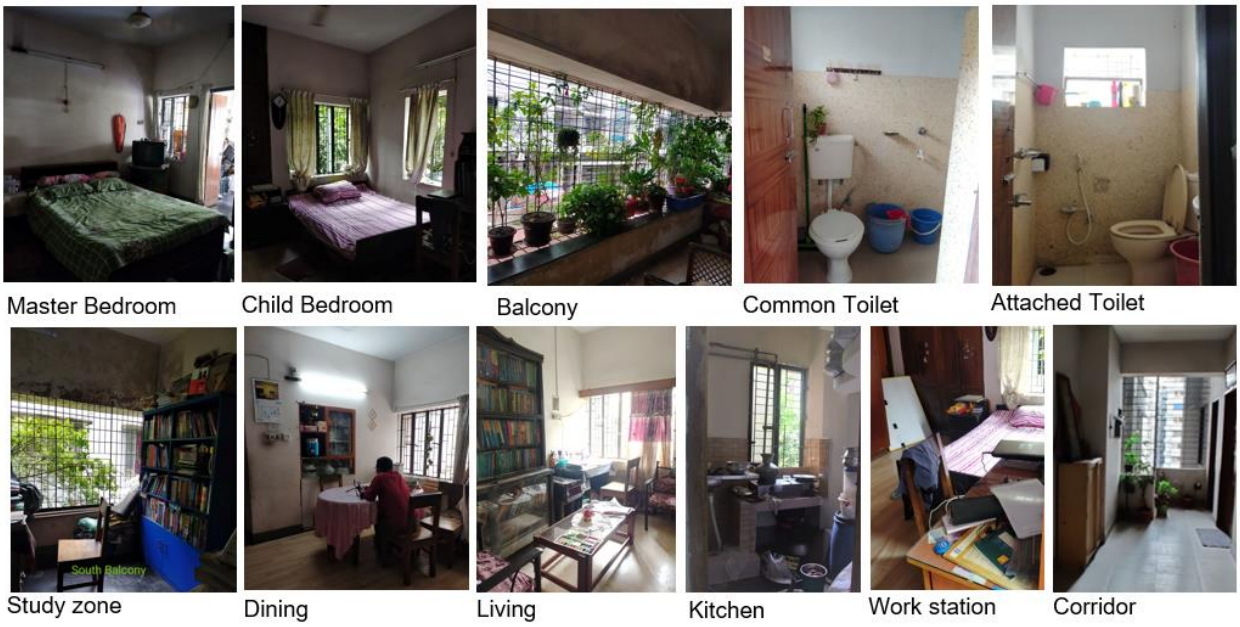

Figure 3. Occupants' living scenario of high-density urban housing in Dhaka, Bangladesh. (Source: author).

Table 2. Identification of different factors from field observation.

Spatial Factors	Occupants' Perceptions	Environmental Factors
Privacy		Daylighting
Functional identity		Artificial lighting
Safety and security		Natural ventilation
Space order and usability		Air quality
Changeability and variety		Acoustic quality
Aesthetics quality		Smells/odors
Flexibility of choice	← **Domestic settings** →	Texture and color
Interaction and sociability		Materials quality
Cleanliness		Outdoor connectivity
Indoor climate control		Indoor natural elements
		Microbe and mold growth
		Indoor temperature

5. Finding Limitations from Field Observation

The way architecture is designed presently limits how users' spatial and environmental design characteristics and contentment can work toward SDGs. Field observation has shown that occupants' perceptions, feelings, and needs in a congested domestic living space impact their mental well-being (i.e., feeling comfortable), which correlates with the spatial and environmental design features. Additionally, there is a study limitation between two prevalent theories, namely "social constructivism" and "environmental determinism" (Figure 4) [16].

The environmental design theory, based on environmental psychology, defines the physical environmental influences on human behavior. It explores the psychological perceptions of the user as well as their socio-cultural and environmental attributes [3,14]. In this theory, the opportunity to further explain users' socio-cultural contexts is somewhat lacking. The social cognitive perspective, in contrast, investigates human socio-cultural perception and its impact on the built environment, which is challenging to measure. The literature claims that user-centered design falls somewhere between the two domains. Previously, indoor air quality (IAQ) and indoor environmental quality (IEQ) studies about residential environments primarily concentrated on occupants' behaviors and health issues.

In the field of built environment research, there was evidence of architectural behavioral perceptions on human performance after 1970 [17].

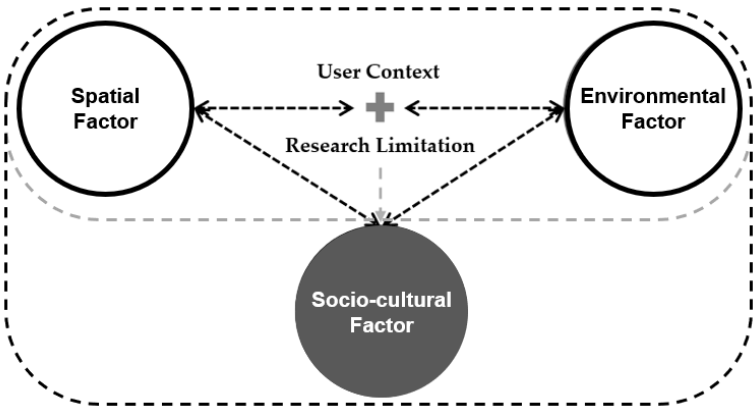

Figure 4. Research limitation (illustration: author).

However, they can only assess office and institutional buildings [18]. Currently, very little research is being conducted to explore how people perceive their homes and surroundings. However, Antje Flade discussed the design and construction of apartment buildings and other housing from a psychological perspective in the book *Living from a Psychological Perspective* (in German) [19]. The psychologist offers practical examples of how people's minds interact with the built environment. By modifying or altering their current domestic living environments related to domestic households' experiences and the physical backgrounds of apartments, occupants' mental well-being can be improved. Alternatively, occupants' domestic living environments could be improved by changing their arbitrary beliefs and actions, or "Human Experience". Due to the socioeconomic limits of Bangladesh's middle-income families, changing existing design components could be complicated. Even though domestic IAQ and IEQ have been extensively considered and studied in Bangladesh, the experiences of occupants' households in middle-income families are still negligible. Due to this conceptual gap, existing theories about occupants' experiences with their living situations and well-being are conceptually limited when applied in other contexts. Environmental design practices and solutions cannot enhance occupant well-being towards SDGs 3, 10, and 11 goals because they lack a thorough understanding of the experiences of occupants' living styles. Therefore, it is necessary to conduct practical studies of domestic environmental experiences to investigate the idea of a new design methodology framework for Bangladesh's middle-income residents [3,14].

6. Theoretical Perception

The term "built environment" describes locations, situations, things, or circumstances. The built environment has four interconnected qualities: it sets the stage for all human endeavors; it shapes human thought processes to fulfill needs and desires; it protects and mediates or modifies the environment in ways that are comfortable and beneficial to people; and finally, it has the power to positively or negatively influence the context [17,20,21]. Human ideas, morality, and ideologies that reflect contextual aspects of society are connected by the built environment. Spaces serve as a reflection of the everyday language of communication used by humans [22]. There are many ways that the built environment influences how people behave. Many intricate connections exist between the built environment and human emotions and behavior [23]. The living conditions in which people spend most of their time are crucial to their psychological health. People can change their behavior or desires to fit the prevailing environment, adapting to their current living conditions. Here, the built environment includes the domestic environment [20,21]. The literature reviews have identified numerous potential human behavioral effects in domestic environmental settings.

The body of literature establishes that structures internally construct interior spaces in various ways to support human needs and demands and assist in mediating people in their current physical environment [22]. Their interpretations suggest that the phrase "built environment" can be used in a broad sense, much like "furniture", "room" or "environment". Everything has also been created or put in place by humans. The literature has identified seven interrelated components of the built environment. Each element is interconnected and a part of a larger framework. The built environment, which has a dual character for both indoor and outdoor environments and satisfies and indicates human spatial needs and demands, combines structural and interior features in the domestic environment [21]. The authors pointed out that this enclosure creates an indoor environment and can shield people from the unpleasant aspects of an outdoor setting. It has favorable aspects of the exterior environment, including a lovely garden or landscape, daylight, fresh air and ventilation, pleasant scents and the sounds of water, birds, and music to support mental health [3,21]. How human interaction with the built environment affects mental well-being is the question that now arises. Human behavior, which may be influenced by hormonal secretion in the brain, is controlled by physical, biological, and social factors. The relationship between humans and the environment is one of collaboration since the physical environment affects human behavior and impacts well-being [22]. Because of physical environmental stimuli such as noise, sound, light, and temperature, and physical structures such as walls, furniture, natural forms, and symbolic artifacts, human-environmental interactions are based on how people perceive their surroundings [3,24,25] (Figure 5).

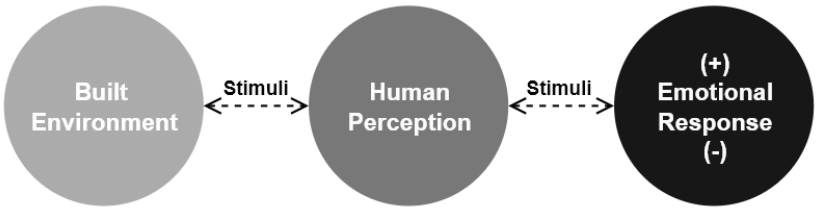

Figure 5. Human environmental interaction (illustration: author).

Control is a psychological need that underlies all human conditions. Psychologists have previously provided notable instances of interactions between people and their surroundings. Successfully influencing and interacting with the environment leads to satisfaction. However, it is impossible to satisfy other needs without control because if people can affect their environment, they will work to improve it. In this sense, the domestic environment has three effects on people: social, physiological, and psychological, all of which are crucial for their well-being [3,14]. People communicate with themselves and others by interacting with their environment. According to human psychology, the connection between people in an environment can occur along five dimensions: visual, acoustic, tactile, olfactory, and symbolic. Human senses play a crucial part in locating a position. Different environmental restrictions have other effects on how people perceive things. On the other hand, the optimization experiment relating to human behavior and perceptions has revealed a correlation between privacy and control in domestic settings. Kaplan (1995) highlighted the built environment's adaptability for people to adapt successfully and provided examples of their perspectives on how human senses interact with the environment [26].

The emotional quality of any environment is the primary factor in influencing the feelings and memories connected to a place, which may even impact a person's well-being [27]. The term "ambient environment" refers to nonvisual elements such as sound, temperature, odor, and illumination that significantly impact people's moods, productivity, and mental health. Researchers discovered that people's environments could affect their moods even after they leave them, and that mood can impact memory and cognitive task performance [22,23,28]. According to psychologists, people tend to seek out and prefer various levels of stimulation in their domestic settings. When stimulated in a high state

of arousal, occupants feel satisfied or at ease. Different environmental factors have other effects on how people perceive things. Due to biological differences, each human receives sensory information differently. Perception is significantly influenced by what people see and touch, according to Gifford (2011) [25]. Pallasmaa (2017) identified how people adjust emotionally to their built environment [29]. The development of meaning in the domestic environment uses the spatial adaptation process. The inhabitants start to identify with the space emotionally and form an emotional bond with it, even though the experience is a composite of perceptional, cognitive, and psychological components.

7. Domestic Environmental Experiences

A domestic environment (also known as a "Home") is a location and building that houses a person [30]. The concept of the domestic environment is multidisciplinary. Over the years, the definition and purposes of a domestic setting have changed. The home is an essential setting where the occupant can maintain connections. Extreme care has been taken to ensure people feel safe and secure in this environment.

Additionally, it is a location where people, things, and possessions coexist. According to Pennartz (1986), five themes—communication, accessibility, freedom, occupation, and relaxation—are required to create a comfortable home environment [31]. Domestic spaces are used in various ways and for different purposes by occupants. Human feelings and emotions can be affected by how space, color, light, and furnishings are arranged. To generalize a design concept for domestic settings, it is difficult to emphasize individual preferences and needs because human perception varies from man to man [3,14]. Residential fulfillment is crucial for the well-being of the entire neighborhood, a single space where personal and cultural backgrounds significantly impact the situation. Researchers described the relationship between soft architecture and the human mind. They realized how strongly comfort levels and building materials interact with people's minds and perceptions. In that situation, adjustability, portability, and multifunctionality are significant to understanding human psychology (needs and demands) in their living environments. Interior surface materials in buildings are crucial and closely related to how people perceive them [32]. Kaplan (1995) expanded on the psychological advantages of gardening in the home environment in the literature. They discovered that the presence of a window in space offers some environmental stimulation for the human capacity for psychological distancing or escape [26]. Ittelson (1976) identified noise as a crucial privacy factor that can change the characteristics of indoor environments [33].

As a result, the architect should create an amenity that offers acoustic comfort and musical appreciation. The bedroom is a crucial area of occupants' lives where people spend most of their time, but they give it little thought and do not keep it organized aesthetically. Graham (2015) pointed out that their concern for space separation extends to the possibility that the shared space might be stocked with items that encourage people to watch or listen in order to feel isolated. It is also true that associations with cherished memories or images arouse the senses in people. The living room is used for reading activities, the kitchen is frequently the hub of family activity, and the room's intended use has significant implications. The bathroom is a complex, multipurpose area where physical hygienic consideration is crucial for human feelings in a domestic setting. Poor kitchen, heating, cooling, and plumbing facilities correlate positively with residents' dissatisfaction [34].

Additionally, the study demonstrates how the lighting scheme impacts people's moods. According to earlier research, insufficient indoor lighting can cause stress and alter circadian rhythms [35]. In addition to being of good quality and quantity, indoor lighting systems encourage residents' mental development. Different lighting levels substantially impact human mental health [24,27]. Furthermore, studies on the connection between color and mood indicate that people relate security to cool colors. Because of their incredible capacity for adaptation, humans can survive in the worst conditions without the chance of change. People eventually attempt to alter their living situation to accommodate their psychological needs. For flexibility and demands, they rearrange the furniture, erect

barriers, and divide the space they already have. The standard of the residing environment influences human requirements and satisfaction. When residents discuss their domestic experiences, there are typically nine common problems. Within human-environmental psychology, these problems reveal their physiological and psychological needs. The nine psychological needs—control, privacy, identity, security, order, variety, aesthetics, choice, and sociability—must typically be satisfied in a domestic environment [36,37]. Therefore, assessing human needs is the most crucial factor when designing a space, and each concept calls for architectural design elements. However, the literature claims that to design spaces that users will use, these design concepts rely on data generalization, personal hypotheses, and untested application of theories. The home environment needs to be planned so that the personalities of the other occupants can be seen in different ways. Researchers discussed their ideas regarding the link between self-concept and housing quality. These days, outdoor aesthetics and beauty are frequently the designer's top priorities. There is not much work to be conducted on the indoor environmental quality of domestic spaces, the surrounding environment, and users' experiences. Any point where people and their immediate surroundings come into contact must guarantee a comfortable, safe, and effective use of space [21].

Caan (2011) noted that physical and psychological interaction is crucial for indoor space design. The author discussed a space's intangible attributes. Thus, tangible factors always impact people on a physiological level, but intangible factors also have an effect that is challenging to explain outside of this interior. The interior experience and the outside world are separated by architectural design [38]. The relationship between human perception and the built environment was covered by Goldhagen (2017) in her book, "How the Built Environment Shapes Our Lives". She claims that our internal reasoning and sensory perceptions combine to interpret the information we receive from our environment, allowing us to express our human experiences. It is the collective perception of what people see, hear, smell, touch, feel, and do in a given moment. She outlines the following process of the human mind to describe the interaction process: first, the human body affects reason; next, the environment shapes the body through internal cognition; and finally, these factors alter how people understand their experiences. It also revealed that every person has nonconscious thoughts and pay attention to the places in their bodies where their emotions are "in the body", or embodied. Every time a memory is retrieved, it is associated with a location and an event, further cementing the memory in the human brain and tying it to fresh stimuli. In this way, human experiences fundamentally shape environments [20]. Human nonconscious sensory and perception faculties cooperate with fictitious motor responses. People observe a built environment's character and functions when they enter it, quickly assessing the possibilities. Designers aim to realize people's experiences, inner lives, and collective actions. A thorough examination of their setting for action is necessary to ensure human habitats. People do not think much about space or even have a basic understanding of human relationships regarding their moods, emotions, and behaviors. A human may have made microscopic observations of how a small space, its objects, light, color, shape, texture, pattern, bed, kitchen, and every other physical element that people inhabit can meet the needs of the human soul and spirit. Lawlor (1997) asserts that contemporary design ignores the human emotions fundamental to a home instead of concentrating only on cost, size, and style [39]. Under different backgrounds and conditions, the socio-cultural characteristics of spatial features are linked to occupants' lifestyles and environmental design decisions [3,14]. As a result, some studies highlighted macro-environmental aspects that influence occupants' perception in a domestic setting, such as socio-cultural factors and household compositions. Therefore, due to the various societal and cultural traits, the context of the occupants influences human perception and behavior. Studies have also revealed that numerous needs and demands of occupant contexts stimulate various environmental features.

Consequently, occupants' contextual personalization in a domestic setting diverges from other socio-cultural characteristics. In contrast, occupants' living arrangements and

backgrounds impact their behavior in domestic settings. Domestic environmental perceptions, therefore, balance users' various socio-cultural needs with spatial and environmental requirements, which may enhance occupants' health and well-being (Figure 6). It will be critical in architectural and environmental design solutions to classify or categorize the fundamental co-relationship between different attributes in a domestic setting to understand user experiences. Numerous qualitative and quantitative studies show that preferences for regional and social contextual variation in domestic settings articulate spatial and environmental appearance. Because of the complex perception of socio-cultural phenomena, users' experiences in the domestic environment may change their preferences for environments and spaces. The psychology of perception has not received much attention from architects, particularly in domestic settings. To fulfill their specific needs as designers, architects must consider the stimulus information from user experiences [3,14].

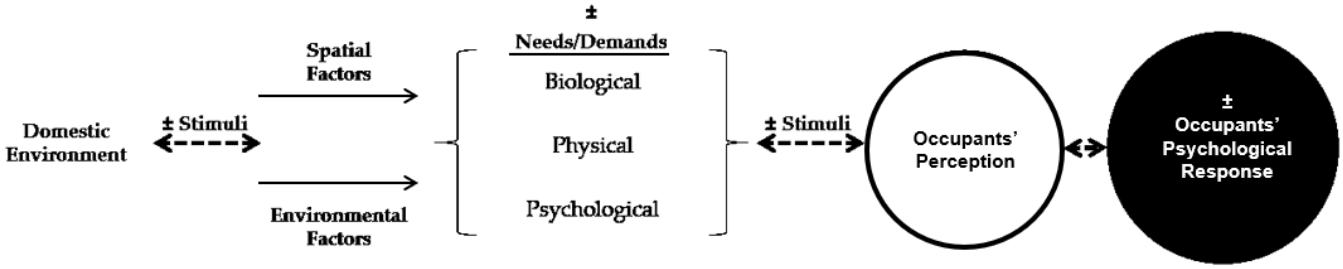

Figure 6. Occupants' perception of the domestic environment (source: author).

8. Towards the Solution

The previously described high-density urban housing is continually expanding in Dhaka, Bangladesh. Furthermore, "compact living" in housing projects is attracting the attention of city-based construction firms. This high-density housing might be temporarily available to middle-class households, particularly in terms of affordability. However, in the current situation, occupants' mental well-being is not sufficiently considered in the architectural design process, rather than only focusing on tangible goals. Nowadays, the main issue is how to provide more middle-income families with housing in a small area. The characteristics of the living environment, such as color, daylight, air, smell, privacy, functionality, and others, have been found to impact the occupant's mind positively or negatively in several studies. Therefore, considering occupants' psychological relationships with domestic space is a crucial issue for the current situation, particularly in a high-density city such as Dhaka, Bangladesh, where middle-income families, who comprise most of the population, face socioeconomic challenges. Families with middle incomes put in much effort to maintain the nation's economy. Current housing design strategies barely consider the unique experiences each family has with their physical and mental abilities. Previous housing and health-related studies identified that more than half of the people who live in high-density urban areas in Dhaka are mentally unstable (e.g., due to mental stress) [3–6]. Almost every family experience various physical and mental issue, such as diabetes, hypertension, depression, irritability, restlessness, and a lousy attitude. Although there are many causes for this, one of the primary causes is the standard of the domestic environment. Residents of high-density urban housing must constantly deal with various difficulties in their daily lives, as well as adaptation and mitigation to climate change.

On the other hand, the COVID-19 epidemic has resulted in an increase in mental health worldwide, which is vital for housing projects in densely populated urban areas such as Dhaka, Bangladesh. Through the occupants' experiences, it might be possible to rethink such densely populated housing projects toward SDG goals for good health and well-being, reducing inequalities, and creating sustainable cities and communities. Prior to now, design has hardly been practical for environmental design solutions. The new architectural design concept known as "Environmental Experience Design (EXD)" may improve occupants' (i.e., middle-income families and all communities that have socio-

cultural restrictions/limitations) perceptions of their domestic living environments and positively impact their mental well-being to enhance productivity. Through EXD as a design tool or framework, the connection between a user's feelings, moods, and emotions and how design components are set up in a built environment can be improved.

9. Environmental Experience Design (EXD)

The term "domestic environmental experience" refers to a user's physical and cognitive reactions to their home environment. Domestic environmental experience connects occupants' needs and demands regarding their physical, psychological, and social well-being to various built environmental factors [3,14]. Using EXD, which can correlate occupants' restrictions and preferences according to their socio-cultural context, will improve the domestic environment. To improve occupants' mental well-being, the EXD approach links their needs and demands with spatial-environmental design elements in a domestic setting with occupants' socioeconomic constraints. This new design philosophy may change the architectural design process from a technology-driven concept to a decision that puts people first [3,40]. The study on "environmental experience design" for a domestic environment does not take the place of fundamental data analysis on user experiences. The "User Experience and Interaction (UX/UI/HCD)" connected within the field of industrial and product design [41], with a primary focus on user-product interfaces for effectiveness and usability, is where the EXD concept originates [41–45]. As a result, organizing the EXD framework helps prioritize selecting environmental design elements and systematize the architectural decision-making process as a tool. As a result, insufficient architectural design considerations and strategies for middle-income families' high-density urban housing in Bangladesh and other developing countries may not be enough to promote occupants' well-being in the context of the area. Although domestic settings in Dhaka, Bangladesh, are the focus of this methodological framework, they may have implications for other architectural design fields locally and globally. Even in broad contexts, the difficulties of examining occupants' domestic experiences seem debatable. As a result, the development of the EXD framework will be the focus of future research in the field of built-environmental design to enhance occupant well-being in high-density urban housing.

10. EXD Hypothetical Construct

Solutions to spatial and environmental architectural design cannot be adequately presented without a thorough understanding of human experiences. People have a variety of experiences, and those experiences are connected to other aspects of the spatial and environmental factors of that space. Space usability and residents' living standards strongly correlate with their mental well-being. In this case, the user experience will be the primary driver of design strategies to investigate occupants' well-being in their domestic living environment. The daily experiences of occupants are viewed as a crucial tool for design development in this EXD concept. The result of combining occupants' experiences in a particular setting with spatial and environmental design factors will be environmental experience design (EXD) [3,14,40]. It is necessary to develop a conceptual design framework for EXD based on the theoretical agenda. In this theoretical approach, the three main components—spatial design factors, environmental design factors, and user contextual factors as human experiences—comprise the essential elements of user experience design. Here, the first section, titled "Environmental Factor (EF)", investigates environmental parameters (such as temperature, humidity, air, noise, light, color, smell, material, texture, and nature) following the priorities of the occupants concerning existing design elements. This section primarily combines the features and quality of the indoor environment with the psychological comfort and satisfaction of the occupants. The second factor, known as "spatial design factors (SF)", primarily emphasizes occupants' spatial requirements. These factors include privacy, variety, identity, control, order, security, choice, sociability, and aesthetics. Users' physical, psychological, and biological needs and demands in their living environments will be connected to them. The third factor, known as "user contextual

experiences or factor (UF)", is linked to the preferences or constraints of the occupants in their domestic environment and can shape how the factors of spatial and environmental design interact. This module primarily addresses users' background information, such as the socio-cultural context, preferences, and limitations in a domestic setting. This contextual factor varies depending on the occupants' age, sex, education, religion, income, restrictions, needs, and demands. To improve the mental well-being of residents in Dhaka, Bangladesh, and worldwide, environmental design solutions can be facilitated using this EXD conceptual framework (Figure 7).

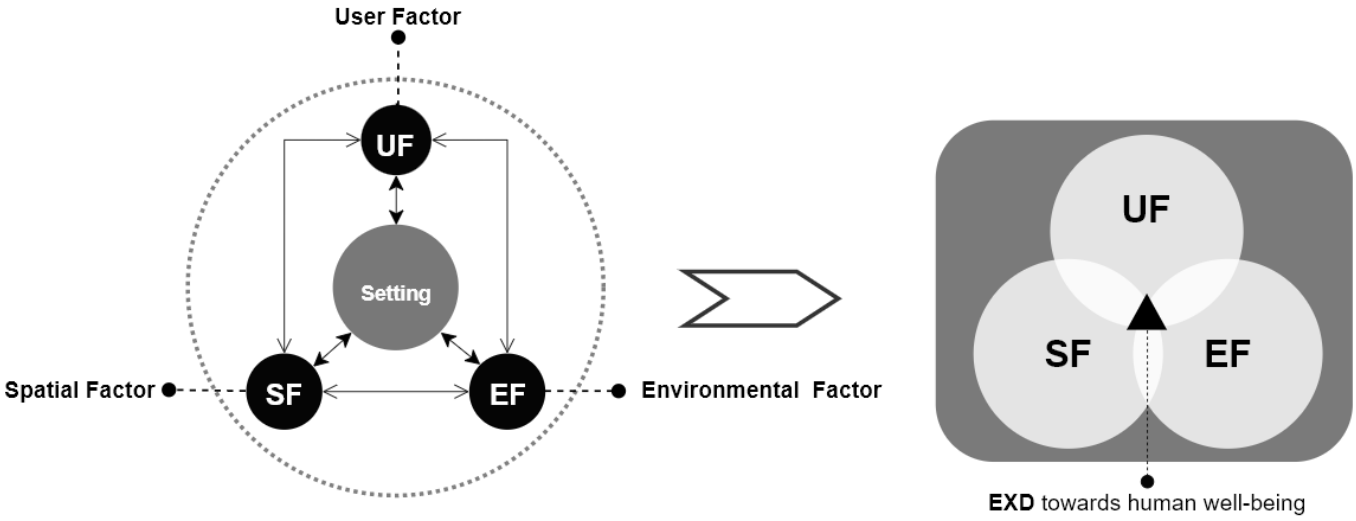

Figure 7. Research hypothetical construct (source: author).

11. EXD Methodological Approach and Conceptual Outcomes

The development of research methodologies to investigate the design of environmental experiences for the occupants may be influenced by identifying research trends frequently used in today's researchers' user experience (UX) design domain. Consequently, the idea of "User Experience (UX) Design" originated from the industrial (product) design field, which prioritized creating user-product interfaces for functionality and usability [40]. Considering this, the UX/UI research trend generates data and analyzes user perceptions [14,41,42]. In contrast to the current research trend, which combines qualitative and quantitative data, built environment research combines cognitive and behavioral aspects. As a result, integrated environmental studies currently apply mixed-mode research approaches [46–48]. Research or investigation combining qualitative and quantitative data is referred to as a "mixed mode" research approach. The mixed-methods research process integrates data at various stages [49]. The sequential strategy has been considered in this mixed-mode research, considering its viewpoint. This strategy follows four questions regarding research sequence, relative priority, integration, and theoretical perspective in the empirical work proposed by Wisdom [50]. Three subgroups of sequential design methods (sequential exploratory, sequential explanatory, and sequential transformative) based on their implementation mechanisms. Sequential transformative strategies should be conducted using a conceptual framework and can be quantitative, qualitative, or both. This sequential design is guided by a particular theoretical direction and findings, which are integrated during the interpretation stage. As a result, the correlational matrix between the user contextual factor (UF), environmental factor (EF), and spatial factor (SF) can aid in the creation of new EXD outcomes for the domestic setting of occupants (Figure 8).

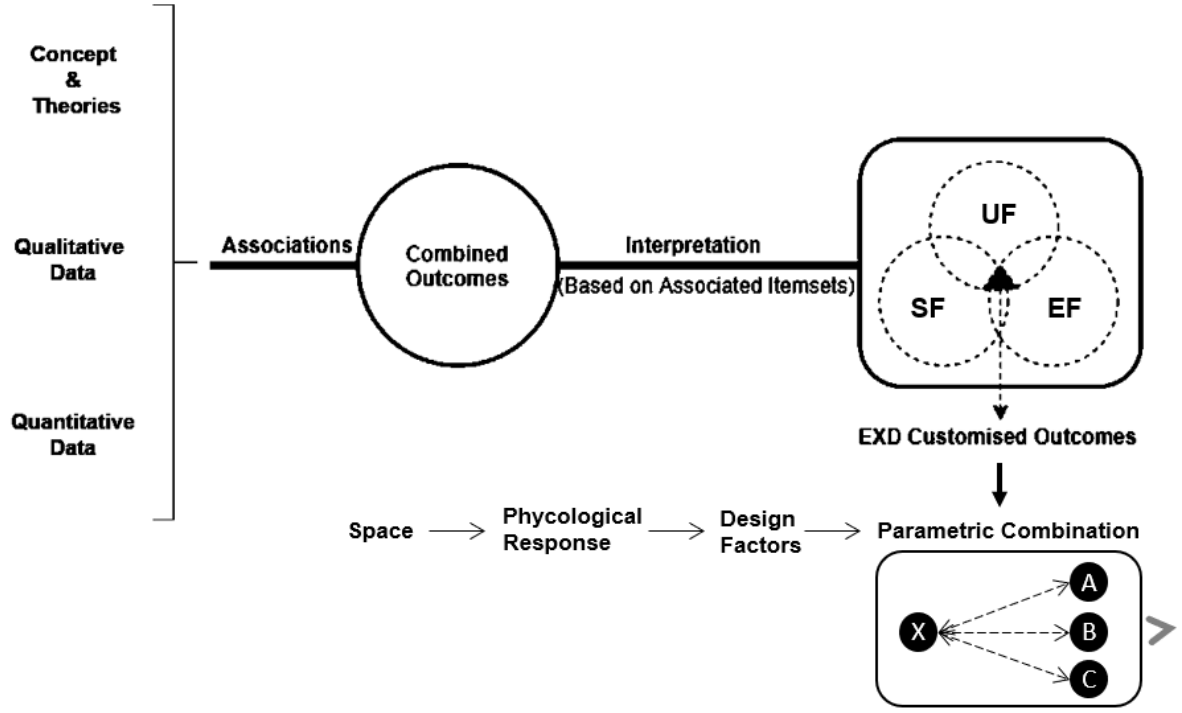

Figure 8. EXD methodological approach to customizing outcomes. (Source: author).

The EXD parametric results will interpret occupants' psychological needs and demands in their domestic settings, basically for those with socioeconomic limitations. This interpretation may offer new design (architectural) combinations or guidelines based on an association itemset that can improve occupants' mental well-being in support of achieving SDGs [51–55].

12. Data Demonstration and Interpretation

In Section 4: Experiencing Occupants: Field Observation, the selection of twelve types of environmental components refers to environmental factors (EF) and ten types of spatial factors (SF) based on the theoretical background and field survey (middle-income households, Dhaka, Bangladesh) that have been chosen as components for the data demonstration and interpretation in this segment. In a structured questionnaire, two parts about environmental design factors (e.g., daylighting, artificial lighting, natural ventilation, air quality, acoustic quality, smells/odors, texture and color, materials, outdoor connectivity, indoor natural elements, indoor temperature, and microbe and mold growth) and occupants' spatial factors (e.g., indoor climate control, privacy, functional identity, safety and security, space order and usability, changeability and variety, aesthetics quality, flexibility of choice, interaction and sociability, and cleanliness) have been conducted during field studies.

Information for all attributes has been encoded with binary numbers such as 0, 1, or Y, N. After binary coding, selected samples were put into groups based on how the occupants answered and what was seen on the field to determine how accurate the analysis was. Most of the time, there are three parts to the name of each spatial and environmental factor. The first letter of a factor name can be used to find it. The middle letter of the word shows the existing situation (E), how comfortable you feel (C), and what occupants want to do in the future (F). The last letter of the name shows how low (L), medium (M), or high (H) the response was. Twenty-two factors, from "A" to "V," have been considered in this case (according to field studies).

In the first step, "Association Rules" were applied to determine the relationship between EF and SF after binary and thematic coding with significance. They identified the most exciting sets or combinations of frequently used items that considered occupants'

current situations, comfort criteria, and future preferences. This criterion is called an association rule when X and Y are parts of the same item. Usually, X comes before Y in the rule, and Y comes after it. Support, confidence, and lift are all essential parts of association rules. The analytical adjustment has been thought about based on confidence (at least 80%), support (at least 50%), and lift (at least +1).

Last, the frequent association item sets were calculated using unique items and a small number of records. In this analysis, the "Apriori" algorithm (Association Rules) looked at the occupants' preferences for rule support, confidence, and lift value and put these connections in order. Agrawal and Srikant proposed the Apriori method in 1994. Apriori is meant to operate on transactional databases. Apriori employs a "bottom-up" strategy in which subgroups are frequently expanded one item at a time (a process known as clustering algorithms) and groupings of candidates are evaluated against the dataset. The algorithm ends when no additional acceptable expansions are discovered [56]. For the numerical analysis through the "Apriori" algorithm, the following equations have been applied to extract the most frequent combination of twenty-two design factors based on their support, confidence, lift, and deployability (Figures 9 and 10).

In the second step, contextual analysis was conducted by NVivo. The factors in Figure 11 have been grouped based on their similarities. This was carried out by analyzing the context of the occupants using thematic coding. In this step of the contextual analysis, after creating a "thematic node," an "items clustered by similarity" analysis was conducted, and a correlational diagram (using the Pearson correlation coefficient, *r*) shows how nodes (i.e., spatial and environmental design factors) are related to each other. This correlation makes it easy to see the similarities and differences between different variables from the occupants' narratives for a specific domestic space (i.e., Space: X in a domestic setting).

In a statistical analysis for linear regression, Pearson's correlation coefficient (Pearson's *r*) is usually used to figure out how two variables are connected [57]. For example, a field study found that for a specific domestic space (X) in Dhaka, the presence of indoor natural elements is closely linked to the safety and security of the room, as told by the occupants who live there. It seems that daylight is also connected to the choose factor and indirectly to air quality and artificial lighting. In this way, the functional identity of a space has a direct effect on climate control and an indirect impact on indoor temperature and socializing in that space. On the cluster analysis diagram, items with a high similarity index (maximum = 1) display a strong resemblance and are shown closer together. This figure (Figure 11) shows the apparent relationship between different factors (spatial and environmental) of a specific domestic space based on the occupants' socio-cultural preferences of middle-income families who live in high-density urban housing in Dhaka, Bangladesh.

$$\textbf{Apriori} = \begin{cases} Support\ (x) = \dfrac{N_X}{N} \\ Confidence\ (x \rightarrow y) = \dfrac{\text{Support (x, y)}}{\text{Support (x)}} \\ Lift\ (x \rightarrow y) = \dfrac{\text{Support (x, y)}}{\text{Support (x)} \times \text{Support (y)}} \end{cases}$$

Consideration, support (50%), confidence (min. 80%), lift (+1)
N = Number of Records

Figure 9. Mathematical modeling of the "Apriori" algorithm [50].

Space: **X**
(Domestic Space)

Coding

A	Indoor Climate Control
B	Privacy
C	Functional Identity
D	Safety and Security
E	Space Usability
F	Changeability (Variety)
G	Aesthetics Quality
H	Flexibility of Choice
I	Interaction and Sociability
J	Cleanliness
K	Daylighting Quality
L	Artificial Lighting Quality
M	Natural Ventilation
N	Air Quality (Dust/Pollution)
O	Indoor Temperature
P	Acoustical Quality
Q	Smell/Odors Quality
R	Texture & Color Quality
S	Quality of Materials
T	Outdoor Connectivity
U	Indoor Natural Elements
V	Microbe & Mold Growth

BE-H	Privacy Existing - High
BC-M	Privacy Comfort - Medium
BF-L	Privacy F. Preference - Low

Numerical Analysis
(Association Rules > Apriori)
Most Frequent Combination

Consequent	Antecedent	Support %	Confidence %	Lift	Deployability
IF-M	ME-M	54.55	100.00	1.38	0.00
IF-M	MC-M	54.55	100.00	1.38	0.00
KF-H	VC-H	54.55	100.00	1.83	0.00
IF-M	LC-M	72.73	100.00	1.38	0.00
FF-M	LC-M	72.73	87.50	1.38	9.09
IF-M	OE-M	72.73	87.50	1.20	9.09
IF-M	GC-M	72.73	87.50	1.20	9.09
HF-M	IC-M	63.64	85.71	1.57	9.09
IF-M	NE-M	63.64	85.71	1.18	9.09
UF-M	OC-M	63.64	85.71	1.35	9.09
IF-M	OC-M	63.64	85.71	1.18	9.09
IF-M	GE-M	63.64	85.71	1.18	9.09
EF-H	IC-M	63.64	85.71	1.35	9.09
JF-H	IC-M	63.64	85.71	1.35	9.09
CF-H	IC-M	63.64	85.71	1.35	9.09
IF-M	IC-M	63.64	85.71	1.18	9.09
BF-M	EE-M	54.55	83.33	1.83	9.09
BF-M	BE-M	54.55	83.33	1.83	9.09
GF-M	UC-M	54.55	83.33	1.83	9.09
GF-M	EE-M	54.55	83.33	1.83	9.09
UF-M	UC-M	54.55	83.33	1.31	9.09
VF-L	UC-M	54.55	83.33	1.31	9.09
IF-M	UC-M	54.55	83.33	1.15	9.09
DF-H	AC-M	54.55	83.33	1.53	9.09
EF-H	AC-M	54.55	83.33	1.31	9.09
JF-H	AC-M	54.55	83.33	1.31	9.09
CF-H	AC-M	54.55	83.33	1.31	9.09
IF-M	AC-M	54.55	83.33	1.15	9.09
KF-H	JE-H	54.55	83.33	1.53	9.09
FF-M	ME-M	54.55	83.33	1.31	9.09
VF-L	MC-M	54.55	83.33	1.31	9.09
FF-M	MC-M	54.55	83.33	1.31	9.09
IF-M	EE-M	54.55	83.33	1.15	9.09
UF-M	BE-M	54.55	83.33	1.31	9.09
IF-M	BE-M	54.55	83.33	1.15	9.09
KF-H	FC-M	54.55	83.33	1.53	9.09
UF-M	FC-M	54.55	83.33	1.31	9.09
KF-H	CE-M	54.55	83.33	1.53	9.09

Figure 10. Numerical correlation (association) of spatial and environmental design factors. (Source: author; based on analysis).

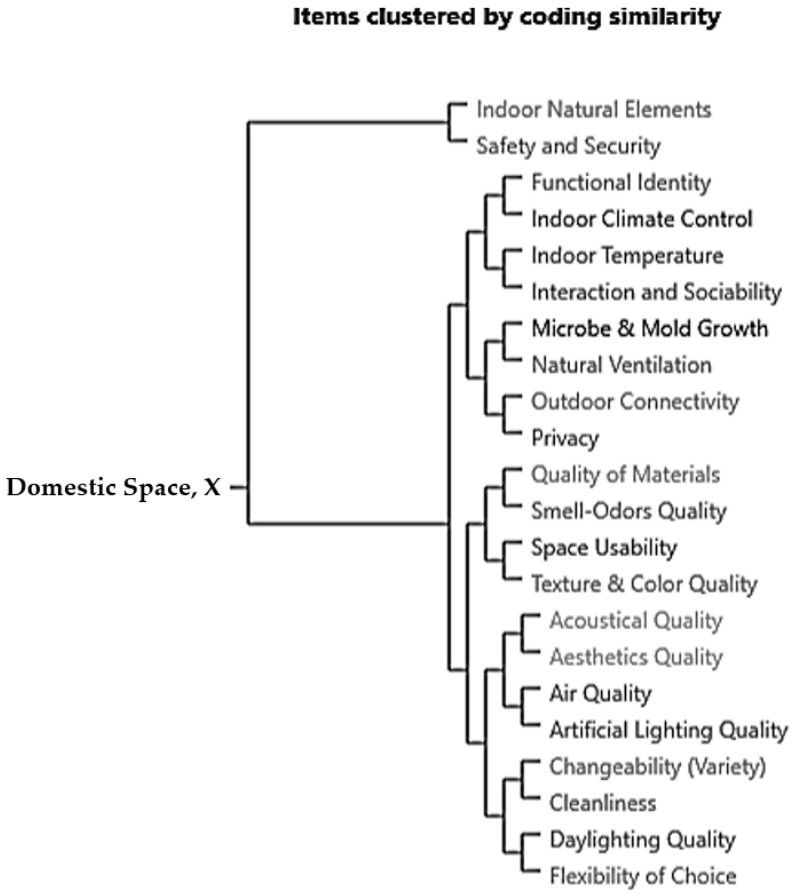

Figure 11. Contextual correlation of spatial and environmental design factors. (Source: author; based on analysis).

In this step of the analysis, the occupants' strong preference for regular combinations (numerical and qualitative) with the highest confidence, support, and lift values was found to be the most interesting and strongly correlated set of items (Figure 12). At this point in the data mining process, all causes and effects that are not strongly linked to each other have been eliminated. The format of the subsequent and antecedent has been linked together for the exact value of lift, confidence, or support. Based on support, confidence, or lift, these associations are later classified (clustering) as low-medium-high combinations. Through contextual analysis, it has been shown that these connections are essential for the occupants, according to their preferences. A thematic literature review has also been used to explain the most common associations in the final analysis stage based on the combination of domestic and environmental parametric relationships. This combination shows how the EXD mass-customized (mass customization is a manufacturing and marketing strategy that combines mass production's inexpensive per-unit costs with the adaptability and personalization of custom-made items. In traditional mass production, standardized products are produced in huge quantities using an effective technique [58–60]) outcomes for a specific domestic space, X, integrate causes and effects.

Numerical Analysis
(Association Rules > Apriori)
Most Frequent Combination

Consequent	Antecedent	Support %	Confidence %	Lift	Deployability
IF-M	ME-M	54.55	100.00	1.38	0.00
IF-M	MC-M	54.55	100.00	1.38	0.00
KF-H	VC-H	54.55	100.00	1.83	0.00
IF-M	LC-M	72.73	100.00	1.38	0.00
FF-M	LC-M	72.73	87.50	1.38	9.09
IF-M	OE-M	72.73	87.50	1.20	9.09
IF-M	GC-M	72.73	87.50	1.20	9.09
HF-M	IC-M	63.64	85.71	1.57	9.09
IF-M	NE-M	63.64	85.71	1.18	9.09
UF-M	OC-M	63.64	85.71	1.35	9.09
IF-M	OC-M	63.64	85.71	1.18	9.09
IF-M	GE-M	63.64	85.71	1.18	9.09
EF-H	IC-M	63.64	85.71	1.35	9.09
JF-H	IC-M	63.64	85.71	1.35	9.09
CF-H	IC-M	63.64	85.71	1.35	9.09
IF-M	IC-M	63.64	85.71	1.18	9.09
BF-M	EE-M	54.55	83.33	1.83	9.09
BF-M	BE-M	54.55	83.33	1.83	9.09
GF-M	UC-M	54.55	83.33	1.83	9.09
GF-M	EE-M	54.55	83.33	1.83	9.09
UF-M	UC-M	54.55	83.33	1.31	9.09
VF-L	UC-M	54.55	83.33	1.31	9.09
IF-M	UC-M	54.55	83.33	1.15	9.09
DF-H	AC-M	54.55	83.33	1.53	9.09
EF-H	AC-M	54.55	83.33	1.31	9.09
JF-H	AC-M	54.55	83.33	1.31	9.09
CF-H	AC-M	54.55	83.33	1.31	9.09
IF-M	AC-M	54.55	83.33	1.15	9.09
KF-H	JE-H	54.55	83.33	1.53	9.09
FF-M	ME-M	54.55	83.33	1.31	9.09
VF-L	MC-M	54.55	83.33	1.31	9.09
FF-M	MC-M	54.55	83.33	1.31	9.09
IF-M	EE-M	54.55	83.33	1.15	9.09
UF-M	BE-M	54.55	83.33	1.31	9.09
IF-M	BE-M	54.55	83.33	1.15	9.09
KF-H	FC-M	54.55	83.33	1.53	9.09
UF-M	FC-M	54.55	83.33	1.31	9.09
KF-H	CE-M	54.55	83.33	1.53	9.09

Contextual Analysis
(Items Clustering > Pearson's r)
Contextual Correlation

User Context (Narratives)
Supported **(Low)**
Supported **(Low)**
Supported **(Observation)**
Supported **(Observation)**
Supported **(Low)**
Supported **(High)**
Supported **(Observation)**
Not Supported
Not Supported
Not Supported
Supported **(High)**
Not Supported
Supported **(Observation)**
Not Supported
Supported **(Medium)**
Supported **(Medium)**
Supported **(Low)**
Not Supported
Not Supported
Not Supported
Not Supported
Supported **(Observation)**
Not Supported
Not Supported
Not Supported
Not Supported
Supported **(High)**
Supported **(Medium)**
Supported **(Medium)**
Supported **(Observation)**
Supported **(High)**
Not Supported
Not Supported
Not Supported
Supported **(Low)**
Supported **(Medium)**
Not Supported
Not Supported

Interpretation
(Most Interesting Combinations > Associations)

Consequent	Antecedent	Support %	Confidence %	Lift	Deployability
IF-M	ME-M	54.55	100.00	1.38	0.00
IF-M	MC-M	54.55	100.00	1.38	0.00
KF-H	VC-H	54.55	100.00	1.83	0.00
IF-M	LC-M	72.73	100.00	1.38	0.00
FF-M	LC-M	72.73	87.50	1.38	9.09
IF-M	OE-M	72.73	87.50	1.20	9.09
IF-M	GC-M	72.73	87.50	1.20	9.09
IF-M	OC-M	63.64	85.71	1.18	9.09
EF-H	IC-M	63.64	85.71	1.35	9.09
CF-H	IC-M	63.64	85.71	1.35	9.09
IF-M	IC-M	63.64	85.71	1.18	9.09
BF-M	EE-M	54.55	83.33	1.83	9.09
BF-M	BE-M	54.55	83.33	1.83	9.09
VF-L	UC-M	54.55	83.33	1.31	9.09
CF-H	AC-M	54.55	83.33	1.31	9.09
IF-M	AC-M	54.55	83.33	1.15	9.09
KF-H	JE-H	54.55	83.33	1.53	9.09
FF-M	ME-M	54.55	83.33	1.31	9.09
VF-L	MC-M	54.55	83.33	1.31	9.09
IF-M	BE-M	54.55	83.33	1.15	9.09
KF-H	FC-M	54.55	83.33	1.53	9.09

Figure 12. Most interesting combinations (interpretation) of spatial and environmental design factors. (Source: author).

Lastly, the two-step cluster analysis [49] looks for common groupings (EXD customized results) in a dataset that might not be visible otherwise. Using the log-likelihood measure, the dataset was put through a two-step cluster analysis in SPSS to find natural groups. By putting the clusters in a hierarchy, the researcher can try out different environmental design solutions with varying numbers of clusters. As a result, many solutions are found, and then Schwarz's Bayesian information criterion is used to pick the best number of design clusters for the architectural decision-making process (Figure 13).

According to this assessment (Figure 13), occupants primarily regarded two spatial (i.e., cleanliness and privacy) and two environmental (i.e., indoor temperature and natural ventilation) elements based on existing scenarios in their domestic living space (space X). Assume, for instance, that the inside temperature becomes unfavorable (hot); in this situation, it affects the occupants' emotions of comfort as a psychological factor related to indoor climate control and natural ventilation difficulties. Moreover, cleanliness is correlated with the interaction and sociability of the residents, whereas privacy is related to the room's artificial lighting and ventilation quality. Furthermore, poor natural ventilation in a dwelling connects with the psychological concerns of middle-income residents regarding microbe-mold, artificial lighting quality, and natural elements. Consequently, EXD customized design outcomes (e.g., clusters 1, 2, 3, and 4) provided multiple architectural design preferences (solutions) to solve specific circumstances (if/then) for that particular domestic space based on the socio-cultural preferences or living environment restrictions of middle-income occupants. In cluster 1, the relevance of microbe-mold growth (importance 1) and interaction-sociability (importance 0.71) should be prioritized over functional identity (importance 0.52) based on the existing circumstances and experiences of the inhabitants. Similarly, for cluster 2, interaction-sociability and daylighting quality have

the same importance value (1); for cluster 3, privacy and interaction-sociability are more significant than changeability (0.67); and for cluster 4, minimizing occupants' existing psychologically negative aspects, space usability, and changeability should be an important design consideration.

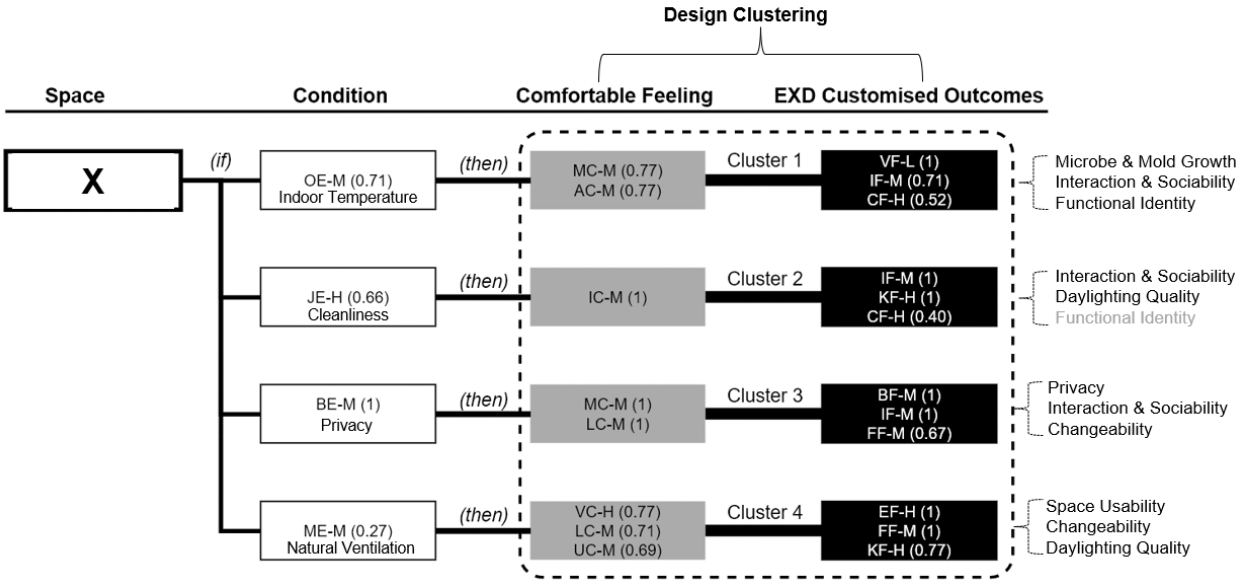

Figure 13. EXD customized outcomes for X as a domestic space. (Here: X = Master bed/childbed/toilet/kitchen/dining space/drawing space/corridor/balcony in a domestic area or others). (Source: author).

To evaluate the EXD methodological approach in this analysis, only one specific space (space = X) of a home setting has been considered using quantitative and qualitative field data from Dhaka, Bangladesh. By utilizing this EXD methodological approach and considering occupants' multiple needs and demands in other domestic spaces (such as the master bedroom, child bedroom, attached toilet, common toilet, living space, dining space, kitchen, balcony, and corridor), an environmental (architectural) design solution can be accomplished. Environmental design defines physical environmental influences on human behavior [61–65]. Still, the approach of environmental experience design demonstrates occupants' (as users) psychological preferences (needs and demands as taking priority) in architectural design solutions that may impact their well-being, where association rules and design cluster analysis provide the opportunities to correlate occupants' socio-cultural aspects in their living environment. To meet the Sustainable Development Goals, this interpretation will offer new architectural and environmental design combinations or directions (as a tool).

13. Conclusions

The demand for high-density housing in Dhaka, Bangladesh, has increased exponentially as horizontal growth is challenging due to a lack of buildable land in urban areas. The housing industry is developing high-density, small-sized flats or apartments to address the current situation by shifting its target demographic from higher and upper-middle income groups to lower-middle and middle-income groups. The occupants' mental well-being is not given much consideration in these housing projects' architectural practices, which are only seen as physical components. The occupants' mental state can be impacted by their home's small size and dense population. This condition, both directly and indirectly, impacts their productivity, which could ultimately affect the nation's overall economic growth. It might prevent Bangladesh and other developing countries from experiencing sustainable development. Additionally, as the COVID-19 pandemic spread, the number of people working from home steadily increased, and every domestic setting needs a comfort-

able space where work can be carried out calmly. Controlling subjective perceptions can enhance the living conditions of occupants. Environmental design, human experiences, and psychological preferences are all constrained by modern architectural design techniques. The Environmental Experience Design (EXD) design concept has advanced as a result of this study and is based on the conceptual parametric framework of user-centered design. This study mainly focused on exploring the EXD approach in three main areas: spatial, environmental, and user-contextual factors based on middle-income families in Dhaka. Pragmatic studies of occupants' (as users) experiences are required to investigate the "Environmental Experiences Design (EXD)" framework for not only high-density urban housing in Bangladesh (as locally) but globally to explore other research domains on environmental issues. This user-centered design concept prioritizes the selection of domestic environmental design components by evaluating occupants' psychological needs and demands through household experiences that may affect their well-being. As a result, organizing the EXD methodological framework helps to systematize the architectural decision-making process as a tool both locally and globally to achieve the SDG's goal.

Author Contributions: S.C. led overall research activities, conceptualization, methodology, the literature reviews, formal analysis, research outcomes, field study, and manuscript drafting; M.N. contributed to principal research supervision and refinement of manuscript development, and H.D. contributed to partial research supervision and refinement of manuscript development. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: This project has human research ethics approval from the University of Melbourne (Ethics approval ID 20752).

Data Availability Statement: Data sharing is not applicable to this article due to privacy.

Acknowledgments: The authors would like to express their sincere gratitude to the Melbourne School of Design (MSD), Faculty of Architecture, Building and Planning; the University of Melbourne for providing access to the facilities required for this research activity as well as a full PhD scholarship given to the first author of this paper.

Conflicts of Interest: The authors declare no conflict of interest. We certify that the submission is original work and is not under review at any other publication. All co-authors have seen and agree with the manuscript's contents and there is no financial interest to report.

References

1. United Nations. *World Population Ageing 2019: Highlights (ST/ESA/SER. A/430)*; Department of Economic and Social Affairs, Population Division, United Nations: New York, NY, USA, 2019. Available online: https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Highlights.pdf (accessed on 15 December 2022).
2. Asian Development Bank. Development Indi, Asian Development Bank. Economics & Re. Key Indicators for Asia and the Pacific 2011. Available online: https://www.adb.org/publications/key-indicators-asia-and-pacific-2011 (accessed on 10 December 2022).
3. Chowdhury, S.; Noguchi, M.; Doloi, H. Domestic Environmental Experience Design. *Encyclopedia* **2021**, *1*, 505–518. [CrossRef]
4. Beyer, R.C.M. *South Asia Economic Focus, Fall 2019: Making (De) Centralization Work*; The World Bank: Washington, DC, USA, 2019; pp. 1–88.
5. MoHFW (Ministry of Health and Family Welfare). *National Mental Health Survey, Bangladesh, 2018–2019*; National Institute of Mental Health: Dhaka, Bangladesh, 2019.
6. BRAC. The State of Cities 2017: Housing in Dhaka. In *BIGD Report*; BRAC Institute of Governance and Development, BRAC University: Dhaka, Bangladesh, 2017.
7. Kjellstrom, T.; Mercado, S.; Barten, F.; WHO Commission on Social Determinants of Health; Knowledge Network on Urban Settings; Centre for Health Development; World Health Organization. *Our Cities, Our Health, Our Future: Acting on Social Determinants for Health Equity in Urban Settings: Report to the WHO Commission on Social Determinants of Health from the Knowledge Network on Urban Settings*; WHO Kobe Centre: Kobe, Japan, 2007.
8. Swapan, M.S.H.; Zaman, A.U.; Ahsan, T.; Ahmed, F. Transforming urban dichotomies and challenges of South Asian megacities: Rethinking sustainable growth of Dhaka, Bangladesh. *Urban Sci.* **2017**, *1*, 31. [CrossRef]
9. Sarker, P. Analyzing Urban Sprawl and Sustainable Development in Dhaka, Bangladesh. *J. Econ. Sustain. Dev.* **2020**, *11*, 9–20.
10. *Dhaka Structure Plan 2016–2035*; RAJUK (Rajdhani Unnayan Kartripakkha): Dhaka, Bangladesh, 2015.

11. BBS (Bangladesh Bureau of Statistics). *Household Income and Expenditure Survey 2016–2017*; Ministry of Planning, Government of the People's Republic of Bangladesh: Dhaka, Bangladesh, 2017.
12. *Towards an Unliveable City*; The Business Standard: Dhaka, Bangladesh, 2019. Available online: https://tbsnews.net/bangladesh/towards-unliveable-city (accessed on 7 February 2021).
13. Mridha, M. The effect of age, gender and marital status on residential satisfaction. *Local Environ.* **2020**, *25*, 540–558. [CrossRef]
14. Chowdhury, S.; Noguchi, M.; Doloi, H. Conceptual Parametric Relationship for Occupants' Domestic Environmental Experience. *Sustainability* **2021**, *13*, 2982. [CrossRef]
15. Ahmed, K.S. Approaches to Bioclimatic Urban Design for the Tropics with Special Reference to Dhaka, Bangladesh. In *Environment & Energy Studies Programme*; Architectural Association Graduate School: London, UK, 1996.
16. Kalvelage, K.; Dorneich, M. A user-centered approach to user-building interactions. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting, Chicago, IL, USA, 27–31 October 2014; SAGE Publications: Los Angeles, CA, USA; Volume 58, pp. 2008–2012.
17. Ulrich, R.S.; Simons, R.F.; Losito, B.D.; Fiorito, E.; Miles, M.A.; Zelson, M. Stress recovery during exposure to natural and urban environments. *J. Environ. Psychol.* **1991**, *11*, 201–230. [CrossRef]
18. Bluyssen, P.M. Towards an integrated analysis of the indoor environmental factors and its effects on occupants. *Intell. Build. Int.* **2019**, *12*, 199–207. [CrossRef]
19. Flade, A. No Place Like Home. *Sci. Am. Mind* **2007**, *18*, 70–75. [CrossRef]
20. Goldhagen, S.W. *Welcome to Your World: How the Built Environment Shapes Our Lives*; Harper Collins: New York, NY, USA, 2017.
21. McClure, W.R.; Bartuska, T.J.; Young, G.L. *The Built Environment: A Collaborative Inquiry into Design and Planning*; John Wiley & Sons Inc.: Hoboken, NJ, USA, 2011.
22. Kopec, D.A. *Environmental Psychology for Design*, 3rd ed.; Bloomsbury Publishing Inc.: London, UK, 2018.
23. Mallgrave, H.F. *From Object to Experience: The New Culture of Architectural Design*; Bloomsbury Publishing: London, UK, 2018.
24. Lawrence, D.L.; Low, S.M. The built environment and spatial form. *Annu. Rev. Anthropol.* **1990**, *19*, 453–505. [CrossRef]
25. Gifford, R.; Steg, L.; Reser, J.P. *Environmental Psychology*; Wiley Blackwell: Hoboken, NJ, USA, 2011.
26. Kaplan, S. The restorative benefits of nature: Toward an integrative framework. *J. Environ. Psychol.* **1995**, *15*, 169–182. [CrossRef]
27. Cooper, C.J.L. *Designing for Human Behavior*; Dowden-Hutchingson: Stroudsburg, PA, USA, 1974.
28. Sussman, A.; Hollander, J.B. *Cognitive Architecture: Designing for How We Respond to the Built Environment*; Routledge: Abingdon, UK, 2015.
29. Pallasmaa, J. *The Eyes of the Skin: Architecture and the Senses*; Wiley: Hoboken, NJ, USA, 2005.
30. Mallett, S. Understanding home: A critical review of the literature. *J. Sociol. Rev.* **2004**, *52*, 62–89. [CrossRef]
31. Pennartz, P.J. Atmosphere at home: A qualitative approach. *J. Environ. Psychol.* **1986**, *6*, 135–153. [CrossRef]
32. Evans, G.W. The built environment and mental health. *J. Urban Health* **2003**, *80*, 536–555. [CrossRef]
33. Ittelson, W.H.; Franck, K.A.; O'Hanlon, T.J. The nature of environmental experience. In *Experiencing the Environment*; Springer: Boston, MA, USA, 1976; pp. 187–206.
34. Graham, L.T.; Gosling, S.D.; Travis, C.K. The psychology of home environments: A call for research on residential space. *Perspect. Psychol. Sci.* **2015**, *10*, 346–356. [CrossRef]
35. Ergan, S.; Shi, Z.; Yu, X. Towards quantifying human experience in the built environment: A crowdsourcing based experiment to identify influential architectural design features. *J. Build. Eng.* **2018**, *20*, 51–59. [CrossRef]
36. Dovey, K. Home and Homelessness. In *Home Environments. Human Behavior and Environment. Advances in Theory and Research*; Altman, I., Werner, C.M., Eds.; Springer: Boston, MA, USA, 1985; Volume 8.
37. Altman, I.; Wohlwill, J.F. *Human Behavior and Environment: Advances in Theory and Research Volume 2*; Springer Science & Business Media: New York, NY, USA, 1977.
38. Caan, S. *Rethinking Design and Interiors: Human Beings in the Built Environment*; Laurence King: London, UK, 2011.
39. Lawlor, A. *A Home for the Soul: A Guide for Dwelling with Spirit and Imagination*; Clarkson Potter Publishers: New York, NY, USA, 1997.
40. Chowdhury, S.; Noguchi, M.; Doloi, H. Defining Domestic Environmental Experience for Occupants' Mental Health and Well-being. *Designs* **2020**, *4*, 26. [CrossRef]
41. Norman, D. *The Design of Everyday Things: Revised and Expanded Edition*; Basic Books: New York, NY, USA, 2013.
42. Noguchi, M.; Ma, N.; Woo, C.M.M.; Chau, H.W.; Zhou, J. The usability study of a proposed environmental experience design framework for active ageing. *Buildings* **2018**, *8*, 167. [CrossRef]
43. Dalmoro, M.; Isabella, G.; Almeida, S.O.; dos Santos Fleck, J.P. Developing a holistic understanding of consumers' experiences: An integrative analysis of objective and subjective elements in physical retail purchases. *Eur. J. Mark.* **2019**, *53*, 2054–2079. [CrossRef]
44. Wright, P.; McCarthy, J. *Experience-Centered Design: Designers, Users, and Communities in Dialogue*; Springer Nature: Berlin, Germany, 2022.
45. Krueger, A.E. Two methods for Experience Design based on the Needs Empathy Map: Persona with Needs and Needs Persona. In *Mensch und Computer 2022. Facing Realities. Tagungsband*; Mühlhäuser, M., Reuter, C., Pfleging, B., Kosch, T., Matviienko, A., Gerling, K., Mayer, S., Heuten, W., Döring, T., Müller, F., et al., Eds.; Gesellschaft für Informatik e.V.: Bonn, Germany, 2022.
46. Amaratunga, D.; Baldry, D.; Sarshar, M.; Newton, R. Quantitative and qualitative research in the built environment: Application of "mixed" research approach. *Work. Study* **2002**, *51*, 17–31. [CrossRef]
47. Williams, C. Research methods. *J. Bus. Econ. Res.* **2007**, *5*, 65–70. [CrossRef]

48. Creswell, J.W.; Creswell, J.D. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*; Sage Publications: New York, NY, USA, 2017.
49. Wisdom, J.; Creswell, J.W. *Mixed Methods: Integrating Quantitative and Qualitative Data Collection and Analysis While Studying Patient-Centered Medical Home Models*; Agency for Healthcare Research and Quality: Rockville, MD, USA, 2013.
50. Agrawal, R.; Srikant, R. Fast algorithms for mining association rules. In Proceedings of the 20th International Conference on Very Large Data Base VLDB, Santiago de, Chile, 12–15 September 1994; Volume 1215, pp. 487–499.
51. Noguchi, M.; Lan, L.; Chowdhury, S.; Yang, W. Environmental experience design research spectrum for energy and human well-being. In *Handbook of Energy and Environmental Security*; Academic Press: Cambridge, MA, USA, 2022; pp. 207–229.
52. Zhang, L.X.; Wang, L. Influence of indoor environment design on occupants' experience. *J. Environ. Prot. Ecol.* **2021**, *22*, 1366–1375.
53. Luck, R. Design research, architectural research, architectural design research: An argument on disciplinarity and identity. *Des. Stud.* **2019**, *65*, 152–166. [CrossRef]
54. Riva, A.; Rebecchi, A.; Capolongo, S.; Gola, M. Can Homes Affect Well-Being? A Scoping Review among Housing Conditions, Indoor Environmental Quality, and Mental Health Outcomes. *Int. J. Environ. Res. Public Heal.* **2022**, *19*, 15975. [CrossRef]
55. Smith, A.W. User experience design for older adults: Experience architecture and methodology for users aged 60+. In Proceedings of the 37th ACM International Conference on the Design of Communication, Portland, OR, USA, 4–6 October 2019; pp. 1–9.
56. Benesty, J.; Chen, J.; Huang, Y.; Cohen, I. Pearson correlation coefficient. In *Noise Reduction in Speech Processing*; Springer: Berlin/Heidelberg, Germany, 2009; pp. 1–4.
57. Shih, M.Y.; Jheng, J.W.; Lai, L.F. A two-step method for clustering mixed categroical and numeric data. *J. Appl. Sci. Eng.* **2010**, *13*, 11–19.
58. Noguchi, M.; Hernàndez-Velasco, C.R. A 'mass custom design'approach to upgrading conventional housing development in Mexico. *Habitat Int.* **2005**, *29*, 325–336. [CrossRef]
59. Stevens, M.; Noguchi, M. The Challenges of Mass Customization for Designing and Constructing Residential Spaces. In Proceedings of the Constructing Smart Cities: Proceedings of the 22nd CIB World Building Congress (CIB2019), Hong Kong, China, 17–21 June 2019; The Hong Kong Polytechnic University: Hong Kong, China, 2019.
60. Bunster, V.; Bustamante, W. Structuring a residential satisfaction model for predictive personalization in mass social housing. *Sustainability* **2019**, *11*, 3943. [CrossRef]
61. Golledge, R.G.; Moore, G.T.; Briggs, R.; Cadwallader, M.T.; Devlin, A.S.; George, D.L.; Zannaras, G.; Kreimer, A.; Nigl, A.J.; Fishbein, H.D.; et al. Environmental cognition. In *Environmental Design Research*; Routledge: Abingdon, UK, 2018; pp. 182–260.
62. Devlin, A.S. *Environmental Psychology and Human Well-Being: Effects of Built and Natural Settings*; Academic Press: Cambridge, MA, USA, 2018.
63. Peters, T.; Halleran, A. How our homes impact our health: Using a COVID-19 informed approach to examine urban apartment housing. *Archnet-IJAR Int. J. Archit. Res.* **2021**, *15*, 10–27. [CrossRef]
64. Mezerdi, T.; Belakehal, A.; Sfaksi, I. Impact of the socio-environmental quality of the courtyard house on occupant satisfaction: The case of M'chouneche oasis, Algeria. *Int. Rev. Spat. Plan. Sustain. Dev.* **2022**, *10*, 74. [CrossRef]
65. Djouad, F.Z. The Biophilic Approach to Qualify the Inhabitant-Nature Relationship in the Domestic Space: The Case of the City of El Kala, Algeria. *Arch. Urban Plan.* **2021**, *17*, 103–111. [CrossRef]