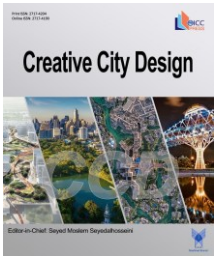

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Research Article

The Role of Environmental Elements of Residential Houses in Reducing Energy Consumption in Cold and Mountainous Climates Comparison of Designers and Users

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Abstract

Aims: Residential buildings consist of various environmental and physical-spatial elements that influence heat transfer, energy efficiency, and occupants' spatial comfort. This study aims to identify and evaluate the key environmental components from the viewpoints of both designers and users, in order to propose effective strategies for reducing energy consumption in residential housing especially under cold and mountainous climatic conditions [1, 2].

Methodology: A mixed-method research design was employed. First, a systematic literature review was carried out, followed by semi-structured interviews with 46 experts to extract primary environmental components. The qualitative data were coded using ATLAS.ti. Then, in the quantitative phase, a Likert-scale questionnaire was circulated among 384 participants (designers and users), and responses were analyzed using inferential statistical methods in ORIGINPRO.

Findings: The analysis demonstrates that among designers, the highest contributing factors in reducing energy consumption are "continuity in the use of materials" and "false ceilings," whereas "ceiling (internal slab)" has the lowest weight. Among users, "continuity in material use" also ranks highest, and "plaster coating" ranks lowest. These differences highlight a divergence in priorities between designers and users.

Conclusion: Environmental components strongly influence energy behaviour in residential buildings. Continuity in material application emerges as the most influential variable across both groups. The findings underline the importance of integrating residents' perceptions with technical and thermal design strategies to optimize energy efficiency in housing. Future research should consider applying building performance simulations to validate the proposed components' effectiveness.

Keywords: Residential environmental components; Energy consumption reduction; Designers; Users; Thermal performance

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1. Introduction

Housing has occupied the human mind since the beginning and is still a problem. At least a third of the hours of the day and night for every person, even working people, are spent at home, and man is more connected with the house than any architectural building from the beginning to the end of his life. It is necessary to establish climatic comfort in the form of a residential unit. In any case, the unorganized situation of housing, valorization of anti-values, inattention to energy and sustainability issues, etc., among the issues raised in the field of house architecture, seem to prepare the ground for presenting research and reports in this category. But among these problems, the issues related to energy consumption are felt to be the most serious and critical due to the threat to life on earth. This is even though considering the amount of energy consumption in residential contexts the reduction of non-renewable resources and the population crisis, the use of renewable and clean energy, and harmonizing the environment with climatic conditions can be effective in reducing energy consumption in residential contexts. In this regard, considering the importance of the housing issue and the importance of optimizing energy consumption in the building, the topic went in the direction of how to realize the issue of energy consumption optimization in the housing issue [3]. Nowadays, the importance and necessity of reducing the consumption of non-renewable energies is no longer hidden from anyone, and this is because the world has undergone changes and transformations in recent centuries. On the other hand, the beginning of the industrial period, native architecture based on local materials and facilities ended, and modern architecture with a global style and making similar buildings in all parts of the world began to destroy the identity of native architecture [4]. The flow of cheap energy from the colonies to European countries also aggravated the lack of attention to the energy issue. On the other hand, the industry, with the facilities and equipment it created by consuming fossil fuel, provided comfort for humans in every climate from the Arabian desert to the polar regions and caused the dependence on fossil fuel to expand day by day. By providing the possibility of integrated heating in the buildings, the central heating system destroyed the importance of saving and wearing warm clothes and using a chair became history. It continued until the gradual increase in energy consumption caused the high cost of energy and, most importantly, environmental pollution, a crisis that endangered human life on earth. Since buildings account for 50% of the world's energy consumption and about 50% to 60% of this amount will be spent on heating and cooling the building, that is, 25% of the total energy consumption is allocated to heating and cooling, and on the other hand, the life of buildings is between the considered 50 to 100 years means that today's architecture will remain for a long time, and today's standards will show their effect during this period. Thinking about solutions to solve the energy crisis caused by buildings is considered a necessary process. Based on the difference in the views of designers and users in the design of residential buildings, causes a difference in the decision to use different materials or elements. This research aims to extract environmental elements and investigate the extent of each of these differences, seeking to know the differences in the views of designers and users to reduce energy consumption in the environmental elements of residential houses and tries to answer the question of what are the environmental elements of residential houses and from the perspective of designers and users, how effective are they in reducing energy consumption?

2. Theoretical foundations

2.1. The concept of residence and home

What allows us to live in real life is the poetic spirit. The poetic spirit has not flown over the earth and taken it under its wings. This spirit is the one that brings a person around the surface of the earth, urges him to belong to it, and guides him to live there. It can be said that home is a place where everyday life takes place. Daily life represents something that has maintained its continuity in our existence and therefore supports us like familiar support [5]. By appearing as architectural figures in the environment, the house establishes our identity and gives us security, and finally, when we step into the house, we achieve "comfort". As a private space, the residential house is the main reference of a person, it is the center of personal experience and it is the place from where a person starts his movement and returns to it. Residence does not only mean spending time in one place but also feeling at home. However, nowadays this matter does not seem as clear as it should be due to the constant change of housing. The house in which man was born, grew and finally died was man's original place from beginning to end. Among many nations, it has been a custom to bury a flower model of the house along with the corpses to maintain continuity. In many parts of the world today, this custom is somewhat common [6]. The house brings us the inner being and puts the need to stay in front of us. The house is formed as a center for human existence, that is, the place where the child learns and finds his existence. It is found in the world and it can be said that it is a place from where mankind has left and will return to again and again. The house serves man in two ways: to give him a shelter where he can feel comfort andlive in peace, and the other is to act as a turning

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point in his activities in this world. These two "functions" are necessary and necessary for each other; Only when the house creates a sense of belonging and safety, does a person get the inner strength he needs to move. In this open world, the last function must be a prominent function, and thus the modern house reveals the surrounding environment and interactions and reactions [7].

2.2. Desirable house

Improper accommodation of humans should be considered the real and root cause of contemporary social unrest. "The main task of every house is to reveal the world not in the form of gems and extracts, but in the form of a "call", that is, in the form of color, placement, and plants. The seasons, the weather, and the light. This is the result of exposure to two complementary methods, the help of being open to the surrounding world, and the help of offering a corner for seclusion from the said world, anyway, this corner of seclusion is a place where the outside world is not forgotten, but it is a place where a person gathers his memories of the world and relates them to his daily life, sleep, conversation, and entertainment [8]. In the second human settlement summit held in Istanbul in 1996; Adequate housing is defined as follows: Adequate shelter does not only mean the presence of a roof over each person's head, Adequate shelter means appropriate comfort, appropriate space, physical access, and appropriate security, property security, structural stability and durability, lighting, ventilation, and proper heating system of the infrastructure. First, suitable environmental quality, and suitable health factors, all of which should be provided according to people's ability [9]. Siegfried Gideon briefly expresses the main axis of modernism in this sentence. We want to be free; this desire is the center of gravity of his discussion in the book entitled Living Freely which he published in 1927. He writes: It is a beautiful house that fulfills the needs of our life, like the light of the air, the space of movement and openness [10].
In housing design, privacy, and social interaction are two mutually exclusive concepts, excessive emphasis on privacy can cause isolation and out-of-control interaction can cause the loss of private life privacy. Providing privacy by controlling visual and sound disturbances is a necessary but insufficient measure. In addition to the general concept of solitude, which exists to some extent in all cultures, the jurisprudential concepts of privacy also add limitations to the previous ones in our culture. Aristocracy and noise pollution, which are important points, are design limitations to some extent in other cultures [11]. The importance of the house is that it can potentially bring happiness or a serious threat to our lives. The home is a rich set of evolving demographics and psychological cultural meanings that we attach to the physical structure. Therefore, contrary to what is suggested by the advertisements of real estate agencies, you cannot buy a house, you can buy or rent a shelter and with some luck, time, and effort, turn it into a house [12]. The most important thing to consider is the human being. Housing should respond to the material and spiritual needs of human beings in an appropriate way. Home is a shelter that surrounds us with privacy, security, safety, and protection against the hardships of life outside, so it should be a home that can be called our own. If one stands in front of this house, one should realize that it creates a connection between one's private world and the public environment [13].
The house helps us find our position in the world, it is the center from which we find courage, we explore and it is the way we organize our life in this world, so it should have a suitable location, and visually and content-wise, it should be the factor of community unity. As social beings, the home gives us a sense of kinship or solidarity, ethnic affiliation, and socio-economic status. Therefore, housing is an important part of our identity. Through personalization and introspection, the house resembles our identity and presents us [14]. Through order and identity, home means solidarity. Spatial patterns and terrestrial order help us to feel solidarity with certain people as well as place, past, and future. Kashan is heat. The heat takes a flame from the heart of the mentioned qualities, but it goes beyond.
This heat is like the heat of a wall heater, but symbolic and between people. The house should be physically suitable since the family members have relationships with themselves and the outside world, they need suitable spaces for individual and collective activities, for which housing is the answer. A suitable place offers humans the possibility of communicating with nature and thinking and rationalizing it [15]. If we are fortunate enough to have a place that provides us with shelter, order, identity, solidarity, warmth, and physical fitness, then we are more likely to experience belonging, joy, personal expression, and good communication in Kashan. If the settlements do not have these characteristics, we are without a house, even if we have settled in a place. This is the true nature of a house. It is a place of peace, a shelter not only from violence, but from fear, doubt, and separation. Otherwise, it is not a house. Rather, it is only a part of the outside world that you have put a roof over [16].
It can be concluded that the desired housing is a suitable solitude for the residents of the house and this solitude gives them security and safety, privacy and peace. Proper housing brings social relations and provides the possibility of communication with nature, this forgotten need for humans.

2.3. Spaces of residential houses

In relation to human needs, Le Corbusier considers the house as a cover that, in accordance with some conditions, establishes a correct relationship between the external environment and human biological phenomena. A person must live in the house. It means to sleep, walk, lie down, see, and think. Whether he is motionless or moving, he needs adequate space, the height should be proportional to his movement [17]. Some of the furniture and household items are like the continuation of human organs and in relation to their duties. On the other hand, in order for man not to waste, some of the biological necessities that have been imposed on him by the thousand-year habits of man and have slowly become a part of his nature, need very specific elements and conditions, such as sunshine, space and green space, and so on. His lungs need the right air, his corner needs enough silence, and his eyes need the right light [18]. It seems that for Le Corbusier, functions of man such as thinking and proportioning height with human movement and paying close attention to thousand-year-old habits of man in the spaces of the house are an emphasis on the two physical and spiritual aspects of man, which should be answered by the spatial organization of the house. In a proposed and popular book plan about the house and its necessities, he considers human needs as equivalent to creating the most suitable mental and physical conditions, and he pays great attention to specifying the various appendices of the house for different ages, special social activities, individual mood, and so on [19]. Therefore, in order to understand the balance between a person's needs and the spaces he needs, we should investigate the most important spaces of the house: the house consists of closed internal spaces and external open spaces and the spaces between them. Thus, it has two very important and different components: internal spaces and external spaces [20].

2.4. Closed spaces

The purpose of architecture is to create an internal space because it separates a part of the environment as a special space from the larger environment. The severity and weakness of this separation depend on the type of openings. What is called inside here is the spaces that are preserved with a barrier in order to be safe from the changing weather conditions outside. Familiar closed spaces in a house or residential apartment usually consist of an entrance and living room or reception and dining room and bedroom and services and kitchen [21].

Entrance The placement of the entrance threshold to the house varies in different cultures, perhaps because the placement against the outside world is symbolic of how people relate to other members of society. In the composition of a Muslim's house, the entrance threshold is placed with more emphasis and consideration and with some distance from the house, and it indicates the ultimate limit of privacy of the people of the house, especially women, in relation to strangers and neighbors [22].

The entrances of traditional houses are important and independent spaces that provide the possibility of necessary pauses, negotiations, and quick meetings. Those who enter are guided to different spaces according to their relationship with the family, the spaces of the house are not known and are revealed gradually. But in today's architecture, the organization of the entrance space does not make a special suggestion for movement inside the house, and there is no sense of a private space distinct from the public space, and this space generally interferes with the living room, hall, and even the kitchen. It is very limited in space and spatial composition and there is no clear direction [23]. Room: Today, with the invasion of Western architecture, western functions have entered directly into Iranian architecture, and titles such as dining rooms, bedrooms, etc. have been created. Alexander mentions subtle points of openness in the room and sees the connection with the outside of the window as if you are in a room for a while, you might want to sit and relax. In a room where there is at least one window that is considered as space, such as a platform next to the window, a window sitting outside, a window with a short and wide threshold from which you can easily look outside, so that it motivates you to move your desired chair and look out of the window or A small, all-glass opening in such a room, you can release both forces, you can resolve that conflict in your favor [24]. In short, you can be comfortable. But a room that has no windows and its windows are nothing more than holes creates an internal contradiction in me that I cannot resolve. If the windows are just holes in the wall and there is no space where the windows are, one force will push me towards the window and another force will push me towards the more natural spaces of the room where the table and comfortable chairs are. As long as I am in this room, I am in a conflict between these two forces, and I cannot do anything to prevent the conflict that arises within me due to these forces in traditional Iranian architecture, rooms are designed without a specific use [25]. With the possibility of converting into larger spaces using sliding doors, it was reminiscent of a flexible architecture, and by considering daily needs as well as weather changes in different seasons of the year, it created the possibility of creating various uses. With the arrival of chairs and tables in the traditional Iranian room, it found another identity and became more stable [26]. The bedroom, which was not a specific room in a traditional Iranian house, found a new identity with the arrival of the bed and found a special place

in the division of the house. The dining room also appeared next to the reception or living room. Since it was difficult to transport furniture and imported furniture today, and their weight and volume did not allow for storage and change of location, the living room with its furniture became a fixed place. Currently, the living room is located in an area that is usually in the view of guests, and therefore its condition should be worthy of this role. Therefore, the living room is expected to reflect the conscious and unconscious individual efforts to express the collective identity of the family more than other parts of the house [27]. Alexander says: If you stay in the living room for a while, several factors affect you, including that you like to go towards the light. Humans are inclined towards light according to their biological structure, as they usually like to be in a place where there is light [28]. Kitchen: In traditional Iranian houses, the kitchen was generally located away from the main part in a corner of the yard. The kitchen was usually a not very clean and dark cellar with straw walls, dirt floors, and beam and clay roofs. The woman of the house did the daily cooking on one or two stoves. The food prepared in this kitchen was often exposed to soot or dust [11]. With the return of foreign-educated architects and their modern designs, the traditional kitchen gradually fell from prosperity. In the new image presented by modernist architects, the kitchen also found a special place. According to them, the space of old kitchens should be replaced by sanitary and functional spaces. Le Corbusier, the famous French architect, says that the kitchen should be as clean as a modern laboratory and equipped with the latest inventions [29]. There was no bathroom or toilet space in European houses, and although the number of these houses was still few in 1920, having a bathroom in a residential space was not considered modern. What made the bathroom a part of modern European spatial design was the idea of the centrality of this space and its connection with the bedroom [3]. German architect Adolph Schenck (in 1927) says in this regard that in a modern house next to the bedrooms, even if it is not more than 70 square meters, there should be a space for residents to breathe, I do not mean a bathroom that is only used on weekends and a crypt without There should be air and light and it should be used as a storage room during the week [6]. At this time in Europe, toilets were moved from public corridors to private residential spaces and were moved to private residential spaces and were presented with a new definition of completely hygienic toilets [4].
Although Iranians cared about their body hygiene due to religious teachings, they usually did not have a place called a bathroom at home. The residents of these houses used the pit ponds in the yard as a bathroom in the summer. Bathrooms in Iran were usually separate public buildings, and the toilets were small and dark places without stone work with tiles and were completely unsanitary, and they were placed in a corner of the house yard. In Iran, for the first time, sanitary ideas were widely proposed since the twenties, and European plans with tiled bathrooms and toilets were used inside the building [30].

3. Research methodology

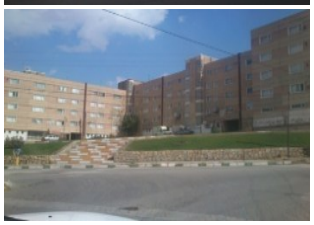
In this research, due to the difference between the components of the theoretical field and the measurement range, it is necessary to refine a variable based on the selected range. Based on this, the research method is a combination of nested type and qualitative in quantitative (qualitative < quantitative). First, the concepts based on the theoretical fields related to the introduction of the ideal housing house and the structural components of each space are extracted with a systematic review system, and the qualitative phase begins. Semi-structured interview questions, definitions, and concepts are compiled and provided to academic experts. The questions are based on extracting the components related to each of the elements of the mentioned buildings related to the target area. The interviews are entered into the ATLASTI software and begin to be labeled with a coding system based on description and interpretation. The results are presented in the form of a conceptual spider diagram in the form of introducing the components. The stage of data reduction is based on open and axial coding and by relating categories. In this stage, the sample size selected from the statistical community of experts is 31 people who were selected by the snowball system, and the results reach saturation from the 24th person onwards. The sampling method is snowball. In the next step, the quantitative approach begins. The components are placed in the form of a questionnaire with a Likert scale. The space is distributed randomly among the users. The sample size is selected based on the highest value of the Morgan table. The results are entered into JMPSAS software and analyzed with inferential statistics. For this stage, analyses involving causal relationships, such as regression and correlation, and corresponding pre-tests are chosen. The validity of the questionnaire was obtained with the CVR formula for 21 experts, whose value was 0.749, and Cronbach's alpha was calculated for reliability, which was 0.831.

4. Study area

4.1. Case study examples

To verify and narrow down the studies in the quantitative part of this research, eight residential complexes in Hamadan were selected from those analyzed in the first stage.

Table 1. Introducing the characteristics of the samples

Name and year of construction of buildings	Location	Typology of the open space of the studied residential complexes	Number of floors	Kendall coefficient	Figures
Saidieh complex in the 70s	Uptown	scattered-stripe	6 and 10 floors	0.711	
Kashani complex The 50s	Citty center	scattered-stripe	4 floors	0.596	
Fardis complex the 70's	Satellite towns	scattered-stripe	4 floors	0.710	
Imam Reza Complex the 70's	edge of the city	Focused-introverted	4 floors	0.474	
Boali residential complex The 80s	edge of the city	Focused-introverted	4 floors	0.218	
Imam Khomeini residential complex the 70's	edge of the city	scattered	4 floors	0.619	
Ahrar residential complex the 70's	Satellite towns	stripe	4 floors	0.228	
The residential complex Gadimiha 60s and 70s	Satellite towns	scattered	4 floors	0.517	

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These complexes were chosen to represent the statistical population and to address the research questions by examining the scope of the study. Only the characteristics of the selected residential complexes are discussed, as shown in Table 1. It should be noted that the selection was carried out by the Delphi committee through three phases: brainstorming, narrowing, and final selection. Ultimately, a Kendall coefficient above 0.5 was used as the criterion for inclusion in the research review. Among the introduced samples, some of them have been removed due to the low Kendall coefficient.

5. Findings

5.1. Qualitative findings

In this section, qualitative findings are presented. The interviews reached theoretical saturation from the 24th participant onward, with data repetition observed thereafter. Open coding was conducted based on description and interpretation using a live (BIO) approach. Immediately after data collection, the information was imported into ATLAS.ti software and coded using a letter-based coding system. The most prominent code, with 19 occurrences, pertained to the connection of materials, while the roof component, with 8 occurrences, was the least prominent.

The questions, designed to extract environmental elements of residential houses in cold and mountainous climates, proved effective in identifying strategies for reducing energy consumption.

The components obtained from the semi-structured interviews are presented, as shown in Figure 1. In the subsequent step, a Likert-scale question was posed to assess the degree of influence of each variable on energy consumption reduction.

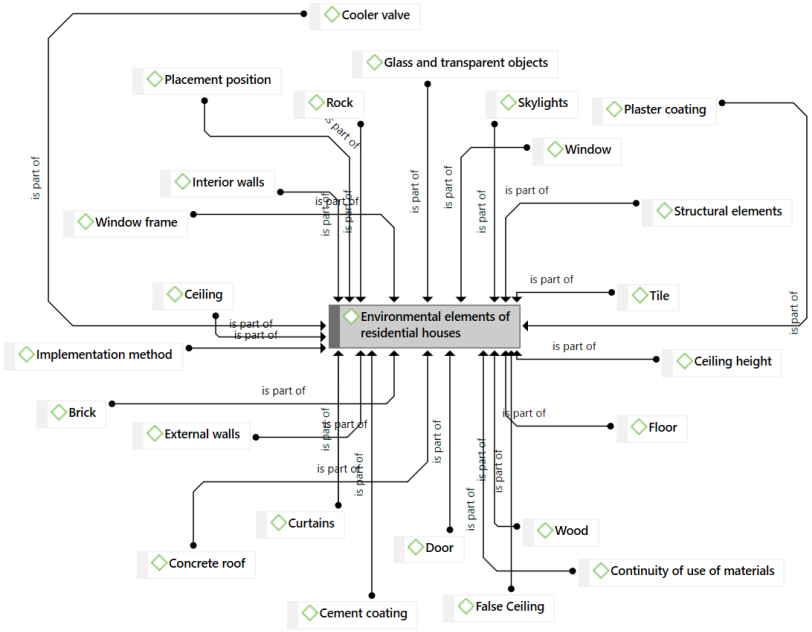

Figure 1. Components obtained from semi-structured interviews

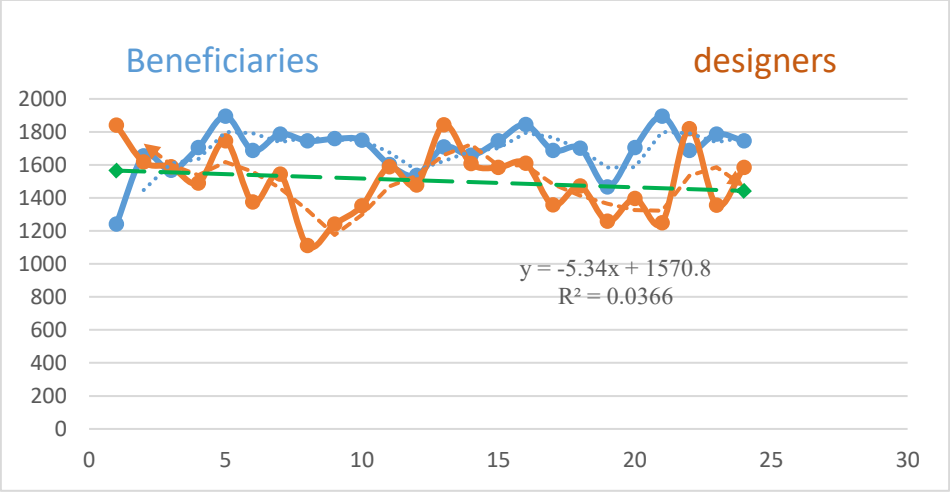

Figure 2. Data distribution diagram and frequency difference in different groups of users and designers

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5.2. Quantitative findings

5.2.1. *Descriptive statistics*

In this section, it was observed that 41% of the participants were female and 59% were male. The highest number of participants belonged to the 20–30 age group, while the lowest was in the 60 and above age group. The abundance of responses varied across the beneficiary groups, showing differences in both magnitude and extremity. The support of the moving average of the data distribution indicates the accuracy of the measurements, and based on the distribution method, predictive analysis is possible using a curve-fitting line.

Table 2. Kolmogorov Smirnov test to check the normality of variables of environmental elements of residential houses

Variable	Average	The standard deviation	Z Kolmogorov Smirnov	p
Environmental elements of residential houses	41.25	5.28	0.893	0.305

Table 3. Correlation of environmental elements of residential houses in reducing energy consumption

	Designers		Users	
Components	The correlation coefficient	meaningfulness	The correlation coefficient	meaningfulness
Brick	0.662	0.001	0.662	0.005
Tile	0.406	0.007	0.406	0.004
Rock	0.355	0.006	0.355	0.004
Floor	0.646	0.006	0.646	0.008
Ceiling	0.262	0.004	0.262	0.009
Plaster coating	0.735	0.002	0.735	0.006
Wood	0.881	0.004	0.881	0.002
Door	0.843	0.008	0.843	0.003
Window	0.882	0.007	0.482	0.001
Window frame	0.274	0.001	0.174	0.001
Structural elements	0.374	0.009	0.374	0.004
False Ceiling	0.971	0.003	0.662	0.005
Cooler valve	0.421	0.004	0.406	0.006
Curtains	0.146	0.002	0.355	0.007
Interior walls	0.821	0.003	0.646	0.002
External walls	0.285	0.008	0.262	0.005
Cement coating	0.675	0.005	0.735	0.004
Concrete roof	0.754	0.001	0.881	0.004
Implementation method	0.662	0.007	0.843	0.008
Continuity of use of materials	0.962	0.001	0.982	0.009
Skylights	0.406	0.007	0.274	0.006
Ceiling height	0.355	0.006	0.374	0.006
Placement position	0.646	0.006	0.662	0.005
Glass and transparent objects	0.262	0.004	0.406	0.004

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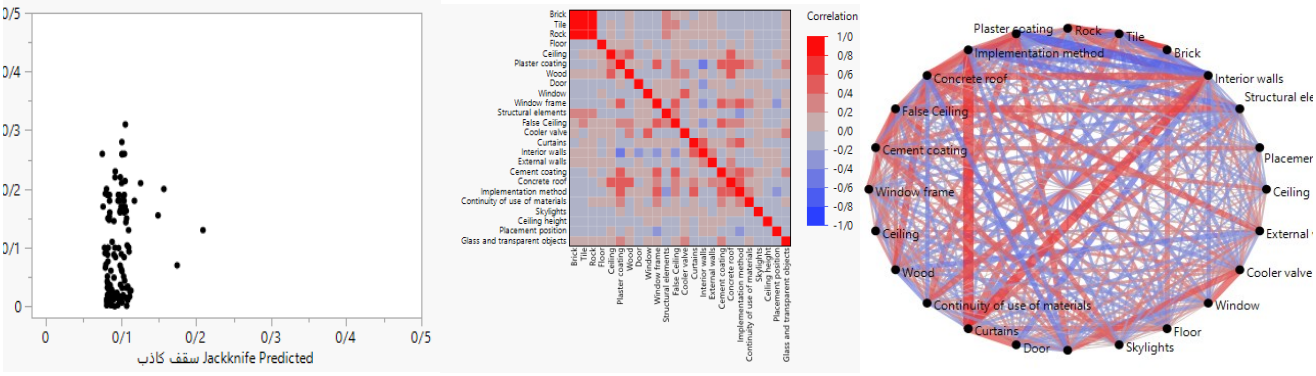
Figure 3. Pairwise correlation of the components of the environment elements of residential houses



The results show that, among designers, the highest frequency was associated with air conditioner valves (1842), while the lowest was related to doors (1110). Among users, the roof had the highest frequency (1895), whereas brick showed the lowest frequency (1241), as illustrated in Figure 2.

5.2.2. *Inferential statistics*

Two-Sample Kolmogorov-Smirnov Test is used to check the parametric and non-parametric type of data. As can be seen in the table above (Table 2), the Kolmogorov-Smirnov test is not significant (p=0.305), and therefore environmental elements of residential houses are not normally distributed, and non-parametric analysis can be used for them.

Based on the results of data correlation, it is clear that the highest correlation in the group of designers is related to false ceiling with a value of (0.971), and the lowest is related to curtains with a value of (0.146).

In the group of users, the most related to the continuity of the use of materials with the value (0.982), and the window frame with the value (0.174) is the least. Based on the findings obtained from the paired correlation between the variables of environmental elements in residential houses, it is clear that the false ceiling variable in both groups shows the highest reduction in energy consumption in residential houses located in cold and mountainous climates.

In addition, the most positive and statistically significant node is observed in the false ceiling component.

To select the type of regression, a pre-test of the correlation matrix was conducted, where the data distribution was alternately changed in pairs along the X and Y axes.

The results show that the range of the forecast line varies for different distributions.

Therefore, multivariate regression should be used to address this issue. Based on the results obtained from the multivariate regression of the components of environmental elements effective in reducing energy consumption, it was determined that the highest factor contribution in the designers' group is related to the continuity of material use and the false ceiling, with a value of 1.000, while the lowest is related to the ceiling, with a value of 0.162.

In the users' group, the highest factor contribution is associated with the continuity of material use (0.942), and the lowest factor contribution is related to plaster coating (0.123). The table below shows The factor contribution of each component of the environmental elements in reducing energy consumption.

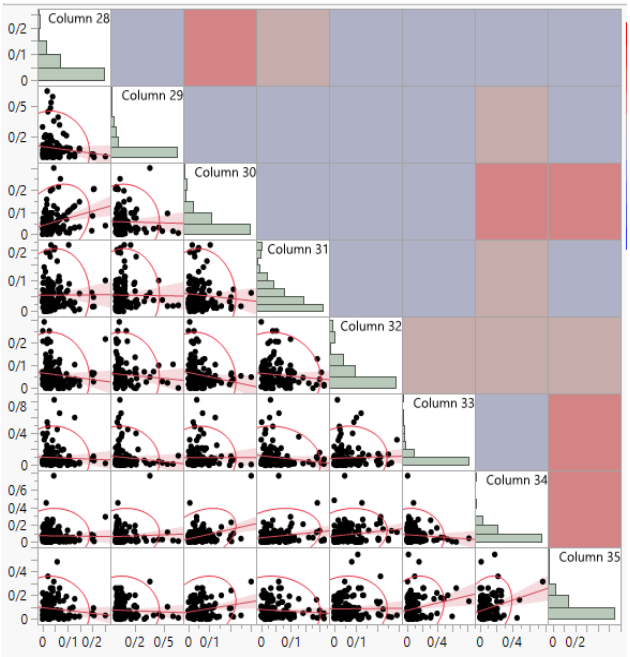


Figure 4. Correlation matrix of environmental components in residential houses

Based on PN modeling, it is evident that the types of materials play the most significant role in reducing energy consumption from the perspectives of both designers and users. Moreover, the data dispersion indicates that each group identifies six components as having the highest coefficients for energy consumption reduction.

Table 4. Multivariate regression of the components of environmental elements effective in reducing energy consumption

	Designers				Users			
Components	The correlation coefficient	F	β	meaningfulness	The correlation coefficient	F	β	meaningfulness
Brick	0.662	318.501	0.662	0.001	0.631	627.245	0.665	0.001
Tile	0.406	544.801	0.406	0.007	0.124	428.255	0.483	0.004
Rock	0.355	369.857	0.355	0.006	0.311	527.383	0.464	0.004
Floor	0.646	710.506	0.646	0.006	0.325	259.911	0.452	0.008
Ceiling	0.162	658.289	0.262	0.004	0.425	243.564	0.463	0.008
Plaster coating	0.735	689.526	0.735	0.002	0.123	621.611	0.472	0.006
Wood	0.881	278.314	0.881	0.004	0.529	872.619	0.661	0.002
Door	0.843	784.586	0.843	0.008	0.679	349.652	0.452	0.003
Window	0.882	174.695	0.982	0.007	0.628	285.941	0.401	0.001
Window frame	0.274	824.261	0.274	0.001	0.542	786.763	0.414	0.001
Structural elements	0.374	512.316	0.374	0.009	0.574	153.943	0.421	0.004
False Ceiling	1.000	984.255	0.921	0.003	0.456	485.624	0.421	0.001
Cooler valve	0.421	518.250	0.421	0.004	0.202	574.034	0.615	0.006
Curtains	0.246	159.211	0.246	0.002	0.301	569.838	0.424	0.007
Interior walls	0.821	453.588	0.821	0.003	0.517	921.864	0.423	0.002
External walls	0.285	439.255	0.285	0.008	0.631	582.351	0.454	0.015
Cement coating	0.675	325.565	0.975	0.005	0.124	447.658	0.521	0.003
Concrete roof	0.754	825.551	0.754	0.001	0.311	683.958	0.414	0.014
Implementation method	0.662	746.133	0.921	0.007	0.325	875.620	0.421	0.018
Continuity of use of materials	1.000	145.655	0.421	0.001	0.942	325.362	0.665	0.009
Skylights	0.406	659.325	0.246	0.007	0.274	742.382	0.483	0.006
Ceiling height	0.355	544.333	0.662	0.006	0.374	675.325	0.464	0.006
Placement position	0.646	318.501	0.406	0.006	0.662	627.245	0.452	0.005
Glass and transparent objects	0.262	544.801	0.355	0.004	0.406	428.255	0.463	0.004

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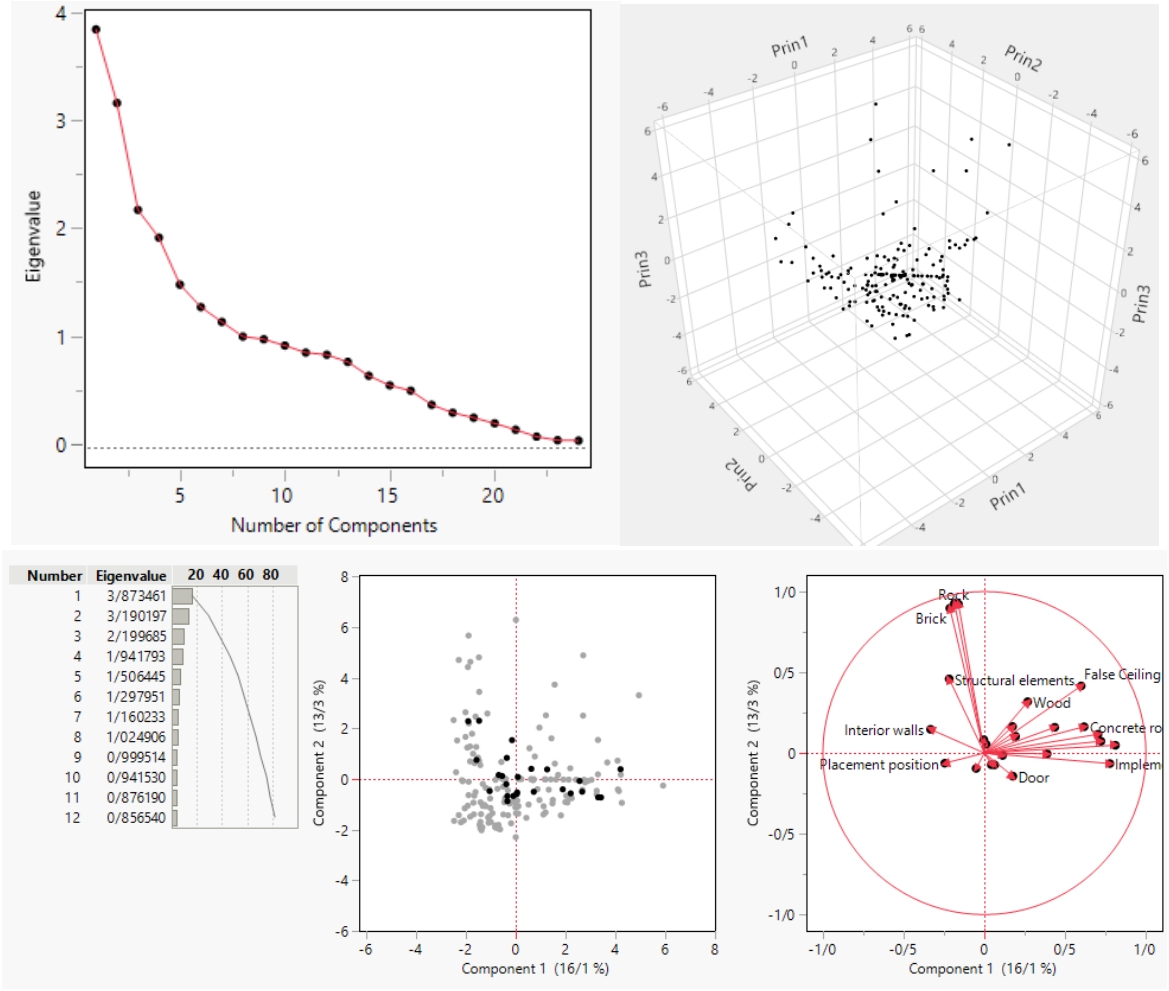
Figure 5. PN modeling of the components of environmental elements in residential houses



6. Discussion

Based on the findings obtained in the qualitative section, 31 codes were extracted, which after summarizing the number reaches 28. The obtained codes can be divided and generalized in the form of components of residential houses and materials and how to use them. Designers consider the integrity of the building shell as an important factor for reducing energy consumption and it was completely repeated among the designers. The difference in inferential and descriptive results indicates the concentration of inferential findings. The frequency of data in users has a higher average than the group of designers. However, the experts have extracted some realistic results. A point worthy of reflection is the attention of users to the fact that bricks are not insulated compared to other materials as the public believes. The correlation between the components in the group of designers considers the focus on the false ceiling and according to this, its application in all projects can lead to the increase of other components in energy reduction and is more welcome, but the curtains have no effect on other components to reduce energy.

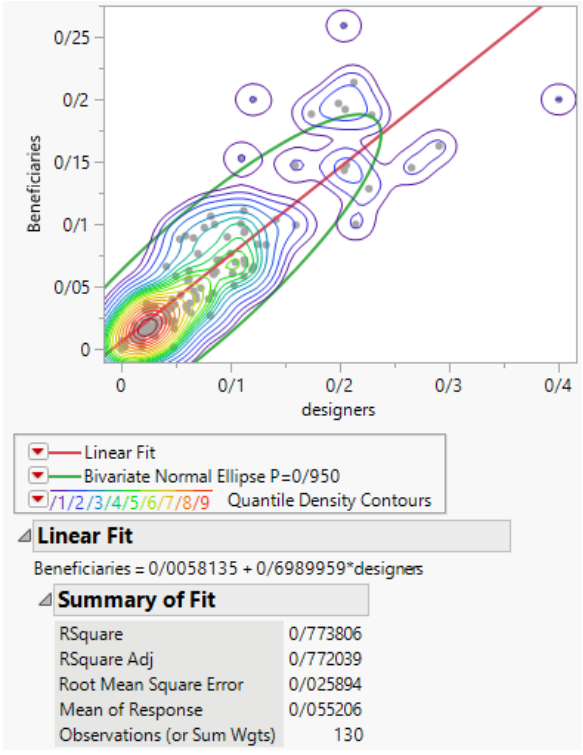


Figure 6. The degree of correlation between the group of designers and users in the environmental elements of residential houses

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Perhaps its use is purely for decorative purposes. The use of materials is also considered by the group of users as an important element in increasing and reducing energy in the rest of the buildings.

The important point is the same factor contribution and correlation in the group of designers and users, but the designers also consider the continuous use of materials as having a high-intensity effect. In this part, designers and users also agree on the maximum intensity of the effect of the component that has the lowest factor contribution. This consensus does not exist. The results show that there is a correlation of 0.77 between the responses of designers and users.

7. Conclusion

In order to create a proper construction and preserve the environment, the materials used in buildings play a significant role, choosing sustainable and appropriate building materials reduces energy consumption and provides more health to the environment because these materials reduce fuel consumption for heating buildings and this reduces emissions. Air pollutants and greenhouse gases will also be reduced, and the use of natural resources will be reduced and the society will be closer to sustainability criteria. In this research, it was done with the aim of differentiating the views of the user group and the designer group. Based on this, it is clear that there is a consensus among designers and experts, the space user group, regarding the maximum reduction of materials in cold and mountainous climates, but there is a great difference in the low effectiveness of the heat transfer coefficient, which is a sign of attention and creating policies to educate people more. Based on this, the following can be explained as policy in this area:

- Cultivation about the use of any material in reducing energy consumption and its positive effects on the environment in cold and mountainous climates.
- Paying attention to spatial aspects in addition to the physical, such as creating an interface space and focusing on spatial hierarchy to achieve the level of activity importance and functional contiguity
- Building height control according to the application of false ceilings in different spaces according to the type of use and also controlling the amount of light.
- Continuity of the type of materials to prevent thermal bridges in the front of building wind, as well as grading the importance of insulating the physical components of different spaces in relation to different functions.
- Educating architects and designers on the climatic benefits of using bricks in creating thermal insulation in different building parts
- Grading the importance of insulating the physical components of different spaces according to the type of activity defined in each space.

Authors Contribution

Conceptualization, Methodology, Investigation, Visualization, Data Curation, Writing- Original draft preparation were performed by Rojan Alborzi; Data Collection and Investigation were performed by Rana Moeini; Supervision, Reviewing, and Editing were performed by Mohammadreza Bemanian. All authors read and approved the final manuscript.

Availability of data and materials:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of interests

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

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