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Privacy as a motivating factor for spatial layout transformation in Jordanian public housing

Bushra Obeidat^{1*} , Amal Abed² and Islam Gharaibeh¹

Abstract

Various studies have addressed the issue of privacy and referred to its critical role in shaping the spatial organization and functional configurations of buildings. Residents of public housing projects tend to modify their homes to achieve different functional and occupancy objectives. While the variables that motivate tenants to alter their spatial layouts have been extensively studied, only a few studies have researched the role of privacy as a motivating factor in modifying public housing units upon extended periods of occupancy. Therefore, this study examines the role of privacy as a motivating factor in the spatial layout modification of public housing units in Jordan. It sampled a Jordanian public housing project in which the spatial layout of several housing units has been modified by residents over time. The spatial configuration of the original and the modified version of the housing unit was assessed in terms of visibility, accessibility, hierarchical structure, and the spatial organization of interior spaces. Additionally, face-to-face interviews were conducted with the residents to gain a better understanding of privacy considerations in modified units. The study of Jordanian public housing units revealed that residents carried out various modifications over time that encompassed enclosing balconies with interior living spaces, adding private entrances, or expanding the space of balconies and terraces. The Visibility Graph Analysis (VGA) and J-Graph analyses showed that home modifications precipitated hierarchical spatial relationships that echo established sociocultural traditions in Jordanian society. The data analysis emphasized the key role that privacy plays as a motivational factor for spatial layout transformation. Hence, this research underlines the imperative of integrating sociocultural needs with functional aspects in the process of designing public housing projects. Designers should embed higher levels of flexibility in their masterplans and home layouts. With residents' satisfaction and spatial flexibility in mind, designers should identify and engage concerned stakeholders during the initial stages of planning and design of public housing.

Keywords: Privacy, Space syntax, Layout transformation, Public housing, Spatial organization

Introduction

Space creation, at the level of the residential unit, is a consequence of the dynamic interaction between spatial representation and spatial practice (Lefebvre and Nicholson-Smith 1991). Space representation is associated with the physical design of space or the envisioned

space where the designer manipulates the size, configuration, form, and distribution of spaces to cater to various functions. On the other hand, Spatial practice is the space as seen and possessed by users- it is the 'actual space, or the space as it is intended to be utilized by occupants (Lefebvre and Nicholson-Smith 1991). Accordingly, space is an outcome of spatial behaviors and human requirements. Space representations and spatial practice mutually define and generate one another, and their right interaction culminates in what is referred to as the lived space (Zhang 2006). To ensure that the designed entity is

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practical and efficient, the architect's main responsibility is to comprehend, elicit, and translate users' spatial practices into spatial representations in order to create livable places (Zhang 2006). Nevertheless, this procedure is often massively overlooked by designers in the architecture of public housing. In most cases, the end-users of public housing units are either unknown or unavailable, which makes it almost impossible to take their needs into consideration in the designing phase resulting in a knowledge gap in 'users, needs,' leading to inadequate design or distribution of spaces (Ibem et al. 2013; Seshadhri and Paul 2017). Hence, after residents move in, they gradually attempt to modify various aspects of their existing residences during the occupation to fulfill their needs over time (Agyefi-Mensah et al. 2020). Despite the research efforts in this domain, little is known about the spatial and functional performance of public housing units in Jordan. Hence, the results of the present study could be highly beneficial for architectural designers in gaining a better understanding of individuals' needs and delivering public housing design solutions that enhance both designs' efficiency and occupants' satisfaction.

Inflation and overpopulation led the Jordanian government to implement a massive production strategy within the housing industry, aiming to balance population needs and housing costs (Al-Homoud and Is-haqat 2019). This endeavor was spearheaded by the Housing and Urban Development Corporation (HUDC), which conducted various public housing projects (HUDC 2017). HUDC succeeded in overcoming the economic challenges accompanying the housing crisis but failed to create flexible designs that fulfill the fundamental needs of residents leading them to make various changes in their housing units like adding or demolishing structural elements (Al-Homoud and Is-haqat 2019; Al-Homoud et al. 2009). The transformations conducted in public housing units in Jordan have been investigated from various perspectives (Al-Homoud and Is-haqat 2019; Al Haija 2011). For instance, some researchers explored the factors which could lead to a change in homes' typologies (Al-Betawi et al. 2020; Malkawi et al. 2008), while others have discussed the way layout transformations reflect the physical, behavioral, environmental, social, and cultural aspects of residents' needs within different regions (Aduwo et al. 2013; Avogo et al. 2017; Sunarti et al. 2019). Moreover, some studies highlighted the role cultural values and beliefs play in shaping homes layouts in western and eastern countries (Al Husban et al. 2021; Graham et al. 2015; Shehab and Kandar 2016). Furthermore, a number of studies were dedicated to discussing the different housing policies emphasizing the gap between residents' needs and the specifications provided by the government (Malkawi et al. 2008).

Despite the fact that privacy is crucial to all human beings, the concept of privacy in the middle east is associated with deeply rooted cultural values and religious beliefs that make it a fundamental priority (Sobh and Belk 2011; Tomah et al. 2016). Nevertheless, only a limited number of studies attempted to highlight its role as a cultural and psychological factor that leads to home layout transformations. In addition, privacy was mainly assessed through users' feedback, namely, without conducting any spatial or functional analysis. In the same vein, limited studies highlighted this sociocultural dimension as a motivational factor for this transformation phenomenon in the HUDC's projects (Al Haija 2011; Malkawi et al. 2008).

Home layout transformation has been thoroughly investigated within private residences, but it has been rarely explored in the context of public housing. Therefore, it would be beneficial to explore home layout transformation within public housing units, especially with the absence of guidelines that acknowledge, respect, and support the ever-changing needs of families at different stages of their lives (Al-Betawi et al. 2020; Al Husban et al. 2021; Kamalipour and Zaroudi 2014). Thus, this study aimed to investigate the configuration of home layout transformation and the role privacy plays as a motivational factor that leads residents to conduct such transformations. This role will be assessed through cross-tabulation of spatial analysis based on space syntax and residents' feedback. Hoping the results of this study will help HUDC develop design guidelines for their future housing projects.

Motivating factors for home layout transformation

In the context of housing, layout transformations are referred to as "environmental modifications", "post-occupancy alterations", and "home renovations" (Aduwo et al. 2013). The home transformation has been defined as the process of expanding, modifying, and redesigning completed structures resulting in changes in the interior and/or exterior appearance of a building and the components of its envelope (Aryani and Wahyuningsih 2015). The transformation activities range from minor, like rearranging furniture and changing rooms' colors, to structural modifications such as addition or modification. Residents appear to make such transformations in order to cater to various needs and expectations, including achieving interaction, sociability, growth, employment; social status, and self-expression (Aduwo et al. 2013; Aryani and Wahyuningsih 2015; Avogo et al. 2017).

A great deal of research emphasized the interrelationship between the built environment and the accumulated sociocultural values affecting human behavior, such as social norms, cultural values, lifestyles, social status,

family structure, social role, social network, hospitality, gender segregation, safety, and privacy (Al-Betawi et al. 2020; Al Husban et al. 2021; Kamalipour and Zaroudi 2014; Makinde 2015; Malkawi and Al-Qudah 2003; Mullins et al. 2001; Shehab and Kandar 2016, 2021; Tomah et al. 2016). Houses are the closest representations of this interrelationship as they exhibit the way culture relates to the built environment, serves to reveal the identity of the community, and conveys messages that reveal people's sociocultural values (Agboola and Zango 2014; Al-Homoud et al. 2003; Lawrence 2019; Mahmud et al. 2012; Malkawi and Al-Qudah 2003).

In general, sociocultural values in societies can be recognized through people's houses and lifestyles. Accordingly, sociocultural factors can be considered motivating factors for housing design and planning transformation. In other words, the lack of social and cultural considerations in interior planning and housing design negatively affects residents' satisfaction (Makinde 2015; Sweis et al. 2013). Similarly, studying home transformations could provide an understanding of the social and psychological changes that occur in society, especially since people's adaptation to new norms, attitudes, and behaviors appears clearly through their houses (Mohit and Azim 2012; Opoku and Abdul-Muhmin 2010). Therefore, it is necessary to highlight the correlation between these factors and the development of housing design.

Privacy and space configurations

Privacy is a sociocultural demand, a social virtue, and a manifestation of cultural values (Othman et al. 2015). It is also viewed as a fundamental factor that determines the way individuals, groups, and organizations interact with each other (Namazian and Mehdi-pour 2013). Altman (1975) stated that privacy includes establishing, maintaining, and altering one's personal boundaries in order to reassert control over one's interpersonal connections. From another perspective, privacy may be seen as a socio-spatial feature that is indispensable for designing and planning spatially hierarchical housing units (Al Husban et al. 2021).

In general, privacy refers to the separation between private and public areas to safeguard residents' wellbeing (Al-Thahab et al. 2016). Such belief appears clearly in conservative communities where privacy is divided into several layers, including: (a) between neighbors, (b) between men and women, and (c) between family members (Othman et al. 2015). These layers, which are associated with the dynamics of semi-public and semi-private places, contribute to residents' comfort and satisfaction. Moreover, privacy is mirrored in the hierarchy of open and closed spaces and the relationship between house's accessibility

and inaccessibility (Al-Mohannadi and Furlan 2021; Alitajer and Nojoumi 2016; Rahim 2015).

In the great majority of traditional Arab communities, privacy is prominently taken into consideration in the design of indoor and outdoor spaces within private residences (Al-Thahab et al. 2016; Othman et al. 2015) in order to allow residents to manage their outside-in visibility, the amount of interaction with their neighbors, the quantity of private outdoor space, and the presence of transitional and intermediate zones (Tomah et al. 2016). Similarly, research has revealed that the Jordanian culture and traditions are strongly reflected in the spatial arrangement of local private houses, forming a well-defined hierarchy that accommodates various religious and social requirements (Tomah et al. 2016).

In a similar fashion, privacy is crucial to the Jordanian community (Al-Betawi et al. 2020). It constitutes a key element that members of a single-family take into account when they attempt to arrange or modify rooms seeking a more comfortable setting. Such modifications appear to be easily made within private residences where privacy has been taken into consideration during the early design stages. However, residents of public housing units find it hard or sometimes impossible to make the required rearrangements due to the lack of sociocultural considerations in the design of these units (Al Husban et al. 2021).

As an inevitable result of inflation and modernism, Jordanians' needs and priorities have changed gradually over time. As part of this change, privacy requirements have been demoted in the design of public housing units to go in line with the international styles and standards where privacy requirements of residential units differ from those of conservative communities. On a similar note, the change in people's income levels and the desired number of rooms have also affected the design of public housing units (Tomah et al. 2016).

The study's main assumption is that the Housing & Urban Development Corporation (HUDC) has not taken privacy into consideration while designing and constructing the public housing units. Accordingly, the following research questions have been posed:

- (1) *Do the spatial layout design of HUDC's public housing units meet the fundamental privacy requirements?*
- (2) *Do the changes in behavioral patterns over time lead residents to transform the spatial configurations of their housing units? If so, in what ways?*

Materials and methods

This study adopted a qualitative approach to understanding the role privacy plays as a motivating factor for spatial layout transformation. Based on field observations, the

researchers were able to document several instances of spatial layout transformations in a Jordanian public housing project called Zebdeh-Farkouh. Afterward, A-Graph and Visibility Graph Analyses (VGA) were conducted to assess the spatial configuration of both the original and the modified version of each unit's layout in terms of visibility, accessibility, hierarchical structure, and the spatial organization of interior spaces. Additionally, face-to-face interviews were held with the residents of these units to gain a better understanding of the transformation's motivational factors.

Zebdeh-Farkouh housing project

The study sampled Zebdeh-Farkouh public housing project (Fig. 1), located in the Rabya district, Irbid, Jordan. The project was designed and constructed by the Housing and Urban Development Corporation (HUDC) between 1980 and 1984. This housing complex was built on an approximate area of 124,700 m², divided into 81 plots: 61 plots for residential units, 12 plots for open spaces, five plots for commercial use, and two plots for educational purposes (schools). In addition, there are 126 three-story buildings distributed in the residential plots. Overall, the housing complex contains 378 units designed in three modules: A, B, and C (as shown in Fig. 2).

As shown in Fig. 2, Modules A and B have a similar layout in terms of spatial configuration with a minor difference in the area, where A is about 119 m², and B is 121 m². Module C is the smallest, with a total area of (108 m²). The original layouts (base cases) have been modified by residents over time, resulting in new layouts (transformed cases).

Field observations and documentation of transformation cases

As mentioned above, the study was built upon firsthand observations of the Zebdeh-Farkouh public housing project designed and constructed by HUDC. As shown in Table 1, these observations were first documented in the form of sketches and photographs. Then, they were converted into 2D architectural plans using AutoCAD. Documenting the transformation cases helped the researchers identify the different types of transformations conducted within public housing units (Table 2 and Fig. 3).

Spatial analysis

The spatial analysis was carried out following the space syntax approach, which determines the influence of sociocultural factors on the formation and



Fig. 1 Zebdeh-farkouh housing master plan



Fig. 2 A–C Original layouts

transformation of architectural spaces (Hillier 2014). Space Syntax is a theory-based technique that was devised in the late 1970s and early 1980s by Bill Hillier, Julienne Hanson, and others (Hillier et al. 1976). This theory is crucial for comprehending the social structure of space and the interaction between human activities and space (Karimi 2012). The term "space syntax" refers to a group of techniques for analyzing spatial layouts, such as the Visibility Graph Analysis (VGA) and the J-Graph analysis, which were conducted using the UCL DepthmapX (Turner 2001) and the AGraph software.

The UCL DepthmapX was used to produce the Visibility Graphs, which assess the level of correspondence between the spatial configuration values and the degree

of privacy and visual accessibility. Two types of widely used indicators were chosen for this investigation: The first one is the visual integration (p-values) which determines the degree of visibility across all spaces. For instance, a cell with a greater integration value is more accessible and visible than the rest of the system (de Arruda Campos and Fong 2003), i.e., its privacy level is low (Alitajer and Nojoumi 2016). As a normalized value, visual integration (p-values) enables the comparison between systems of varying sizes (de Arruda Campos and Fong 2003; Turner 2001). The second indicator is the Visual Step Depth which determines the visual depth of cells and spaces in relation to the entrance (Turner 2001).

Table 1 Sample of units' layout transformations in Zebdeh-Farkouh public housing

		
a) Residents tend to close balconies, especially on the floors that are accessible to the public.	b) Addition of two new entrances, one for the guest room and the other one for the living room.	c) Enlargement of the balcony on the first floor, in addition to a private entrance on the ground.
		
d) The exterior entrance with a private garden is common in most ground-floor apartments.	e) Noticeable enlargement on the ground floor -and balcony enlargement on the first floor.	f) Addition of entrance, two rooms, and a balcony on the ground floor- and close balconies in other apartments.
		
g) Building fences and walls around the ground floor unit with many trees and landscaping is a common feature.		
		
h) Open spaces in-between buildings are mostly neglected; residents tend to build fences and walls and plant large trees, and Pathways between buildings are shaped through time.		
		
i) Balconies that are on the street level were turned into private entrances	j) Expansions on the ground floor also lead to first-floor transformations.	k) The same layout of additions on the ground and first floors.

Table 2 The percentage of each transformation category in relation to the overall number of transformation cases within each prototype:

Categories of transformation forms	Prototype A (%)	Prototype B (%)	Prototype C (%)
1. Covering one balcony	23	28	19
2. Covering both balconies	51	27	20
3. Addition of a private entrance	16	16	22
4. Enlargement of the floor area	06	02	08
5. Enlargement of balconies/terraces	20	16	25

The AGraph software was used to create justified graphs (j-graph) (Manum et al. 2005). A justified graph depicts the spatial relationships or connections between distinct spaces. A node (=vertex or circle) represents a space, whereas an edge (=line) represents a link between two nodes (Manum et al. 2005). The J-graph denotes the spatial hierarchy of rooms (from public to semi-public to private) along with the step depth from a particular room (in this study: the entrance) and consequently determines the degree of privacy (Mustafa et al. 2010).

Interviews

The researchers conducted face-to-face interviews with 35 residents who have made significant alterations to the inside arrangement of their homes at the Zebdeh-Farkouh housing complex. The primary objective of the interviews was to elucidate the fundamental sociocultural elements that influenced the spatial layout transformation. A thematic network analysis was conducted using the NVivo 12 software (Edhlund and McDougall 2019) to deduce key themes from the participants' comments regarding the sociocultural aspects that influenced their decision to make layout transformations. During the interviews, which were all recorded and transcribed, the participants were first asked some demographic questions, including age, gender, educational level, duration of living in the housing unit, and type of the housing unit. Then, they were asked to explain the reasons that led them to conduct such layout transformation.

The researchers were keen to find rich and significant data patterns regarding the motivating factors for layout transformations. Hence, they resorted to the thematic analysis, which delves into the fundamental and structuring themes of the qualitative data. The analysis started with extracting the interview transcripts, followed by text reduction, exploration, and theme discovery, respectively. NVivo 12 employs the node nomenclature to identify and organize the fundamental themes (denoted by child nodes) and the global themes (denoted by parent nodes)

(Edhlund and McDougall 2019). The NVivo 12 interface uses the term 'sources' to refer to the research material, which in this case is the interview transcripts, and the term 'references' to refer to the total number of coding references associated with a certain node. This allows researchers to determine the number of participants who provided information about a certain theme. A note worth mentioning is that a lack of sources and coding references for a given node implies that the subject is irrelevant to the participants.

Results

Categories of units' transformation

The data analysis revealed that the way residents interact with their environment is reflected in various transformation forms. Moreover, the observations showed a pattern in the transformation forms that acquired the transformed units a set of shared characteristics (Table 1). This could be illustrated through the following examples:

- Each prototype has two balconies which residents of different floors tend to enclose either with a movable or a fixed cover to make it part of the living space or transform it into kitchen storage (e.g., Table 1a).
- Residents of the ground floor deal with their apartments as an independent dwellings by adding exterior and private interior entrances, a garage, and a garden surrounded by fences or walls (e.g., Table 1b–g)
- Balconies at the street level were transformed into private entrances (e.g., Table 1i)
- Enlargements of the ground floor led to other transformations on the upper floor (e.g., Table 1j and k).
- Additions are more frequent on the ground floor than they are on the first floor.
- In the case of the ground floor addition, residents mostly use it as a guest room with a separate entrance (e.g., Table 1b and f).

Each of the transformation forms shown in Fig. 3 took place across various units on all three floors of the public housing buildings. Due to privacy concerns, the researchers were not able to take actual photographs of the transformations from the inside of the housing units. Thus, they resorted to a top view plan of the complex' buildings to illustrate the layout transformations. Five colors were used to indicate the transformation form that occurred on the three prototypes, A, B, and C: green indicates the action of enclosing one balcony; orange indicates the action of enclosing two balconies; blue indicates the action of adding a private entrance; red indicates the



Fig. 3 The transformation categories shown on the top plan of the housing complex

action of expanding the floor area, and yellow indicates the action of expanding the balconies.

The transformations were classified into five categories (Table 2): (1) Enclosing one balcony, (2) Enclosing both balconies, (3) Addition of a private entrance, (4) Enlargement of the floor area, and (5) Enlargement of balconies/terraces. The percentage of each transformation category was calculated in relation to the overall number of transformation cases within each prototype (Table 2) as follows: Covering one balcony was the highest in prototype B (28%), followed by prototypes A (23%) and C (19%), while the percentage of covering both balconies was the highest in prototype A (51%), then prototypes B (27%) and C (20%), the percentage of the addition of a private entrance was the highest in prototype C (22%), then prototypes A and B (16%). Enlargement of floor area and outdoor area were also the highest in prototype C (8% and 25% respectively), followed by prototypes A (6%) and B (2%) for the enlargement of floor area, and prototypes A (20%) and B (16%) for the enlargement of outdoor area.

- Enclosing balconies: Each unit of the three prototypes has two balconies: the first one can be seen from the building's front elevation, and its door opens to the living room, whereas the second one can be seen from the building's back elevation and its door opens to the kitchen. Some residents enclose only one balcony, while others enclose both of the balconies. In most cases, the kitchen balcony was transformed into a storage room due to the small area of the kitchen. On the other hand, the living room balcony was either extended to the living room by removing the internal wall or transformed into a small sitting room.
- Addition of private entrances: It was noticed that the residents of the ground and the first floors added a private entrance to their units. In some cases, entrances were added directly to the original layout without any change, while others added the new entrance after extending the unit's area.
- Enlargement of the floor area: Enlargement of the housing units at prototypes AB and C took place either from the living room side, the kitchen side, or both sides. The residents who extended their unit's area from the living room side (front elevation) have also added a private entrance and a new guest room, while the residents who extended their unit's area from the kitchen side (back elevation) have added new bedrooms.
- Enlargement of balconies/terraces: This kind of enlargement of balconies and terraces was only recorded in prototype C, where residents expanded the area of the existing balconies.

Spatial analysis

Base cases analysis

Since the layouts of prototypes, A and B are identical, they were consolidated and will be described hereafter as a single prototype, dubbed Prototype AB. Table 3 shows the spatial analysis of the two original layouts (AB and C). The mean integration value (INTn) for layout AB was (INTn=1.009), while the mean integration value for layout C was (INTn=0.885), which means that AB's space visibility is higher than that of C. Moreover, as shown by the visual step depth and J-graph analyses, AB and C layouts indicate a comparable spatial hierarchy despite being different in terms of structure and organization of rooms.

Transformed cases analysis

The mean integration values (Fig. 4a) of the various layout transformation forms differ from the mean integration values of the original layouts AB and C. This indicates that the residents of these units were seeking either more or less privacy. Moreover, the mean integration values of most of the transformed layouts (except for layouts AB4 and C5) were less than those of the original layouts: AB (integration p-value=1.009) and C (integration p-value=0.885). Namely, most of the transformation forms reduced the visibility of the internal areas and made them less accessible. On the other hand, the mean integration values of units AB4 (integration p-value=1.066) and C5 (integration p-value=0.903) have exceeded those of the original layouts and the other transformed cases due to the increase of open spaces that are directly connected to the layout's central space.

The Visual Step Depth and the J-graph analyses were used to determine the number of steps required to go from the entryway to the different rooms of the housing unit. As illustrated in Table 3 and Fig. 4b, the visual depth values have increased significantly in the majority of the housing units, indicating a shift in the hierarchical structure of spaces. This shift is associated with the increased number of rooms, expansion of spaces, and changes in the type of connection and circulation between these spaces.

Thus, altering units' spatial layouts led to a change in the visual integration and the visual step depth values relative to the original layouts AB and C, as follows:

- Enclosing balconies: enclosing one or both balconies decreases the mean integration values and increases the visual step depth values, as balcony enclosure increases the number of interior spaces available in the layout. However, since these spaces are not directly connected to the other rooms, their visibility

and accessibility are reduced. In addition, the average values of integration are decreased while the average values of the visual step depth are increased.

- Addition of private entrances: The addition of private entrances from the kitchen side decreased the mean integration values and increased the visual step depth values. In contrast, adding a private entrance

from the side of the living room or the guest room (like layouts AB4 and C5) increased the mean integration values. As shown through the layout analysis, entrances from the kitchen side are private and indirect, i.e., they do not allow direct access to the house's core, which reduces the levels of visibility and accessibility and increases the number of steps required to

Table 3 The spatial analysis for basic and transformed layouts

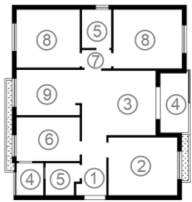
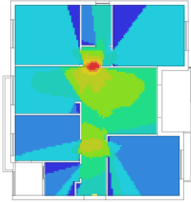

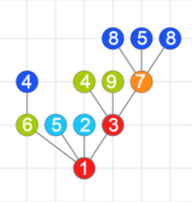
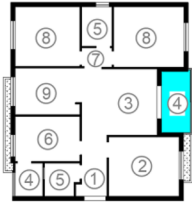
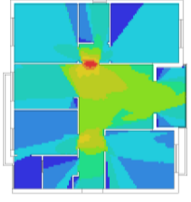

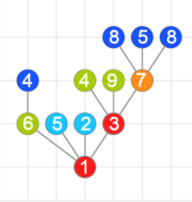
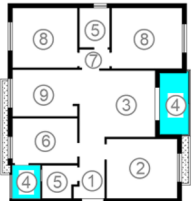
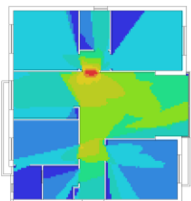

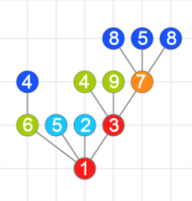

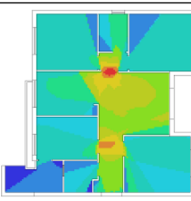

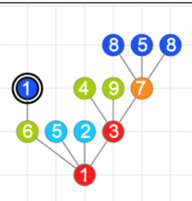
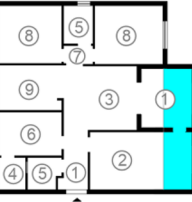
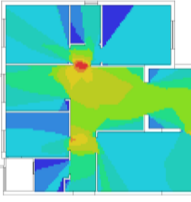

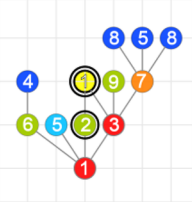
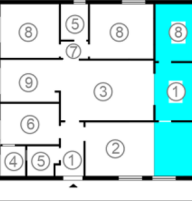
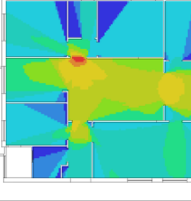
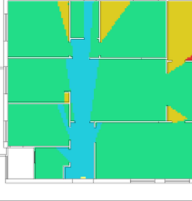
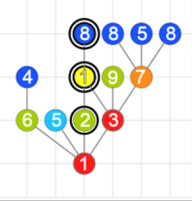
	The unit layout	Visual Integration P-value	Visual Step Depth	J- Graph
Original Unit AB				
Transformed Unit AB1 Covering one balcony				
Transformed Unit AB2 Covering two balconies				
Transformed Unit AB3 Addition of a private entrance				
Transformed Unit AB4 Enlargement from the living room side with the addition of a private entrance				
Transformed Unit AB5 Enlargement from the living room side with the addition of a private entrance				

Table 3 (continued)

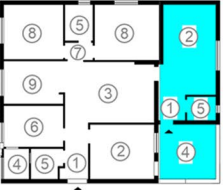
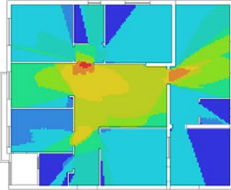
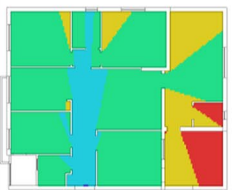
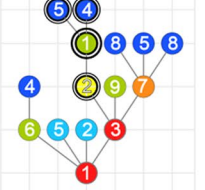

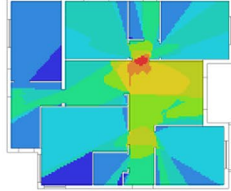
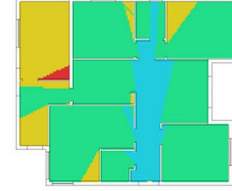
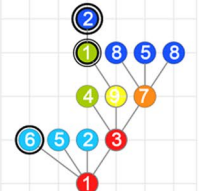
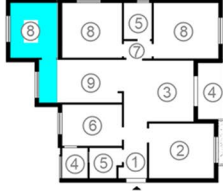
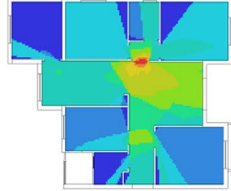

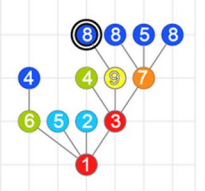
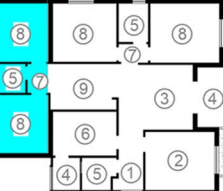
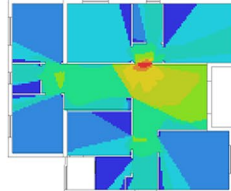
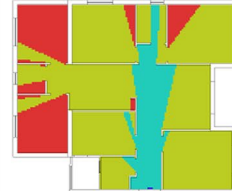
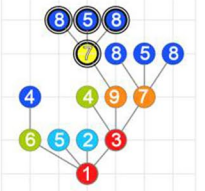

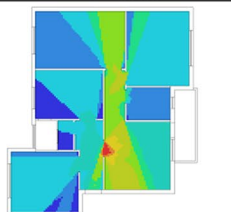

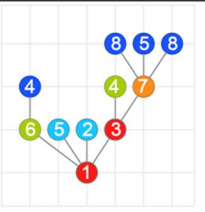

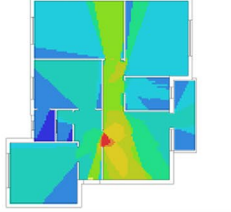

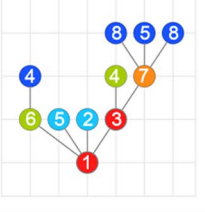
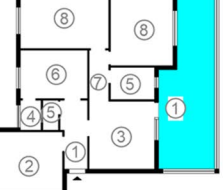
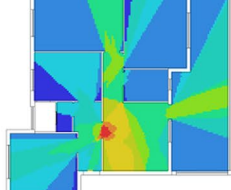

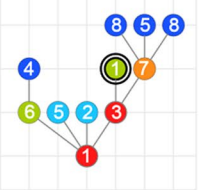
Transformed Unit AB6 Enlargement from the living room side with the addition of a private entrance				
Transformed Unit AB7 Enlargement from kitchen side with the addition of a private entrance				
Transformed Unit AB8 Enlargement from the kitchen side				
Transformed Unit AB9 Enlargement from the kitchen side				
	The unit Layout	Visual Integration P-value	Visual Step Depth	J- Graph
Original Unit C				
Transformed Unit C1 Covering two balconies				
Transformed Unit C2 Enlargement from the living room side				

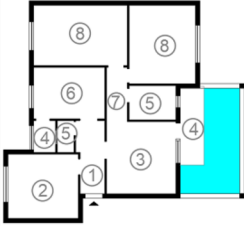
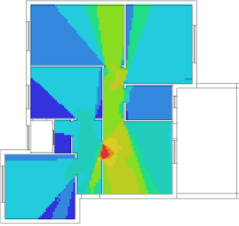
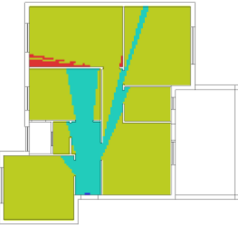
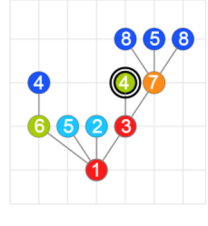
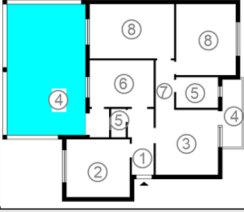
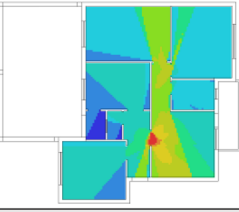


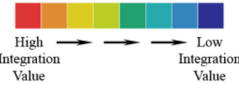
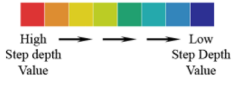
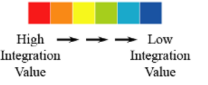
Table 3 (continued)

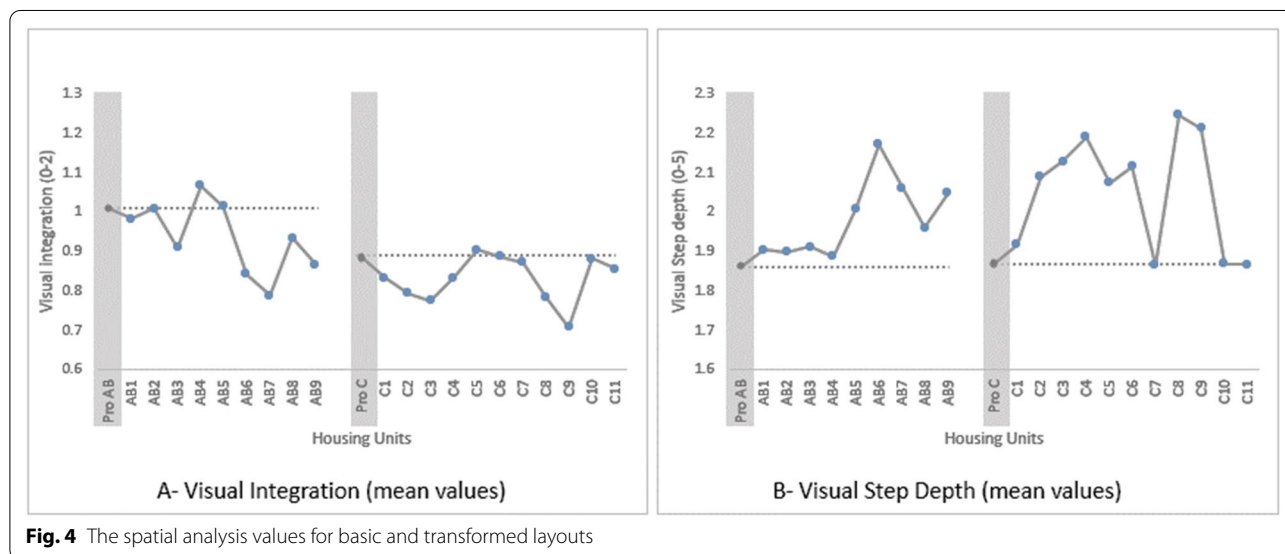
Transformed Unit C3 Enlargement from the living room side			
Transformed Unit C4 Enlargement from the living room side			
Transformed Unit C5 Enlargement from the living room side			
Transformed Unit C6 Enlargement from the living room side			
Transformed Unit C7 Enlargement from the living room side			
Transformed Unit C8 Enlargement from the kitchen side			
Transformed Unit C9 Enlargement from the kitchen side			

reach the layout’s core. Whereas the entrances added from the living room side (like the case of layouts

AB4 and C5) lead directly to the layout’s center (living room), which improves the integration values.

Table 3 (continued)

Transformed Unit C10 Enlargement of balconies/ terraces				
Transformed Unit C11 Enlargement of balconies/ terraces				
Notes				
1- Entry Hall 2- Guest Room 3- Living Room 4- Balcony 5- W.C	6- Kitchen 7- Corridor 8- Bedroom 9- Dinning 10- Storage			

**Fig. 4** The spatial analysis values for basic and transformed layouts

- Enlargement of the floor area: Enlargement of spaces either from the living room side or from the kitchen side decreased the mean integration values and increased the visual step depth values of the layouts. However, the mean integration values of the living room enlargements have higher integration values than that of the kitchen side enlargements. Expansion of spaces often includes the addition of new rooms, which increases the number of interior spaces. Internal partitioning isolates the spaces and shifts the spaces' center to the corridors or the areas that connect rooms (often small), leading to a decrease in the average integration and visibility values of the layout as a whole.
- Enlargement of balconies/terraces: Enlargement of balconies and terraces decreased the mean integration values. However, it did not affect the visible step depth values. The study considered balconies as exterior areas; hence, they were excluded from the VGA and step depth analyses. However, balconies enlargement turned the existing balconies into entry halls

that do not lead directly to the layout's core; therefore, the average integration values decreased.

Interviews results

Thirty-five residents were interviewed. Males comprised 36% of them, while females made up 64%. All the participants were over the age of 28. They all have a university degree. 36% of them have lived in the housing complex for 5 to 10 years, 55% for more than 11 years, and just 9% for less than 5 years. 33% were from A-units, 18% from B-units, and 49% from C-units.

The thematic network analysis of the interviews revealed three prominent themes (Fig. 5) which constitute significant sociocultural factors affecting homes' internal layout: (1) privacy, (2) values and cultural beliefs, and (3) safety. The content analysis conducted via NVivo 12 software determined the number of participants who shared information reflecting a particular theme as follows: privacy was mentioned by 29 participants with 31 coding references. Values and cultural beliefs were extracted from 22 sources and 29 coding references, and safety appeared in 19 sources and 22 coding references.

Being layered hierarchically, privacy is translated into hierarchical physical levels reflected through the housing's designs (Al Husban et al. 2021; Hasan et al. 2021; Namazian and Mehdipour 2013). Based on the information extracted from the interviews, families attempted to establish privacy through various transformation forms that go in line with the community's conservative norms, traditions, and values. In other words, the majority of the modifications were conducted to maintain three main privacy-related issues, including gender segregation,

safeguarding women's privacy, and security. For instance, some modifications were made to provide separate rooms for male and female children, as shown through the statements of participants R01 and R04.

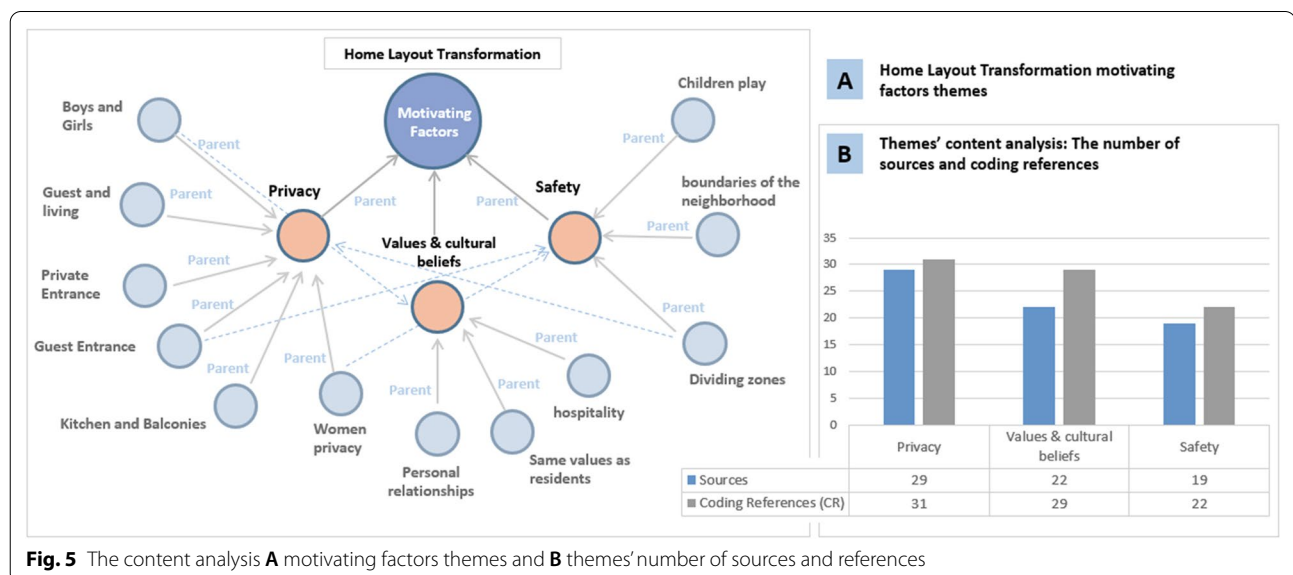
R01: "In order to address some privacy concerns related to our values and beliefs, it was necessary to separate the boys' bedrooms from the girls'. So, we wanted to expand our apartment to three bedrooms. I believe that house design should take family structure into account"

R04: "In our houses, boys' and girls' bedrooms, as well as women's and men's areas, must be separated. As a result, we have made many adjustments and additions over time to achieve the desired level of comfort"

Similarly, the residents' comments pointed out that they had concerns regarding the privacy of the family's women, which also stems from the community's conservative traditions and beliefs. Thus, they resorted to several transformation forms to address this issue. For instance, participants R02, R011, and R23 conducted layout transformations in order to create a designated women's area.

R02, R011, R23: "Women's Privacy must be addressed while designing a dwelling." In accordance with our cultural beliefs, gathering venues should be segregated for all female family members and relatives. Similarly, ladies are not permitted to socialize with male visitors. As a result, a dedicated guest room has been created to serve this purpose"

Additionally, issues associated with security and hospitality have influenced the layout transformation of the



dwellings. Residents' comments suggested that improvements were made to accommodate such needs, including providing a separate entrance for guests to maintain the residents' privacy. This was made quite evident in the remarks made by participants R06, R16, R20, and R31.

R06: "It is essential to demonstrate appropriate hospitality to our families, neighbors, and visitors in accordance with Jordanian cultural and social norms. Thus, we expanded the guest room and provided it with a private entrance and a separate bathroom".

R16: "We decided to expand the entry area in order to create a larger transition zone between the guest room and the other house areas, which will give our guests and us more privacy".

R20: "Because I live on the ground level apartment at the front elevation, I made certain improvements to make my house more distinctive on the one hand and to get more privacy on the other, such as expanding the living room and adding a private entrance".

R31: "For safety considerations, we tended to enclose balconies. Their areas were subsequently integrated into the interiors of the residences".

Discussions

The study highlighted the role privacy plays as a sociocultural factor that motivates spatial layout transformation. This role was examined in the context of the Zebdeh-Farkouh housing complex, one of HUDC's public housing projects in Irbid, Jordan.

The primary influence of culture on the design of housing units was highlighted by Rapoport (2000) culture-environment studies. Moreover, scholars have discussed the negative impact of neglecting sociocultural aspects in designing the internal layout of houses (Malkawi et al. 2008; Mohit and Azim 2012; Sweis et al. 2013). Since cultural issues can only be understood through social observations, then sociocultural factors can also be studied through either direct or indirect observations. Accordingly, this study aimed to investigate the role privacy plays as a sociocultural factor that motivates spatial layout transformations.

To fulfill the purpose of the study, the researchers followed a qualitative and a quantitative approach to data analysis. The qualitative analysis included the A-Graph analysis and the Visibility Graph Analysis (VGA) employed to assess the spatial configuration of both the original and the modified version of each unit's layout in terms of visibility, accessibility, hierarchical structure, and the spatial organization of interior spaces, as well as the thematic network analysis conducted using the

NVivo 12 software to deduce key themes from the participants' comments regarding the sociocultural aspects that influenced their decision to make layout transformations. The qualitative approach included personally analyzing the comments provided by the residents through the interviews. The integration of these two approaches helped the researchers provide a better explanation of the role privacy plays as a sociocultural factor that motivates spatial layout transformation, especially within conservative communities.

This study has emphasized that privacy is a significant sociocultural factor that highly affects people's daily lives. It also revealed that privacy influences the architectural aspects governing the way residents interact with their surrounding environment. This goes in line with Al-Homoud (2009), who stated that privacy is one of the most important requirements of the Jordanian community. The use of space and the way privacy is adjusted are two notable ways cultures differ worldwide (Bahammam 2004; Rapoport 1969).

The research revealed that the spatial layouts of HUDC's public housing units do not fulfill the residents' privacy needs, leading them to change the spatial layout design of their housing units. Additionally, the study emphasized that the spatial arrangements of dwellings evolve over time in response to the changes in behavioral patterns. Several sociocultural factors appeared to influence the residents' decision to conduct such transformations. However, privacy was the most significant of all. The big influence of privacy was reflected in the transformed units' internal design.

The results of the space syntax analysis of the new layouts (transformed cases) showed that residents alter their houses' spatial layouts due to their desire to have more or less privacy in different spaces. Thus, privacy needs to be considered a fundamental factor in designing public housing units. This requires a higher level of flexibility in designing houses' layouts to suit the differences between individuals and accommodate for the changes residents might go through overtime.

Conclusion

Architectural artifacts are a reflection of people's lifestyles, values, and beliefs (Al-Homoud et al. 2003; Mahmud et al. 2012). Recognizing and comprehending users' needs is a critical first step in delivering functional and successful (lived) spaces. Numerous studies have shown that housing units created following a one-size-fits-all design approach result in dwelling environments that fail to fulfill residents' needs over time (Agyefi-Mensah et al. 2020; Al-Betawi et al. 2020; Howell et al. 2019). This can be viewed clearly in residential units in general and public housing units in particular. Given the

limitations associated with public housing design, this study used residential transformations as means to better understand residents' spatial needs. The investigation of Zebdeh-Farkouh public housing units revealed that residents had conducted various spatial layout transformation forms ranging from minor changes such as enclosing balconies to major changes like expanding or / and adding new space(s) to achieve different functional and occupancy related objectives. Those alteration practices signal the designs' failure to accommodate residents' needs, especially those associated with the sociocultural features of the Jordanian community. This study revealed that residents carried out various modifications over time involving enclosing one balcony, enclosing both balconies, addition of a private entrance, enlargement of floor area, and enlargement of balconies and terraces. Accordingly, transformed units are an outcome of spatial behaviors and human requirements.

The research was supported by the Visibility Graph Analysis (VGA) and J-Graph analyses of the original and the transformed layouts to evaluate the level of visibility, accessibility, and privacy provided by each layout. The data analysis revealed that the different transformation forms created a hierarchical system that echoes several established sociocultural traditions in Jordanian society. Moreover, the integration values of all the transformed cases have decreased, while the visual step depth values have increased, asserting that privacy is a significant motivational factor of home layout configuration. Accordingly, spatial layout transformation does not only take place due to functional reasons but also to accommodate various sociocultural factors.

In conclusion, this research underlines the crucial need to integrate sociocultural and functional aspects in the designing process of public housing projects. Moreover, designers should embed higher levels of flexibility in the masterplans and the spatial configuration of public housing units which could take place at several levels: (a) A flexible plan provides an opportunity to customize the layout based on residents' needs (Elkady et al. 2018); (b) Space volume (e.g., sliding walls) provides a variety of spatial alterations that residents can determine based on the situation (Raviz et al. 2015); and (c) Furniture (e.g., foldable furniture) that supports several functions (De Paris and Lopes 2018). With residents' satisfaction and spatial flexibility in mind, designers should identify and engage concerned stakeholders during the initial stages of planning and design of public housing projects, which would enhance the quality of public housing and increase residents' satisfaction. Moreover, developing a set of guidelines that govern the design of public housing projects will positively impact the architectural identity of these

projects and promote their potential to accommodate their resident's needs. There are various sociocultural aspects that should be taken into consideration while setting out these guidelines, and since such sociocultural aspects differ among countries and communities, similar studies should be conducted worldwide to elicit personalized guidelines that suit the various needs of each community.

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Author contributions

The authors have jointly written the manuscript in all parts. All authors read and approved the final manuscript.

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Declarations

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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