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In the Name of God

Dear Readers,

I, on behalf of the editorial board, am proud to present this issue of the *International Journal of Applied Arts Studies (IJAPAS)* under the sponsorship of the Islamic Azad University, Yazd Branch. We were driven to found the *IJAPAS* by a noticeable lack of journals, in the Islamic Republic of Iran in particular, devoted to architecture, urban design, urban planning, architectural conservation and restoration, painting, art history, graphic, digital arts, fashion design, performing art, industrial design, aesthetics and semantics. Although the academic world is increasingly driven by cross-disciplinary visions and models, we seek multi-disciplinary views, an attempt to inform researchers, graduate students, and professionals about the trends, ideas and innovations being put forward in applied arts. To this end, in addition to standard articles, in every volume of the *IJAPAS* we hope to provide a special issue related to a respective field with innovation.

We are also sending out a call for papers related to *Applied Arts* to appear in the next issue of *IJAPAS* in Aug – Sept 2024.

Finally, I should mention that we are committed to a speedy refereeing process for every article submitted to us. We effort to reply to all papers submitted within five weeks' time with a response about acceptance or rejection. We also do not require formatting for submissions in our style until *after* the paper has been accepted by us for publication.

I would like to thank our Editorial Board for their work so far in helping to establish the *IJAPAS*. And, finally, I would like to extend my deepest gratitude to Dr. Ali Boloor, the assistant editor of the *IJAPAS*, for all of his hard work to ensure the timely completion of the issue.

I am delighted to invite you to visit us at www.ijapas.org.

Sincerely,

Dr. Abolfazl Davodi Roknabadi
Editor-in-Chief
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Compilation of the Area Design Principle's Social Housing Complexes in Shiraz, Emphasizing the Preferences of the Residents

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Research Article

Abstract

The present research aims to compile the principle's design of area's (one of the most important issues and components in the design) social housing complexes built by the government based on the preferences of the residents, focusing on the social housing complexes of Shiraz (as one of the metropolises of Iran) and identifying the preferences of the residents of the social housing complexes in regarding the design of area, as well as determining the priority of them in choosing the type of area. The present research tried to compile and present principles and solutions for these constructions in order to increase the quality of these residential spaces. From the perspective of research methodology, this research is qualitative research that is conducted with the content analysis method with the help of library and field studies, using the study of documents related to the topic, semi-structured interviews and visual questionnaires with 387 residents of social housing complexes in Shiraz, and the selection of complexes was done using the AHP method and Expert

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This article is taken from the doctoral thesis of "Kimia Sadat Tabibzadeh" entitled "Explanation of the Design Component's Social Housing with the Aim of Promoting Users' Attachment to the Place (Case Study: Shiraz)" which was guided by "Hamed Moztarzadeh" and advised by "Mohammad Parva" and "Vahideh Hodjati" at Department of Architecture, Shiraz Branch, Islamic Azad University, Shiraz, Iran is in progress.

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Choice 11 software. The findings have indicated that the users of these residential complexes have prioritized the following: 1- Areas with communal seating areas and green spaces (flowers and plants), 2- Areas with green spaces (flowers and plants), various types of seating areas, children's play area and water feature and 3- the area with green space (flowers and plants), all kinds of sitting areas and water features.

Keywords: Compilation of Design Principles, Residential Complex Design, Social Housing Design, Open Space Design, Area Design, Shiraz's Social Housing

1. Introduction

Governments, including Iran, have adopted various policies in different historical periods to build housing for special classes or groups. One of these adopted policies has been the construction of social housing complexes. According to the experience of the various constructions of these residential complexes and the feedback from the opinions of their residents, as well as the many researches that have been done especially about Mehr housing complexes and social housing complexes, it has been concluded that these residential complexes were not able to eliminate the needs of their users. and have not brought much satisfaction. Governments, including Iran, have adopted various policies in different historical periods to build housing for special classes or groups. One of these adopted policies has been the construction of social housing complexes. According to the experience of the various constructions of these residential complexes and the feedback from the opinions of their residents, as well as the many researches that have been done especially about Mehr housing complexes and social housing complexes, it has been concluded that these residential complexes were not able to eliminate the needs of their users. and have not brought much satisfaction.

It seems that the main root of the formation of this problem is mass production with minimal facilities and economic savings; This is despite the fact that the basic facilities of the users (for example, paying attention to dimensions and sizes, the existence of a play area for children, etc.) have not been considered in the design of their living spaces. In addition, it should be noted that paying attention to the basic needs of users and even using modern technologies may increase some costs in the beginning, but in the end, it improves the quality of the space and the sense of belonging to the place and brings a healthier society.

Therefore, the present research is based on the needs and wishes of the residents of these residential complexes with the aim of compiling the design principles of the area (one of the important space in the design) of the residential complexes built by the government based on the preferences of the residents, focusing on the social housing complexes of Shiraz (as one of Metropolises of Iran) has tried to formulate and present principles and solutions for these constructions so that according to the preferences of their residents, the quality of these residential spaces can be improved and other positive consequences can be achieved; Because housing is one of the basic needs of every human being according to Maslow's pyramid and paying attention to providing it leads to peace, comfort, self-esteem and other positive results. It is worth noting that the minor aims of the research included the following: 1- Identifying the preferences of the residents of social housing complexes regarding the design of areas, 2- Specifying the preference of women and men living in social housing complexes in choosing the type of area. This research has tried to answer the following questions: 1- What are the preferences of the residents of social

housing complexes regarding the design of the area of these residential complexes? 2- What is the priority of men and women living in social housing complexes in choosing the type of area?

2. Research Background

Many researches have been carried out on open spaces, which can be mentioned as follows: Shahpuri and Moztarzadeh (2022) in a quantitative descriptive-analytical research using the space syntax technique and Depth Map software and data analysis through examining the correlation coefficient using SPSS software, they realized that factors such as: method of ownership, square footage, ratio of semi-open space to infrastructure, semi-open space per capita have been effective in the interactivity of semi-open spaces. Hedayat et al. (2020) in an article with content analysis method through quantitative research method and by R software and Fisher's, Kruskal Wallis and Dunn's exact tests, came to the conclusion that for women the spatial component and for men the functional components have the greatest impact and the human component between both male and female groups has had the least effect on the quality of semi-open outdoor spaces in contemporary residential apartments in Bushehr Port. Also, the sub-component of aesthetics with the index of visual harmony in the spatial component, facilities with the index of connection with the elements of nature in the functional component, the sub-component of culture with the index of lifestyle in the environmental component and the psychological aspect with the index of attachment to place in the human component have the most impact among the components. They have sub-categories and indicators related to them in this field.

In descriptive-analytical research, Shariatifar and Shakuri (2020) realized that there is always a stable correlation between the amount of provision and realization of solitude and the increase in the quality level of human presence in space. Khakzand and Bagalian (2015) in research with the grounded theory method came to the conclusion that suitable places for walking, semi-open spaces between apartments, suitable spaces for sitting, plant spaces cultivated by the residents themselves, beautiful green spaces, playgrounds and parks for children, each independently and to the same extent is effective in promoting the social interactions of the residents. Rezaei and Tahbaz (2016) in a research with the help of descriptive-analytical method, presented suggestions for climate design in Kashan city and its similar climates.

According to the investigation of the background of the research, so far solutions have been presented in the direction of climate design and sustainable architecture, as well as the sociability of open space in the design of the area. Therefore, it is appropriate to compile the principles of the design’s social housing complexes (from examples of residential complexes built by the government based on complex building policies) of Shiraz (as one of the metropolises of Iran) with an emphasis on the preferences of the residents.

3. Theoretical Framework

3.1. Social Housing

In addition to the physical location, the concept of housing includes the entire residential environment, which includes all the necessary services and facilities needed for the well-being of the family and the plans for employment, education and health of people. In fact, the general definition and concept of housing is not a residential unit; Rather, it includes the entire residential environment. Housing is more than a mere physical shelter and includes all the public services and

facilities necessary for human well-being, and it should provide a relatively long and secure right of occupancy for its user (Pourmohammadi, 2012: 3).

In recent decades, following extensive political, social and economic developments, cities have been developed and consequences such as: lack of housing and suitable land for urban development have appeared; Therefore, the government's attention has always been on housing projects. One of these projects; It is social housing that is designed by the government for low-income groups (Saqqaei et al., 2018). Social housing is a tool for the implementation of social housing policy (Rajai et al., 2015: 30), which is mainly based on social goals, as well as acceptable minimums and lower consumption pattern standards. These units are leased on the condition of possession (Abdi et al., 2019). Various thinkers and theorists have presented theories about social housing, which can be seen in summary (Table 1).

Table 1 Theorists' opinions about social housing (Source: authors)

Source	Theories
Meshkini et al., 2016	A special type of housing provision, provided primarily by local or national government and aimed at housing low-income groups.
Pourmohammadi, 1392, pp. 134-135	Due to social goals, based on acceptable minimums and sometimes lower than the standards of the housing consumption pattern, the users include: young couples, low-income groups and families without a guardian, the residence of the users with a maximum of 30% of their income in these housings in the form of rent. Social housing according to housing policy makers: units with a useful infrastructure area of 50 square meters, mass construction, construction with the participation and intervention of the government, especially in urban centers.
Rajaee et al., 2015, p. 30; 40-41; 125	Social housing, one of the solutions of social support in the field of housing; providing affordable housing for the needy; Considering how social housing projects can benefit the housing sector (for example, by bringing together expertise related to management); Integrating social housing with other policies, especially government employment, urban planning and transportation; Social housing planning with a long-term perspective and according to the demographic trend and according to the increasing trend of elderly people in the society; Integration of social housing with other types of housing with the aim of avoiding social segregation in residential areas; Attention to capacities with the aim of reducing inequalities in welfare and income; avoiding social polarization; mutual support to achieve common goals; feeling of belonging to a similar society; strengthening bonds and social trust between people (social capital); Integrity and civic responsibility
Kingsley & Turner, 1993; Stewart, 1992	Dealing with social deprivation; Linking social housing with employment opportunities in the region for the possibility of achieving social integration (through the labor market)
Lund, 2011	Public, government and affordable housing

In general, it can be said that social housing is considered a type of housing that is usually created by governments with their support for the use of its users (which includes the financially vulnerable section of the society), and in terms of construction, equipment and facilities, it has the minimum possible.

3.2. Social Housing in Europe and Iran

The concept of social housing emerged, grew and developed in European industrialized countries at the beginning of the 20th century (Lund, 2017). From the beginning of the 20th century until the Second World War, changes in housing policies in Western Europe were mainly determined by market forces. Public participation in the housing market has been relatively weak and temporary,

and in many cities, measures in the housing sector have belonged to poor families. After 1945, significant changes have been made in the housing sector; Because the government (in most European countries) became more active in the housing sector and governments entered this sector. In Western Europe, the changes related to housing policies (between 1945 and the 1990s) can be divided into three periods: 1- Recovery (1960-1945); 2- The increasing diversity (1960-1975 AD) and 3- New realities in the housing sector (1975-1990 AD) were divided (Rajaei et al., 2015: 12-13), shown in Table 2.

Table 2 Developments of social housing in Western Europe (Source: authors taken from Rajaee et al., 2015)

Description	Periods of social housing developments in Western Europe
Adopting policies aimed at dealing with the lack of housing Housing construction as an important issue and heavily supported by subsidies or direct government funding	Recovery (1960-1945 AD)
Strong focus on housing quality and urban renewal Seeing a major divergence in government housing policy Regulation of housing policies by governments in line with economic prosperity (the dominant policy in the 1960s) Attaching housing ownership to the category of social housing in the political agenda	Increasing diversity (1960-1975 AD)
Revealing facts in the housing sector rooted in economic issues Transforming the role of housing into a market-oriented role, coordinated with economic and competitive pressures Diminishing the role of the government in providing housing and, as a result, reducing housing costs	New realities in the housing sector (1975-1990)

The social housing policy in Iran includes: before the Iranian Islamic Revolution (the first and second seven-year construction plan, the third construction plan (1962-1967), the fourth construction plan (1968-1972), the fifth construction plan (1973-1977) and after The Islamic Revolution of Iran (first construction plan (1989-1993), second construction plan (1994-1994), third construction plan (2000-2004) and fourth construction plan (2005-2009), respectively: 1- for building institutional houses housing for employees, 2- building housing for poor and low-income people and cleaning pits and slum dwellers, 3- further expanding the specific goals of the housing sector for the low-income sections of society and including the private sector in addition to the government, 4- the appearance of signs of use and participation low-income groups in the construction of housing for themselves, 5- reconstruction of war-torn areas subject to the non-codified program of building housing for the underprivileged, 6- social housing policy: granting loans for the purchase of housing to special groups (teachers, government employees, etc.), 7- construction of social housing and Handing it over as rental housing with the aim of changing the ratio of rental housing to private housing and encouraging the private sector to build rental housing, 8- Supplying 50,000 rental residential units for construction and supply (with the objectives: 1- To increase the share of rental units supply, 2- Countering by raising rent prices) has been done.

There are two types of social housing in Iran: 1- Renting and 2- Renting with the condition of ownership (it is considered a rental contract in which it is stipulated that the tenant will own the same tenant at the end of the lease term and if the conditions included in the contract are fulfilled) (Ziyari et al., 2016).

3.3. Social Housing and its Characteristics

The standard of social housing always reflects specific national conditions, but there is a general agreement among experts that the standards of this type of housing should at least be similar to the average quality of housing in each country in order to avoid discrediting this plan and, as a result, social segregation; In addition, social housing should be located among other residential buildings (Lujanen, 2003). According to various researches, different components are influential in the design of housing, including social housing, which can be categorized into: Physical-Environmental component, Semantic and perceptual-cognitive component, Functional- Behavior component, Economical component, Political component. Cultural-Social component.

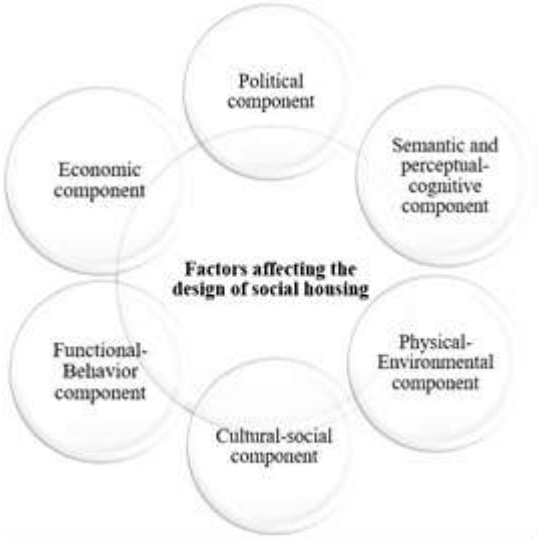

Fig 1 Factors affecting the design of social housing (Source: authors)

Kochakiyan and colleagues (2018) considered permeability, adequacy of local services, accessibility, optimal density, human scale, compatibility and spatial hierarchy, optimal enclosure, stability, readability, strength of buildings, etc. as part of the category of physical sub-components. As its name suggests, the functional component is related to the performance and existing applications. The Cultural-Social component refers to the culture and religion of the inhabitants. The economic component is also specially related to social housing, in other words, the construction and provision of the minimum, and at the same time, achieving the desired quality. The semantic and perceptual-cognitive component is also related to the psychological fields of the environment, memories and values. Figure 1 shows the components influencing the design of social housing.

The present article has been done with emphasis on the design of social housing complexes, which includes the components described in picture one. Building size (number of floors and number of apartments) (Lewicka, 2009), dimensions and size of spaces (Rahimi, 2017; Ahmadi et al., 2014), physical characteristics (density and proximity) (Fried, 2000), desirable landscape (Rahimi, 2017) related to the lack of installation of undesirable additional elements and view and scenery, furniture and equipment (Alimardani et al., 2016; Mojtabavi et al., 2019; Ahmadi et al., 2014), spatial facilities (Riahi Dehkordi et al., 2015), facility management and supervision (Rahimi

et al., 2019), visual quality (Kharabati and Yazdanfar, 2015; Rahimi et al., 2019; Regnier & Pynoos, 1987), the external beauty of buildings and aesthetic characteristics (Alimardani et al., 2016; Rahimi et al., 2019; Mojtabavi and colleagues, 2019; Zarifpour Langeroudi et al., 2020; Mojtboi et al., 2014; Bonaiuto et al, 1999; Lewicka, 2009), cohesion and unity (harmony) (Rahimi et al., 2019), type of materials (Zarifpour Langroudi et al., 2019), green spaces and natural landscapes (Bonaiuto et al, 1999; Lewicka, 2009; Manzo and Devin Wright, 2015: 131; Talischi and Rezaei, 2018; Rahimi et al., 2019; Mojtbavi et al., 2019; Haqqani and Majidi Hatkeloui, 2021), safety (Mojtboi et al., 2019), security (Baba and Austin, 1989; Kamalipour et al, 2012; Haqqani and Majidi Hatkeloui, 2021), social control (surveillance) (Kamalipour et al, 2012), maintenance (Lewicka, 2009; Hashas, 2004), comfort and visual quality (Regnier and Pynoos, 1987), personalization (Lewicka, 2009), natural factors (Regnier and Pynoos, 1987), flexibility (Rivlin, 1987; Haqqani and Majidi Hatkeloui, 2021); orientation and readability (Rahimi et al., 2019), facilities (Regnier and Pynoos, 1987), balanced physical development and adaptive activities (Kamalipour et al, 2012), attention to Maslow's pyramid at the third level (residential unit as a lively space, sense belonging of the family to the house, distinguishing the privacy between the neighborhood and the house, the house and the separation of private and public privacy) (Ezmati et al., 2016), the existence of full and empty surfaces, materials and colors, coordination with local and contextual dimensions, flooring (Ahmadi et al., 2021), facilities and services (Zarini and Ebrahimi, 2017) are considered among physical sub-components.

Activity rules (Low and Altman, 1992; Kharabati and Yazdanfar, 2015), social arena (Fried, 2000; Scannell and Gifford, 2010; Kharabati and Yazdanfar, 2015), compatible activities (Kamalipour et al, 2012), place capacities (activities and disturbing uses) (Khodai et al., 2014), the possibility of investment and functional development (Hashas, 2004), the possibility of specific activities in the place, the possibility of forming social connections and connections and the suitability of activities with human needs (Rahimi et al., 2016); the possibility Various activities in the place (Rahimi et al., 2019; Ahmadi et al., 2014); social arena (Fried, 2000; Scannell and Gifford, 2010; Kharbati and Yazdanfar, 2015) including functional sub-components; apartment living culture (social order) (Amirkafi and Fathi, 2013), paying attention to holding religious ceremonies and rituals (Zamani and Hanrour, 2016; Alimardani et al., 2016) and turning to traditional and local games, including Cultural-Social sub-components, responding to the environment's leisure needs (Haji Parvaneh, 2015), a platform for meeting needs (Hojjat et al., 2016), signs (Lennard, 1993), sensory experiences (Haji Parvaneh, 2015; Mojtboi et al., 2022) and avoiding mental pressure, crowding and visual, auditory, movement disturbances, etc., including perceptual, semantic-cognitive sub-components, and paying attention to the adoption of different design policies are related to political-economic sub-components.

3.4. Design of the Area’s Residential Complexes

Modern urban life and technological advancements have created fundamental changes in humans, and as a result, mental and emotional illnesses resulting from mental and environmental pollution have also increased. Surveys in urban areas indicate the lack or absence of urban stimuli for more mobility of citizens, as well as heart and mental diseases, etc. The expansion of urbanization and the rapid movement of technology and the density of cities have caused people to distance themselves from open spaces and nature (Karimi et al, 2018). Also, the development of green and instructive play spaces in the open spaces of the complexes as a potential and flexible space, the design of children's paths, the development of participation-oriented activities between adults and children in residential complexes, can develop and improve child-friendly open spaces

(Karimi and Jalilisadrabad, 2021). Unfortunately, our living spaces today are not able to respond to the natural needs of our children (Mortezaiemanesh et al, 2016).

The open spaces of residential complexes play an essential role in the formation of the communication meaning of the residents. The adaptation of these spaces according to the needs and functional patterns of the user groups in order to attract the presence of different strata in all age and gender groups is one of the most important concerns of the designers (Mansour Hosseini et al, 2023). Nowadays, the sociability of residential complexes is important for the residents, especially the elderly who need social relations and are among those who spend most of their time at home (Elmi et al, 2020).

The type of design of the open spaces of residential complexes and the use of effective ideas to create suitable conditions for the presence of as many residents as possible in the premises of the complexes and paying attention to the needs of the elderly and children as the most users of the open spaces of the complexes, play a great role in increasing the sense of neighborhood and social interactions of residents of residential complexes (Yazdani and Teimouri, 2013).

Today's housing has lost its cultural identity with the emergence of global cultures and ignoring local values, and by ignoring the concept of cultural sustainability, it has lacked the required quality of new housing (Salahimehr and Hashempour, 2023).

Nature and its elements are effective in increasing the quality of open space in residential complexes (Afifian et al., 2023). "Spatial provision", "sight and scenery", "spatial organization" and "aesthetic aspects" are among the factors affecting the elderly residents of residential complexes (Salehinia et al., 2020). Factors such as: reducing social cohesion and solidarity and reducing the level of trust and individual and social partnerships, originate from the inappropriate architecture of public spaces in residential complexes (Rasoulzadeh et al., 2022).

Therefore, it is necessary to have spaces to improve social communication in residential complexes. In addition, paying attention to the physical, economic and social factors in the design of the area of residential complexes creates security in these spaces (Jalalian et al., 2016). Also, the structural form of paths in the open space of residential complexes is effective in making more appropriate decisions for users in emergency situations (Mansoori and Zarghami, 2020).

4. Research Methodology

From the point of view of research methodology, the present research is a qualitative research with the content analysis method with the help of library and field studies using the study of documents related to the topic, semi-structured interview and visual questionnaire with 387 residents (It is worth mentioning that the number of samples was based on the Cochran formula (when the number of the statistical population is large) of social housing complexes in Shiraz including: Eskan residential complex, Bo Ali, Esar, Sadaf and Eram (Salman Farsi) who were selected by random probability method have been done. First, the questions were determined by the method of collecting information in the form of library studies with the help of studying the available sources in the field of the subject, and after determining their validity, the data obtained from the semi-structured interview and the visual questionnaire obtained by the field method were analyzed, and the results were qualitatively and some are presented in the form of tables and graphs. It should be said that the number of sample size is determined based on the experimental method as well as the sample of similar researches.

It is worth mentioning that the validity of the visual questionnaire was done using the Delphi method by 15 experts and the validity of content analysis was done using the content validity method, which was the result of the agreement of 20 experts in the field of residential complex

design. The reliability of the content analysis was also reported as 0.95 using Cohen's kappa method (1960), which, based on the interpretation of the different levels of the kappa coefficient, the intensity of agreement is almost perfect; Because the reported number is in the range of 0.81 to 1.

AHP method has been used in order to select selected samples with different conditions of social housing with the aim of evaluating different social housing. The names and locations of social housing complexes in Shiraz are presented in Table 3. It should be mentioned that due to the absence of "Bahman" residential complex in the address announced by the Ministry of Roads and Urban Development of Fars province and the unwillingness of the officials of "Delgosha" residential complex to cooperate with the authors, these two cases have not been analyzed and investigated. In addition, the two complexes of Selahshoran 1 and 2 were also excluded from the surveys due to being located in Sadra town (which has a separate municipality from Shiraz city).

Table 3 Social housing in Shiraz city (Source: authors)

Row	Name of social housing complexes	Place
1	Eskan 1	Shiroudi Blvd, Forsat Shirazi Square, Fazel St., Dana St
2	Eskan 2	Shiroudi Blvd, Forsat Shirazi, Fazel Street, 9th Alley
3	Eskan 3	Shiroudi Blvd, Fazel St, Forsat Shirazi Square
4	Eskan 4	Shiroudi Blvd, Fazel St, Forsat Shirazi Square
5	Esar	Mianroud, West Baharestan Blvd
6	Bo Ali 1	Shiroudi Boulevard, Zamzam Crossroads
7	Bo Ali 2	Shiroudi Boulevard, Zamzam Crossroads
8	Bo Ali 3	Shiroudi Boulevard, Zamzam Crossroads
9	Bahman	20 meters from Imam Khomeini
10	Selahshoran 1	Sadra Town
11	Selahshoran 2	Sadra Town
12	Salman Farsi (Eram)	Salman Farsi Street (Pirnia)
13	Delgosha	Northern Fazilat Street
14	Sadaf 1	West Abo Nasr Blvd, 22 Alley
15	Sadaf 2	West Abo Nasr Blvd, Mououd St

As stated earlier, AHP method was used in order to select selected samples of social housing with different conditions in order to evaluate different social housing; For this purpose, the evaluation components of social housing design features were determined based on the studies conducted in the doctoral dissertation of the first author, which included: 1- Physical-Environmental component, 2- Semantic and perceptual-cognitive component, 3- Functional-Behavior component, 4- Economical component, 5- Political component and 6- Cultural-Social component and were considered as evaluation criteria; Then, a questionnaire was prepared and provided to experts to determine the importance and superiority of each of the influencing components over the other (based on the frequency of superiority coefficients (mode)). It is worth mentioning that the relative importance of each of the criteria was a spectrum of nine hourly degrees: 1- Equal importance equal to the number 1; 2- The average importance is equal to the number 3; 3- strong importance (special) equivalent to the number 5; 4- very strong importance equivalent to the number 7; 5- extraordinary importance equivalent to the number 9; 6- intermediate values equivalent to the number 2, 4, 6 and 8; 7- Values for reverse comparison are equivalent to 1.3, 1.5, 1.7 and 1.9. After determining the importance coefficient between each of the components, these numbers were given to "Expert Choice 11" software and finally, according to the analysis, all social housing complexes were chosen due to their homogeneity in terms of the mentioned

components shown in Figure 3 (a, and b). It should be mentioned that the research model of the theoretical foundations is shown in Figure 2.

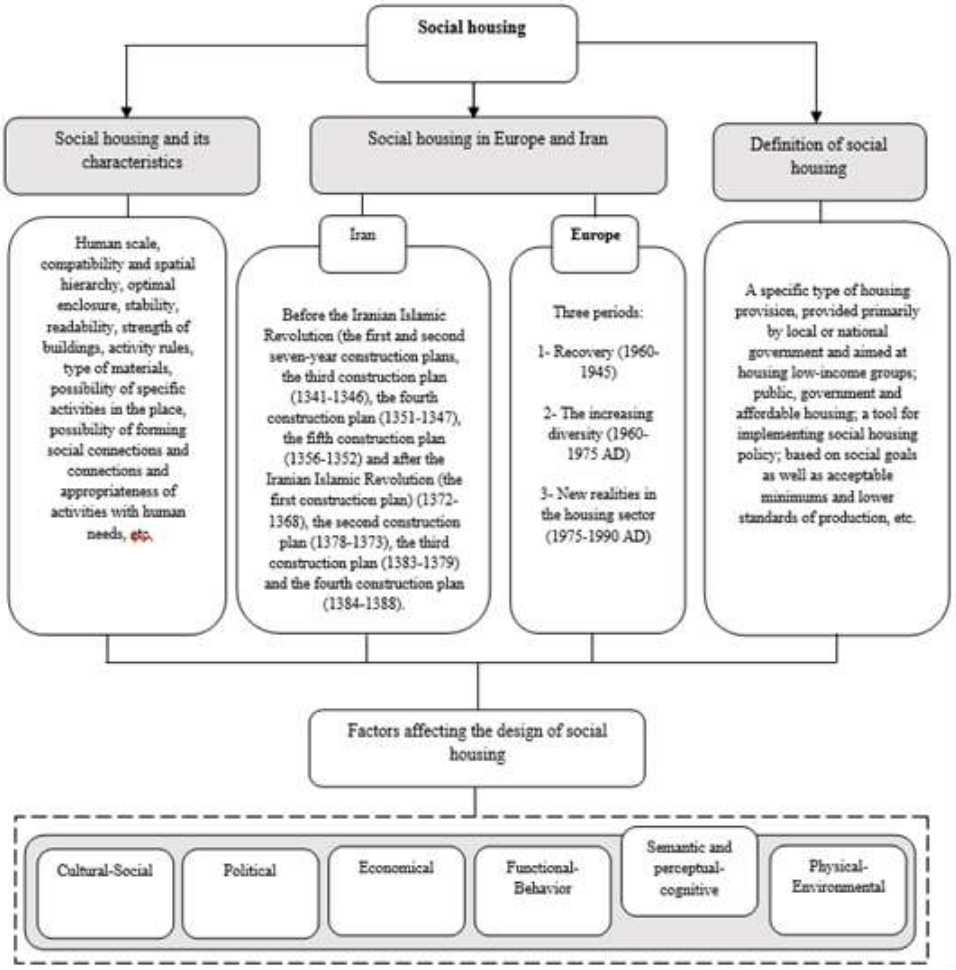

Fig 2 Research model of the theoretical foundation (Source: authors)

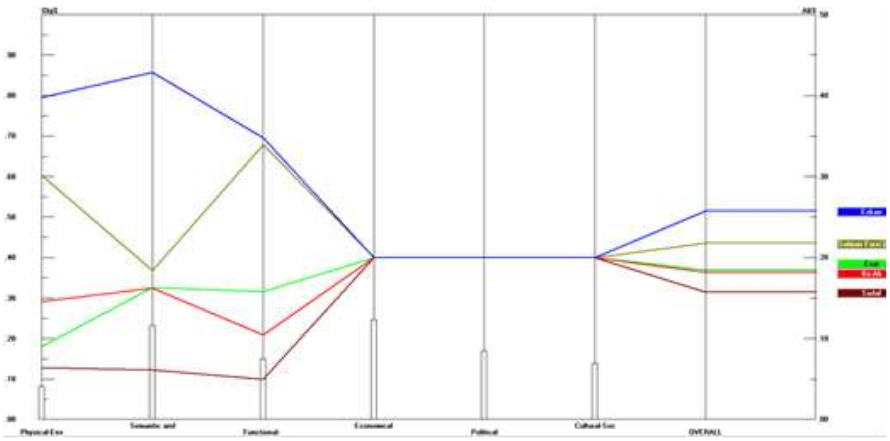

Fig 3a The output of the Expert Choice 11 software based on the AHP model regarding the comparison scores of the influential components in the design of the analyzed complexes (Source: authors)

Fig 3b The output of the Expert Choice 11 software based on the AHP model regarding the final scores of the analyzed complexes (Source: authors)

5. Results and Discussion

The semi-structured interview with 387 users living in social housing complexes was about three main questions as follows: 1- In your opinion, what are the strengths and weaknesses of the area of the residential complex where you live? 2- In your opinion, what methods and solutions are useful for creating the area of the residential complex where you live? 3- What are your suggestions about correcting the area of the residential complex where you live?

After content validity, the results obtained from the answers of the interviewees have been divided and coded into subcategories and concepts. It should be mentioned that the relationship between these codes and the components affecting the design of social housing complexes, which were mentioned in theoretical framework, are presented in Table 4.

Table 4 Analysis of the content obtained from the interviews with the users of social housing complexes and the relationship of the expressed codes with the components affecting the design of social housing complexes (Source: authors)

The connection of codes with the components affecting the design of social housing complexes	Codes	Concepts	Subcategory	Category
Physical-Environmental; Functional- Behavior; Semantic and perceptual-cognitive; Political	Proportion of the dimensions of the area with the number of residents and users of the complex	Dimensions and proportions	Attention to the dimensions, proportions and size of the building	Area
	Proportion of the number of furniture in the area with the number of residents of the complex			
	Proportion of the parking spaces number with the number of residents and guests			
	The number of parking spaces required for guests according to the number of units considered			
	Fewer units and blocks of complexes and as a result fewer residents in the complex			
Physical-	Failure to install ropes and clothespins to trees in the area	No embedding of additional	Attention to visual beauty	
	Controlling the spaces of the area			

The connection of codes with the components affecting the design of social housing complexes	Codes	Concepts	Subcategory	Category
Environmental; Functional- Behavior; Cultural-Social; Semantic and perceptual-cognitive; Political	to prevent the accumulation of garbage and extra belongings of the residents	elements	Attention to visual beauty	Area
	Failure to install speakers and additional elements in the area			
Physical-Environmental; Semantic and perceptual-cognitive; Political	Creating beautiful designs and colors on the walls of the compound area as well as the materials, furniture and elements used in the area	Design and color		
	Designing fences for gardens and separating paths with special and beautiful designs and colors			
	The presence of visual order and harmony in the design of the area using shapes, geometry, color, materials, texture, plants, etc.	Visual order and coordination		
	Creating beautiful and diverse perspectives	View		
Physical-Environmental; Functional- Behavior; Cultural-Social; Semantic and perceptual-cognitive; Political	The existence of gathering spaces	Functions	The flexibility and usability of the area for all classes	
	The existence of indoor spaces such as meeting hall and sports hall in the compound area for the use of all classes			
	The existence of a hall, a prayer room or a flexible space for holding congregational prayers			
	The existence of an open amphitheatre in the area with the purpose of holding various rituals, religious ceremonies, etc			
	The existence of sitting areas in the vicinity of sports fields and children's playground area for the purpose of supervision			
	The existence of flexible spaces in the campus for the possibility of showing individual and cultural talents and skills			
	The existence of a space with the function of a library in the campus			
Physical-Environmental; Functional- Behavior;	Space for installing park sports equipment			
	A space to play Pétanque with the aim of entertaining adults, especially men			
	Different shared functional spaces such as laundry room			
	Spaces for public telephone			

The connection of codes with the components affecting the design of social housing complexes	Codes	Concepts	Subcategory	Category
Cultural-Social; Semantic and perceptual-cognitive; Political	booths in the area	Functions	The flexibility and usability of the area for all classes	Area
	Normal and disabled toilets in the area			
	The presence of parking space for the use of guests			
	There is a space for parking bicycles and motorcycles			
	play area for children			
	Fun spaces for adult residents			
	Allocation of spaces to green spaces			
Physical-Environmental; Functional- Behavior; Semantic and perceptual-cognitive; Political	Not allocating occupied space to park residents' cars in the area with the aim of avoiding congestion			
	The existence of a management and security room near the entrance of the complex			
	A space to collect mechanized trash cans			
	Applying and changing the use of unhealthy, low-quality or unused spaces			
	The existence of a space with the purpose of waiting for people near the entrance of the complex in order to wait for the school service, telephone or internet taxi, etc.			
	The presence of 24-hour uses such as: supermarket, vegetable shop, men's and women's beauty salon, bakery, etc. in the complex itself			
Physical-Environmental; Functional- Behavior; Semantic and perceptual-cognitive; Political	Existence of uses such as Kharazi, Game Net, meat and chicken shop and fast food in the complex itself.			
Physical-Environmental; Semantic and perceptual-cognitive; Political	Separation of gardens from sidewalks, etc., by creating a fence or wall	Paths and accesses		
Physical-Environmental; Functional- Behavior;	The existence of different doors for the use of riders and pedestrians to the complex, especially for pedestrians			
	The opening of different doors of			

The connection of codes with the components affecting the design of social housing complexes	Codes	Concepts	Subcategory	Category
Semantic and perceptual-cognitive; Political	the complex for the possibility of access from different places to the complex and also the possibility of accessing different adjacent spaces in a shorter period of time			Area
Physical-Environmental; Functional- Behavior; Cultural-Social; Semantic and perceptual-cognitive; Political	Not parking cars in front of the passageways and blocking them			
	No parking of cars inside the passageways (passages)			
	The presence of sloping surfaces in the area for the use of the disabled and people with physical problems			
	Separation of access routes for pedestrians, riders, the blind and cyclists with their own signs and symbols			
Physical-Environmental; Semantic and perceptual-cognitive; Political	Using sound and acoustic insulation materials for noisy indoor spaces in the area such as: sports hall	Materials	Noise control with the aim of improving comfort and relaxation	
Physical-Environmental; Functional- Behavior; Cultural-Social; Semantic and perceptual-cognitive; Political	Controlling the traffic of vehicles, especially motorcycles, in order to avoid turning in the area and creating noise pollution	Monitoring and control		
Physical-Environmental; Cultural-social; Semantic and perceptual-cognitive; Political	The impossibility of adding worn-out furniture by the residents themselves by producing unbalanced sounds			
	Absence or impossibility of using speakers placed in the compound area for unnecessary purposes			
Physical-Environmental; Functional- Behavior; Cultural-Social; Semantic and perceptual-cognitive; Political	Not allowing noisy pets, especially dogs			
	Not allowing gathering and sitting in the area for the purpose of cleaning vegetables			
	Not allowing residents to sit in the complex until late at night			
	Not allowing children to play, especially with balls, near building blocks			
	Not allowing water features in the area to become swimming pools, especially for children			
	Controlling the youth hangout late			

The connection of codes with the components affecting the design of social housing complexes	Codes	Concepts	Subcategory	Category
	At night		Noise control with the aim of improving comfort and relaxation	Area
Physical-Environmental; Functional- Behavior; Semantic and perceptual-cognitive; Political	Absence of gathering space in front of the stores in the complex or placing the stores in places with a favorable distance from the building blocks (such as the entrance of the complex)	Placement and depth of space		
	Placement of seating spaces for several people (group) with a suitable distance from the complex blocks			
	Placement of high-traffic indoor public spaces such as indoor sports space at a suitable distance from complex blocks			
	The depth of the desirable space of complex buildings from noisy open spaces such as: children's play area, open sports field, street, etc.			
Physical-Environmental; Semantic and perceptual-cognitive; Political	Planting plants special to control noise	Coexistence and connection with nature		
	Planting plants for the gathering of birds and creating pleasant sounds, as well as being more present in nature			
	Absence of worn-out furniture of the residents themselves with the production of unbalanced sounds	Elements and furniture		
	Replacement of worn and old furniture in the children's play area			
	Absence of loudspeakers placed in the compound area for unnecessary purposes			
	Correct placement of urban furniture with a suitable distance from each other and the possibility of easy passage			
	Placement of elements and furniture in appropriate places (not in the parking space of cars or in the middle of passages and passages)			
	The existence of urban furniture with support for sitting			
	The presence of various urban furniture in structure, color, scale, functionality, etc			

The connection of codes with the components affecting the design of social housing complexes	Codes	Concepts	Subcategory	Category
Physical-Environmental; Semantic and perceptual-cognitive; Political	The presence of flexible urban furniture to change to a lying position to receive vitamin D	Elements and furniture	Elements, furniture and materials in the area	Area
	The existence of collective furniture for people to sit			
	The presence of informational billboards near the main entrance of the complex			
	The presence of information billboards near the main entrance of the blocks			
	The presence of suitable furniture for park sports equipment			
	The presence of suitable furniture for the football field, basketball field, etc			
	The presence of suitable furniture for playing chess, hand football, table tennis, etc. in the area			
	Availability of suitable and safe furniture for children's play area, especially swings and slides			
	The presence of suitable tiles and flooring to prevent injury and damage to children's health in their play spaces			
	Coordination of the form, color, structure, etc. of the furniture used in the area with the whole complex			
	The existence of public urban furniture, such as public telephone booths, ATMs, grocery shopping counters, etc			
	The presence of various urban furniture in connection with the lighting of the area during the day and night in all the paths and spaces of the area	Elements and furniture		
	The presence of mechanized urban elements to collect waste			
	The existence of signboards to access the blocks and different spaces of the area			
Physical-Environmental;	The presence of elements such as: fences, guards, protectors, etc. for the walls of the area (with a suitable height and with a suitable design to prevent the unauthorized passage of children and other people from outside the		Elements, furniture and materials in the area	

The connection of codes with the components affecting the design of social housing complexes	Codes	Concepts	Subcategory	Category
Semantic and perceptual-cognitive; Political	complex into the complex)			
	The presence of fences and guards for stairs, ramps, etc			
	The existence of surveillance cameras in different areas of the campus in order to increase security and the existence of watchful eyes			
	Use of healthy and desirable materials	Materials		
	Using suitable flooring and not being dull			
	Replacing worn and broken materials, especially in flooring and urban elements and furniture			
	Renewing the color of materials, furniture, etc. in the area	Maintenance and personalization	Maintenance, personalization and cleaning	
	Supervising not to light a fire in the vicinity of the trees and walls of the area			
	Circulating guards at different hours of the day and night in the area			
	Monitoring different spaces, especially children's play space			
	Planting plants, especially seasonal flowers, and caring for them, as well as pruning and spraying them			
Physical-Environmental; Cultural-Social; Semantic and perceptual-cognitive; Political	The possibility of changing some spaces of the area by the users themselves (for example, planting flowers, placing pots, etc.) (personalization)			
	The presence of trash cans in all parts of the area and paying attention to the cleanliness of the area	Cleaning		
Physical-Environmental; Cultural-Social; Semantic and perceptual-cognitive; Political	The impossibility of throwing garbage, cigarettes, etc. in the area, especially in green spaces and lawns			
Physical-Environmental; Cultural-Social; Semantic and perceptual-cognitive; Political; Economical	The presence of plants and trees suitable for the climate	Coexistence and connection with nature		
	The presence of waterview, fountains, etc			
	Installing shade and planting trees with the aim of creating shade for sitting			

The connection of codes with the components affecting the design of social housing complexes	Codes	Concepts	Subcategory	Category
Physical-Environmental; Semantic and perceptual-cognitive; Political; Economical	Installation of shade for parking cars and motorcycles	Pay attention to the climate	Localism and landscape design	
Physical-Environmental; Cultural-Social; Semantic and perceptual-cognitive; Political; Economical	Installation of shade for bicycle parking			
	Appropriateness of colors and materials used in the area according to the environment and climate of the region			
	Appropriateness of the materials used in the area according to the environment and climate of the region			
	Creating various canopies with local materials on the paths			
	Design in the form of a central courtyard and suitable for the climate			
	Create a garden pit			

The findings have indicated that according to the preference of the residents of social housing complexes, the following should be paid attention to: the concept of dimensions and proportions from the sub-category of attention to the dimensions, proportions and size of the building and the concepts: 1- not embedding undesirable additional elements, 2- design and color and 3- visual order and coordination and 4- view from the subcategory of attention to visual beauty and concepts: 1- functions, 2- paths and accesses from the subcategory of the flexibility and usability of the area for all classes and concepts: 1- materials, 2- placement and depth of space, 3- Coexistence and connection with nature, 4- elements and furniture and 5- culture and lifestyle from the subcategory of noise control with the aim of improving comfort and relaxation and the concept of elements and furniture from the subcategory of elements and furniture in the area concepts: 1- security and surveillance and safety, 2- maintenance and cleaning from the subcategory Security, monitoring, safety, maintenance and cleaning and concepts: 1- coexistence and connection with nature and 2- pay attention to climate from the subcategory of localism and landscape design.

Figures 4 to 13 are pictures of the investigated residential complexes, which were photographed based on the opinions raised.

Fig 4 Poor quality space in the vicinity of facilities and a supermarket of the Eskan 3 residential complex (Source: authors)

Fig 5 The special sitting area and flowers planted by the owner of one of the units in front of his unit in Ekan 3 residential complex (Source: authors)

Fig 6 Broken materials and stolen or broken lights and the lack of security and absolute darkness of the children's playground area at night in Esar residential complex (Source: authors)

Fig 7 Blocking the way to the sitting areas near the entrance of the complex by cars due to the limited space of the car park in Bo Ali 2 residential complex (Source: authors)

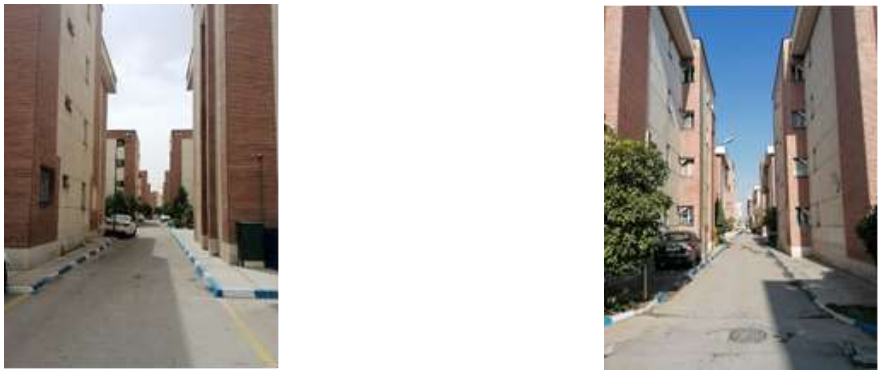

Fig 8 Limited parking space in Boali 2 residential complex (Source: authors)

Fig 9 Collective sitting spaces in front of Sadaf 1 and Sadaf 2 residential complex blocks (Source: authors)

Fig 10 Children's play ground in Ekan 3 residential complex during the day and night

Fig 11 Collective seating areas in the area of Bo Ali 1 residential Complex

Fig 12 A collection of pictures of the area of Ekan 2 residential complex

Fig 13 Lack of proper distance between furniture and tree for easy passage of people in Eskan 3 residential complex blocks (Source: authors)

According to Table 4 and the connection of codes with social housing design components, the number of repetitions of each component is specified in Figure 14. It should be mentioned that the total number of mentioned codes was 104.

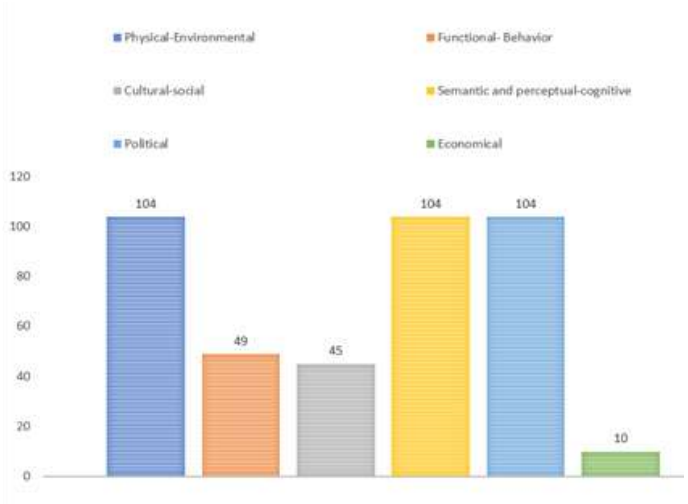

Fig 14 Frequency of attention to social housing design components according to the codes stated in table number five (Source: authors)

Table 5 shows a visual questionnaire that was aimed at gathering the opinions of the interviewees regarding the priority of their preferences regarding the type of enclosure.

Table 5 Visual questionnaire of social housing complexes area (Source: authors)

1- Which of the following images do you prefer as the view of your housing? (About the area)

Green space (flowers and plants), various sitting areas, children's play area and pool

With a large playground for children and teenagers

With bicycle path, a sitting area and a large green area (flowers and plants)

With green spaces (flowers and plants), various sitting spaces and fountain

With communal seating areas and green spaces (flowers and plants)

Table 6 shows the patterns of priorities regarding the type of area's social housing complexes based on the preferences of the interviewees. It should be noted that the table also shows the number of responses received based on the number of opinions of women and men, which according to the sample size that included 387 people, the number and percentage of respondents' opinions in each row are equal.

Table 6 Priority preference of social housing complexes' residents regarding the type of area (Source: authors)

Patterns	Respondents' preference	Total number	Number of women	Number of men
1	1- With communal seating areas and green spaces (flowers and plants); 2- With bicycle path, a sitting area and a large green area (flowers and plants); 3- With a large playground for children and teenagers; 4- With green spaces (flowers and plants), various sitting spaces and fountain; 5- Green space (flowers and plants), various sitting areas, children's play area and pool	15	-	15
2	1- With green spaces (flowers and plants), various sitting spaces and fountain	8	8	-
3	1- With communal seating areas and green spaces (flowers and plants)	15	15	-
4	1- With green spaces (flowers and plants), various sitting	35	31	4

	spaces and fountain; 2- With communal seating areas and green spaces (flowers and plants)			
5	1- With communal seating areas and green spaces (flowers and plants); 2- With bicycle path, a sitting area and a large green area (flowers and plants); 3- With a large playground for children and teenagers	65	54	11
6	1- Green space (flowers and plants), various sitting areas, children's play area and pool; 2- With communal seating areas and green spaces (flowers and plants); 3- With bicycle path, a sitting area and a large green area (flowers and plants); 4- With green spaces (flowers and plants), various sitting spaces and fountain; 5- With a large playground for children and teenagers	16	16	-
7	1- With communal seating areas and green spaces (flowers and plants); 2- With a large playground for children and teenagers; 3- With bicycle path, a sitting area and a large green area (flowers and plants)	32	28	4
8	1- With communal seating areas and green spaces (flowers and plants); 2- With a large playground for children and teenagers	15	15	-
9	1- With a large playground for children and teenagers; 2- With communal seating areas and green spaces (flowers and plants); 3- With green spaces (flowers and plants), various sitting spaces and fountain; 4- Green space (flowers and plants), various sitting areas, children's play area and pool; 5- With bicycle path, a sitting area and a large green area (flowers and plants)	25	2	23
10	1- Green space (flowers and plants), various sitting areas, children's play area and pool; 2- With a large playground for children and teenagers; 3- With communal seating areas and green spaces (flowers and plants)	22	2	20
11	1- Green space (flowers and plants), various sitting areas, children's play area and pool; 2- With green spaces (flowers and plants), various sitting spaces and fountain	50	14	36
12	1- With bicycle path, a sitting area and a large green area (flowers and plants); 2- With communal seating areas and green spaces (flowers and plants); 3- With a large playground for children and teenagers	32	-	32
13	1- With communal seating areas and green spaces (flowers and plants); 2- With green spaces (flowers and plants), various sitting spaces and fountain; 3- Green space (flowers and plants), various sitting areas, children's play area and pool	30	4	26
14	1- With communal seating areas and green spaces (flowers and plants); 2- With green spaces (flowers and plants), various sitting spaces and fountain	27	24	3
		387	213	174

Figure 15 shows the frequency of the first choice of all types of enclosures based on the preference of users of social housing complexes.

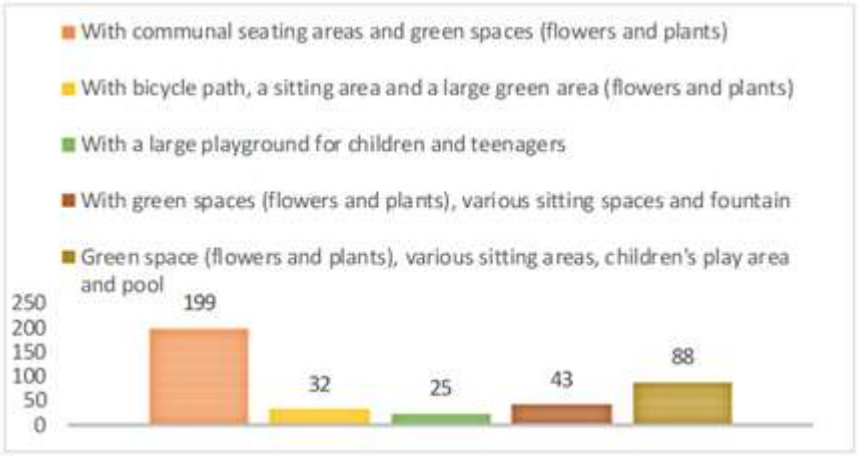

Fig 15 The frequency of the first choice of types's premises based on the preference of users's social housing complexes (Source: authors)

Figure 15 indicates that the frequency of the first choice of area types based on the preference of users social housing complexes, respectively, includes: 1- with communal sitting areas and green spaces (flowers and plants), 2- with green spaces (flowers and plants), various Sitting area, children's play area and pool, 3- With green spaces (flowers and plants), various sitting spaces and fountain, 4- With bicycle path, sitting area and a large green spaces (flowers and plants), 5- With a large playground for children and teenagers.

Table 7 shows the first and second priority preferences of women and men, the overall first and second priority based on frequency regardless of gender, as well as the prioritization of the area type based on the frequency of the first priority regardless of gender.

Table 7 The first and second priority preferences of women and men, the overall first and second priority based on frequency without considering gender, as well as the prioritization of the type of enclosure based on the frequency of first priority regardless of gender (Source: authors)

Questionnaire	**priorities**			**Overall preference based on frequency of first choice**
Area	Priority for women	1	1- With communal seating areas and green spaces (flowers and plants), 2- With bicycle path, a sitting area and a large green area (flowers and plants), 3- With a large playground for children and teenagers	1- With communal seating areas and green spaces (flowers and plants), 2- Green space (flowers and plants), various sitting areas, children's play area and pool, 3- With green spaces (flowers and plants), various sitting spaces and fountain, 4- With bicycle path, a sitting area and a large green area (flowers and plants), 5- With a large playground for children and teenagers
		2	1- With green spaces (flowers and plants), various sitting spaces and fountain, 2- With communal seating areas and green spaces (flowers and plants)	

	Preference for men	1	1- Green space (flowers and plants), various sitting areas, children's play area and pool, 2- With green spaces (flowers and plants), various sitting spaces and fountain	
		2	1- With bicycle path, a sitting area and a large green area (flowers and plants), 2- With communal seating areas and green spaces (flowers and plants), 3- With a large playground for children and teenagers	
	Priority in general	1	1- With communal seating areas and green spaces (flowers and plants), 2- With bicycle path, a sitting area and a large green area (flowers and plants), 3- With a large playground for children and teenagers	
		2	1- Green space (flowers and plants), various sitting areas, children's play area and pool, 2- With green spaces (flowers and plants), various sitting spaces and fountain	
1- With communal seating areas and green spaces (flowers and plants), 2- Green space (flowers and plants), various sitting areas, children's play area and pool, 3- With green spaces (flowers and plants), various sitting spaces and fountain				

6. Conclusion

The present article was conducted with a qualitative method of content analysis using semi-structured interviews and a visual questionnaire with 387 residents of social housing complexes in Shiraz city with the aim of compiling and presenting the principles and solutions for the design of residential complexes built by the government based on the preferences of the residents. In this way, studies were first conducted on the subject to formulate questions, after that, social housing complexes were selected with the AHP method and the content analysis of the answers provided was done. According to the analysis, the findings and results are presented in Figure 15, in the form of an analytical model of the results.

According to the coding of the interviews, it was found that in total, 7 main subcategories are important in the design of social housing complexes. Table 8 shows the number of concepts and the number of codes of each of the 7 main subcategories in the design of social housing complexes.

Table 8 The number of concepts and the number of codes of each of the 7 main subcategories in the design of social housing complexes (Source: authors)

Category	Subcategory	Number of Concepts	Number of Codes
Area	Attention to the dimensions, proportions and size of the building	1	5
	Attention to visual beauty	4	7
	The flexibility and usability of the area for all classes	2	31
	Noise control with the aim of improving comfort and relaxation	5	19
	Elements and furniture in the area	2	24
	Maintenance, personalization and cleaning	2	8
	Localism and landscape design	2	10

According to the analytical model, it is possible to get answers to the research questions; It should also be mentioned that the results of the current research have been able to resolve the existing research gap in the field of social housing complexes and provide solutions based on the preferences's residents of these complexes in the design of the area of these living spaces, In addition to increasing the quality of life of residents, the following things can also be achieved: in promoting social interactions between residents, comfort, facilities, expansion of green space and sustainable design, comfort and such things.

The principles's design of the area based on the visual questionnaire include the following: 1- Installation of single sitting spaces with the ability to open and close the shade; 2- Installation of seating areas for several people, along with the ability to open and close the awning and walls when necessary; 3- Installation of group sitting spaces with the ability to open and close the shade and walls when necessary; 4-Using the flexible light membrane canopy to create thermal comfort in hot and dry climates; 5- The use of flexible furniture to move them in the area and the flexibility of the furniture itself for various uses; 6- planting all kinds of green spaces and beautiful flowers according to seasons and climate; 7- Installation of shade for the parking space in the area; 8- Creating waterviews and fountain in the area.

Providing design solutions for the area according to semi-structured interview: proportion of the dimensions of the area with the number of residents and users of the complex; Proportion of the number of furniture in the area with the number of residents of the complex; Proportion of the parking spaces number with the number of residents and guests; The number of parking spaces required for guests according to the number of units considered; Fewer units and blocks of complexes and as a result fewer residents in the complex; Failure to install ropes and clothespins to trees in the area; Controlling the spaces of the area to prevent the accumulation of garbage and extra belongings of the residents; Failure to install speakers and additional elements in the area etc.

It should be mentioned that by comparing the mentioned codes with the components of social housing design and estimating the frequency of each of them, it was concluded that the components: 1- physical-Environmental, 2- semantic, perceptual-cognitive and 3- political are more prioritized with the number of 104, the Functional-Behavioral component is the second priority with 49 items, the Cultural-Social component is the third priority with 45 items, and finally, the Economic component is the last or fourth priority with 10 items. In addition, according to Table 4, the largest number of codes were related to the concept of functions, which indicated the presence of active behavioral positions (loud noise) and passive positions (low noise), which are presented in more detail in Figure 16.

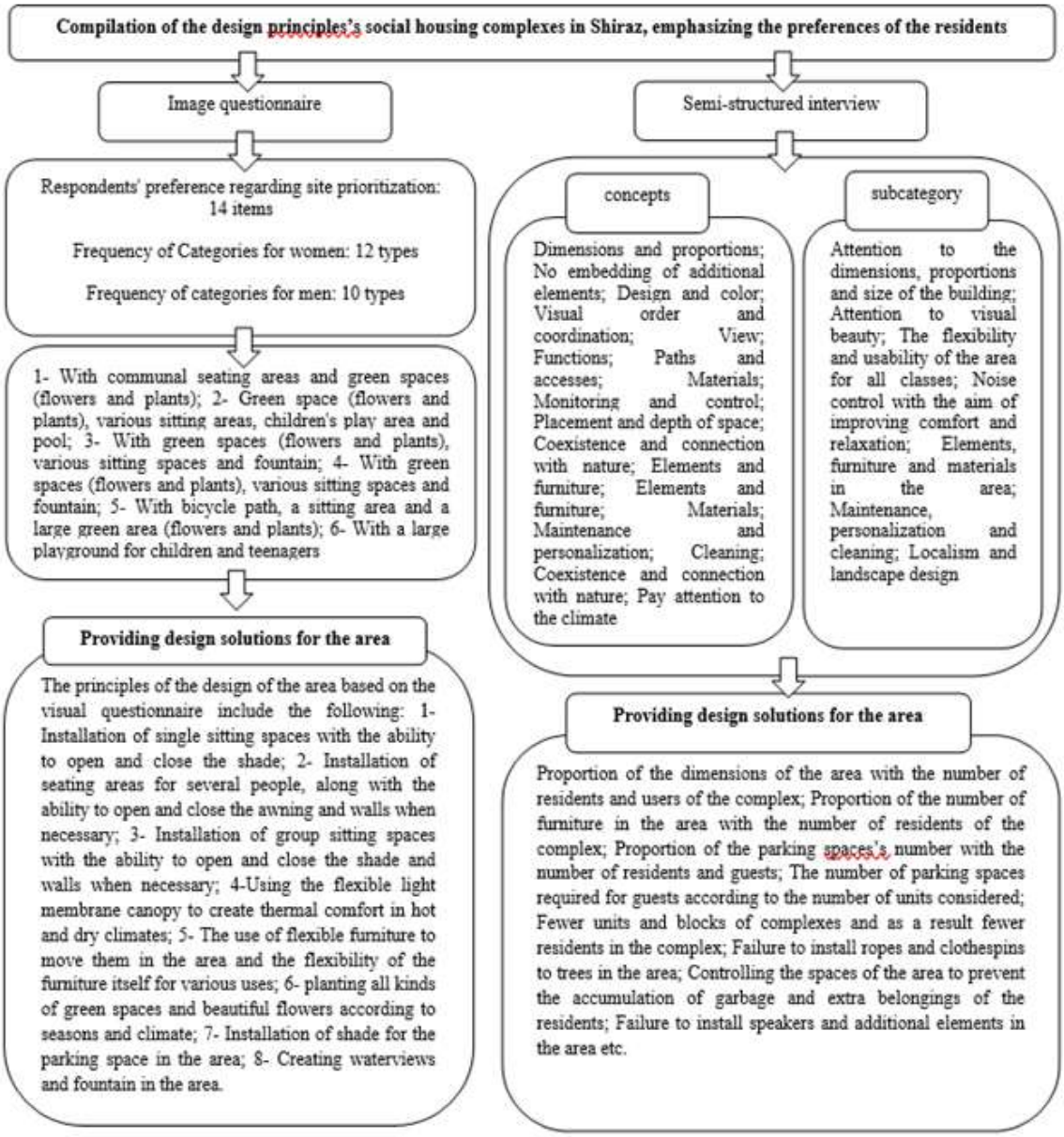

Fig 15 An analytical model of research results (Source: authors)

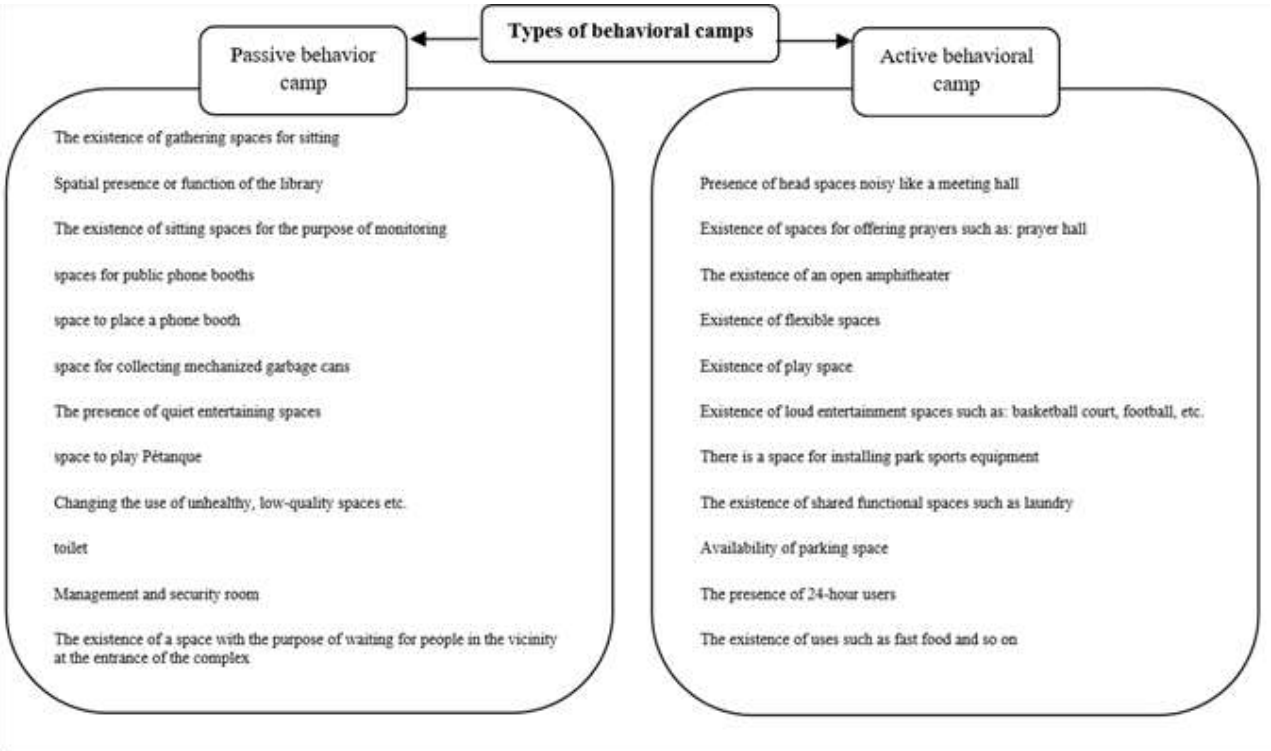

Fig 16 Active and passive campuses required by social housing complexes based on residents' preferences (Source: authors)

Future researchers are advised to try to design effective and sustainable environments, especially for the affected or special sections of the society, so that the existing research gap can be resolved; For example, address the preferences of users in the design of treatment centers for specific diseases such as autism, or the preferences of the elderly in the design of nursing homes, or the preferences of users in care centers for war-affected and traumatized people.

Acknowledgement

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References

Abdi, M. A., Mehdizadegan, S., & Kurdi, F. (2010). *Six decades of housing planning in Iran (1948-2008)*. Tehran: Building and Housing Research Center.

Afifian, M., Keshmiri, H., Moztarzadeh, H., & Ziari, K. (2023). Evaluation of the Relationship between Biophilic Outdoor Elements of Residential Complexes and the Elderly's Residential Satisfaction (Case Study: Residential complexes of Shiraz). *Journal of Sustainable Architecture and Urban Design*, *11*(1), 215-234. doi: 10.22061/jsaud.2023.9041.2049.

Ahmadi, S. Y., Ghalehnoee, M., & Zamani, B. (2021). Explanation of the Physical Factors Influencing the Formation of Place Attachment Among Newcomers: A Case Study of Elective Urban Spaces of Isfahan. *Journal of Conservation and Architecture in Iran, 11*(27), 1-18.

Amir-Kafi, M., & Fathi, Sh. (2011). Factors affecting attachment to the residential area: a case study: Kerman. *Journal of Iranian Social Studies, 5*(1), 5-41.

Alimardani, M., Mohammadi, M., & Zibaee Farimani, N. (2018). The Effect of Place Attachment-Walking- on Health Issue at Neighborhood Level, Case Study: Motahary Neighborhood in Mashhad City. *Armanshahr Architecture & Urban Development, 10*(21), 193-204.

Azemati, H. R., Pourbagher, S., & Rostami, V. (2017). The Place of Fundamental Human Needs in Housing Developments (Case study: Houses in Ardabil city based on history of the city). *Honar-Ha-Ye-Ziba, 22*(2), 43-50.

Baba, Y., & Austin, D. M. (1989). Neighborhood environmental satisfaction, victimization, and social participation as determinants of perceived neighborhood safety. *Environment and Behavior, 21*(6), 763-780.

Bonaiuto, M., Aiello, A., Perugini, M., Bonnes, M., & Ercolani, A. P. (1999). Multidimensional perception of residential environment quality and neighborhood attachment in the urban environment. *Journal of Environmental Psychology, 19*(4), 331-352.

Cole, L. B., Coleman, S., & Scannell, L. (2021). Place attachment in green buildings: Making the connections. *Journal of Environmental Psychology, 74*, 101558.

Elmi, Z., Hashempour, P., & Medghalchi, L. (2020). Physical Sociability of Residential Complexes for the Elderly Group in Tabriz (Case Study: Sattarkhan, Aseman, Allameh Amini and Sepidar Residential Complexes). *Journal of Iranian Architecture & Urbanism (JIAU), 11*(1), 187-207. doi: 10.30475/isau.2020.156546.1125.

Fried, M. (2000). Continuities and discontinuities of place. *Journal of Environmental Psychology, 20*(3), 193–205.

Gulabchi, M., Khalatbari, R., & Fazel, A. (2014). The participation of users in the design process, the foundation for realizing the social sustainability of mass housing in Iran; Case example: Parand industrial town housing. *Urban Management, 35*, 7-24.

Haqqani, M., & Majidi Hatkeloui, S. (2021). An attitude towards the place of walking in the urban space, focusing on the sense of attachment to the place: Case example: Qaran Sari Street. *Specialized scientific quarterly of urban design studies and urban researches, 4* (3 and 16 consecutive), 1-14.

Hajiparvaneh, A. (2016). *Identifying the influencing factors on creating a sense of attachment to a place among young people. Case study: design of Babol city youth house*. Master's thesis, Mazandaran University.

Hashas, M. H. (2004). *Residents' Attachment to New Urbanist versus Conventional Suburban Developments*. North Carolina State University.

Hedayat, A., Eshrati, P., & Karimi, B. (2020). A Study of the Effect of Outdoor Semi-open Space on the Quality of the Residential Environment (Case Study: Apartment in Bushehr City). *Journal of Iranian Architecture & Urbanism, 11*(2), 57-76.

Hojjat, E. (2017). Investigating Home Effective Attributes in Developing Dwellers' Attachment. {Presenting a Causal Process Model}. *Honar-Ha-Ye-Ziba, 22*(2), 51-62.

Hosseini Moghadam, S. Z. (2016). *Designing social housing with the approach of flexibility of interior spaces*. Master's thesis, Islamic Azad University, Maroodasht branch.

Jalalian, S., Habib, F., & Zaker Haghighy, K. (2016). Conceptual Modeling of Environmental Factors Influencing the Security Residential Complexes (Case Study: Residential Complexes of Hamedan City). *Oloom va Tecnoloji-ye Mohit-e Zist, 18*, 345-360. https://journals.srbiau.ac.ir/article_10380_85a65cc2fe426582825621591109e9e7.pdf.

Kamalipour, H., Yeganeh, A. J., & Alalhesabi, M. (2012). Predictors of Place Attachment in Urban Residential Environments: A Residential Complex Case Study. *Social and Behavioral Sciences, 35*, 475-469.

Karimi, F., Heidari, A. A., & Belaghi, R. (2018). The effect of landscape environment in residential complexes on women's depression (Case Study of Khatoon and Chogan Residential Complex in Shiraz). *Haft Hesar Journal of Environmental Studies, 7*(25), 81-92. URL: http://hafthesar.iauh.ac.ir/article-1-612-fa.html.

Karimi, F., & Jalilisadrabad, S. (2021). Analyzing the Compliance of Open Space of Residential Complexes with the Approach of "Child-Friendly City" and its Promotion through Children's Participation (Case Study: Amin Residential Complex in Yazd City). *Urban Planning Knowledge, 5*(2), 63-78. doi: 10.22124/upk.2021.15594.1389.

Kingsley, G. T., & Turner, M. A., eds. (1993). *Housing Markets and Residential Mobility*. Washington, D.C. Urban Institute Press.

Khakzand, M., & Baghalian, A. (2017). Investigation of influential parameters on improvement of social interaction in open and semi open areas of residential complexes (a case study: zone 22 of Tehran municipality). *Journal of Iranian Architecture & Urbanism (JIAU), 11*, 19-28.

Kharabati, S., & Yazdanfar, S. A. (2016). Effective factors in creating attachment to place in student dormitories (case example: Semnan University Dormitory). *Scientific-Research Journal of the Scientific Association of Architecture and Urban Planning of Iran, 12*, 139-148.

Khodaee, Z., Rafiean, M., Dadashpoor, H., & Taghvaei, A. A. (2015). The Effect of Physical Capacities on the Place Attachment from the View of Teenagers in Tehran. *Geographical Urban Planning Research, 3*(1), 33-54.

Kochakiyan, M. (2018). Representation the concept of housing in social and economic factors. *Urban Management, 16*(49), 263-286.

Lewicka, M. (2009). What makes neighborhood different from home and city? Effects of place scale on place attachment. *Journal of Environmental Psychology, 30*(1), 35- 51.

Low, S. M., & Altman, I. (1992). Place Attachment: A Conceptual Inquiry. In *Place Attachment* (pp. 1-12). Boston, MA: Springer US.

Lujanen, M. (2003). The Role of Social Housing in Housing Policies. In *Workshop on Social Housing* (pp. 19-20).

Lund, B. (2017). Understanding Housing Policy. In *Understanding Housing Policy* (pp. 1-22). Policy Press.

Mansoori, S. T., & Zarghami, I. (2020). Analysis of Formal Structure of Routing in the Spaces of Residential Complexes Based on Space Syntax Theory (Case Study: Mehr Housing Complex, Phase 3, Pardis, Tehran). *Quarterly Journals of Urban and Regional Development Planning, 5*(14), 29-54. doi: 10.22054/urdp.2021.61412.1340.

Mansour Hosseini, N., Javan Forouzande, A., Motalebi, G., & Yaghoobi, M. (2023). Explain the Effect of Components of Open Spaces in Forming Different levels of meaning for the Elderly (Case study: Ekbatan Complex). *Journal of Sustainable Architecture and Urban Design, 11*(1), 193-214. doi: 10.22061/jsaud.2022.8707.2014.

Manzo, L. C, Devin Wright, P. (2016). *Attachment to place. Advances in theory, methods and applications* (Sajjadzadeh, H., and Qasimzadeh, B. Trans.). Hamedan: Boali Sina University Press.

Mojtabavi, S. M., Namdar Feiz Abadi, M., & Azadiun, H. (2020). Investigating the factors influencing the creation and promotion of place attachment in public libraries of Iran. *Ferdows-e-Honar Journal of Arts, 1*(2), 82-107.

Mortezaiemanesh, F., Rahbarimanesh, K., & Kiani, M. (2016). A Study of the Relationship between the Quality of Residential Outdoor and Children's Anxiety Level on the Basis of Erikson's Theory of Psychosocial Development (Case Study: A Number of Residential Buildings in Tehran). *Hoviatshahr, 10* (3), 85-98. https://hoviatshahr.srbiau.ac.ir/article_9855.html?lang=en.

Mozeni, A., & Sanaeirad, A. (2019). Evaluation of social housing and the effective factors in housing provision for low-income classes (a case study: Eslamshahr). *Geography, 17*(63), 179-195.

Pourmohammadi, M. R. (2012). *Housing Planning*. Tehran: Organization for the Study and Compilation of Humanities Books of Universities (Samt) (Editor: Ebrahim Moghimi).

Rahimi, L. (2019). The Explanation of the Attachment in Urban Environment based on Islamic Text and Concepts. *Journal of Conservation and Architecture in Iran, 8*(16), 87-108. URL: http://mmi.aui.ac.ir/article-1-392-fa.html.

Rahimi, R., Ansari, M., Bemanian, M., & Mahdavinejad, M. (2020). Evaluation of the Effect of Physical Components on Place Attachment in Communal Spaces of Selected Residential Complexes in Tehran. *Bagh-e-Nazar, 17*(83), 15-30.

Rasoulzadeh, F., Shahcheraghi, A., & Bandarabad, A. (2022). Measurement and correlation analysis of social capital variables and environmental-physical quality in residential complexes based on structural equation model (Study sample: Golha (Justice) and Shaghayeghg of Sadeghieh residential complex, District 2 of Tehran). *Journal of Sustainable Architecture and Urban Design, 10*(2), 201-220. doi: 10.22061/jsaud.2022.9297.2086.

Regnier, V., & Pynoos, J. (1987). Housing the aged: Design directives and policy considerations. *(No Title)*.

Rajaei, S. A., Zarghamfard, M., & Karimi, B. (2016). *Guidelines for social housing principles and examples*. Tehran: Tahan.

Rezaei, N., & Tahbaz, M. (2016). The Evaluation of Climatic Quality of Open and Semi-Open Communication Pathways in Kashan University Campus. *Journal of Architecture and Urban Planning, 8*(16), 163-181.

Rivlin, L. (1987). The neighborhood, personal identity, and group affiliation. In *Neighborhood and Community Environments* (pp. 1-34). Boston, MA: Springer US.

Riahi Dehkordi, A., Montazerolhoja, M., & Sharifnejad, M. (2021). Determining the effective factors on promoting the "place attachment" for the residents of contemporary neighborhoods centers (Case study: Kooy-e-Asatid neigborhood in Yazd city). *Journal of Iranian Architecture & Urbanism (JIAU), 12*(1), 93-110.

Sadeghi, F., R., Daneshgar Moqadam, G., & Dejdar, O. (2013). Studying the relationship between skeletal scheme of residential complexes and sense of interest to the place among the residents. 253-264.

Salahimehr, F., & Hashempour, P. (2023). Measuring the quality of residential complexes from the perspective of cultural sustainability in architecture; Case study: Aseman and Sattarkhan residential complex in Tabriz. *Journal of Sustainable Architecture and Urban Design, 11*(1), 101-126. doi: 10.22061/jsaud.2023.9709.2150.

Salehinia, M., Madani, R., & Alsaheb fasol, F. (2020). Elderly Satisfaction Priorities in Residential Complexes' Open Spaces. *Soffeh, 30*(2), 45-56. 20.1001.1.1683870.1399.30.2.3.6.

Scannell, L., & Gifford, R. (2010). Defining place attachment: A tripartite organizing framework. *Journal of Environmental Psychology, 30*, 1-10.

Shahpouri, F., & Moztarzadeh, H. (2022). investigating the interaction between user and semi-open spaces in contemporary residential units using space syntax. *Journal of Architectural Thought, 6*(12), 133-149.

Shariati Far, Sh., & Shakouri, R. (2020). The Study of Mechanisms of Securing Privacy in Urban Open Spaces and Explaining the Relationship between Provided Privacy and Improving the Qualitative Levels of User's Presence Case study: Naghshe Jahan Square. *Journal of Architecture and Urban Planning, 12*(27), 27-42.

Talischi, Gh., & Rezaei, S. (2019). The Role of Faculties' Public Open Spaces on Students' Place Attachment; Case Study: Faculty of Fine Arts of University of Tehran. *Armanshahr Architecture & Urban Development, 12*(28), 59-73.

Yazdani, S., & Teimouri, S. (2013). The Effect of Open Spaces of Residential Complexes on the Social Interactions of Residents, (Case Study: Three Residential Complexes in Isfahan). *Hoviatshahr, 7*(15), 83-92. https://hoviatshahr.srbiau.ac.ir/article_2347.html?lang=en.

Zamani, B., & Honaravar, M. (2018). Investigation of Place Attachment Factors in Urban Neighborhoods, Case Studies: Dardasht, Charsoghiha, Mollasadra and Doteflan Neighborhoods of Isfahan. *Armanshahr Architecture & Urban Development, 10*(21), 161-172.

Zarifpour Langeroudi, A., Alborzi, F., & Sohili, J. (2020). Explaining the role of urban views in creating place attachment for citizens (Case Study: Tehran Residential Views). *Research and urban planning, 11*(40), 217-232.

Zarini, E., & Kameli, M. (2017). Investigating the relationship between security, attachment to place and the economic components of the city of a case study: Qom city. *Geography (Quarterly scientific-research and international geography of Iran), 15*(52), 355-365.

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Assessing the Vulnerability of Geographical Regions to Potential Infrastructure Risks in the Energy Sector Through the Lens of Passive Defense

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Abstract

In modern times, the significance of energy sector infrastructures has significantly increased as they play a crucial role in catering to the needs of society. Ensuring land security entails prioritizing the protection of infrastructures against attacks and threats. One crucial aspect of this security provision involves evaluating the vulnerabilities of these infrastructures based on their location, which is the main focus of this research. The aim is to assess the susceptibility of the energy infrastructure in the Yazd province and determine the capacity of the territory to withstand such vulnerabilities. To achieve this, the descriptive-analytical approach was employed along with the utilization of network analysis techniques and Arc GIS software. The findings indicate that when considering passive defense, the arrangement of infrastructure in the province was not appropriately designed. In Yazd province, the central region is at a higher risk compared to the surrounding areas, resulting in over 55% of the energy network infrastructure being situated in this highly vulnerable zone. Additionally, 18% of the infrastructure also falls within this high-risk area. The significance of passive defense measures is particularly emphasized in the province.

Keywords: Vulnerability, Spatial Vulnerability, Energy Infrastructure, Passive Defense, Yazd Province

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1. Introduction

Infrastructure protection, specifically the safeguarding of critical infrastructure, has gained significant importance in recent times (Abedi, Gaudard, and Romerio, 2018: 2; Huang, Liou, and Chuang, 2014: 66). The economic prosperity and the quality of life of a particular area rely heavily on the consistent and trustworthy functioning of its infrastructure (Ouyang, 2014: 44). These essential structures are likened to the lifelines that are crucial for the sustenance of urbanization in the modern world (Sultani, Mousavi, and Zali, 2016: 97). There are certain infrastructures in different societies that can cause significant harm to security, economy, and society at both regional and national levels if they are damaged or fail. Various countries have varying lists of their vital and sensitive infrastructure, encompassing communication infrastructure systems, electricity, gas and oil systems, banking and financial operations, transportation, water supply systems, government services, and emergency services (Ouyang, 2014: 44). Examining various infrastructures and their categorization demonstrates that energy infrastructures possess greater significance and play a more substantial role compared to other infrastructures.

The growing demand for and reliance on energy, coupled with the comparatively slower development of energy infrastructure in comparison to other types of infrastructure, significantly heightens the significance of energy infrastructures (Abedi et al., 2018: 3). Moreover, any potential harm to energy infrastructures holds much greater importance as they serve as a crucial lifeline and a central hub of activity and vitality in every region (Farji Melai, Zahedi, and Hosseini Amini, 2014: 199). According to Razaviyan, Alian, and Rostami (2017: 32), these infrastructures now face a higher likelihood of risks and an increased vulnerability to threats. In simpler terms, if these infrastructures are damaged, it can not only disrupt the equilibrium of urban and regional systems but also pose significant challenges for the society residing in that area, ultimately creating a crisis (Sarmi and Hosseini Amini, 2013: 56). Vulnerability is a term used to indicate the magnitude and level of potential harm resulting from an infrastructure crisis. It encompasses different forms, and location vulnerability, being one of those forms, involves identifying vulnerable areas and regions as a means of assessing the consequential destruction of infrastructure. Due to the significance of a region's energy infrastructure and the objective of understanding and evaluating its vulnerability, it is regarded as a suitable approach for conducting scientific and well-thought-out planning. The main objective of the present study is to evaluate and examine the vulnerability of energy infrastructures in the province of Yazd. Initially, it seeks to identify the spatial vulnerability of these infrastructures, and subsequently, it investigates the potential risks associated with them. Furthermore, given its strategic positioning and placement within the country's strategic depth, Yazd province holds significant importance as one of the country's vital provinces. It possesses vital infrastructures in diverse sectors owing to its unique location, including energy-efficient infrastructures. These infrastructures can serve as the driving force behind industrial activities and densely populated areas, while also playing a crucial role in bolstering national security and amplifying their impact. The current study aims to address the following questions considering the vulnerability of the energy infrastructure in this region.

1. From an energy infrastructure standpoint, how susceptible is Yazd province to spatial vulnerability?

2. What is the extent of harm and potential dangers posed by threats to the energy infrastructure in Yazd province?

2. Literature Review

2.1. Spatial Damage and Vulnerability

Despite vulnerability being a widely discussed concept in academic literature concerning passive defense, various scientific disciplines have interpreted and employed it differently, encompassing areas like social, organizational, economic, environmental, geographical, and territorial aspects, as well as physical and systematic elements (Dolan, Walliman, Amouzad, and Ogden, 2017: 744; Kundak, 2013: 196).

Vulnerability is commonly described as the potential for harm or negative impact (Cutter, 1996: 531). It entails the extent and magnitude of damage within a factor or group of factors caused by the presence of any event or phenomenon (M. Little, Paul, Jordens, and Sayers, 2000: 495). Another definition of vulnerability is the inadequate ability of society to confront dangers and uncertainties, which is influenced by the position of individuals and groups within the physical and social environment (Clark et al., 1998: 59).

Generally, vulnerability can be defined as the extent of harm that a specific element is exposed to, typically represented on a scale ranging from zero (indicating no harm) to one (representing complete damage and destruction). Vulnerability, it should be noted, is not a fixed occurrence. Instead, it is an ever-changing process that alters the likelihood and extent of harm caused by destructive elements, subsequently impacting them (Ghafory-Ashtiany, 2005: 2). Concerning this matter, spatial vulnerability pertains to the extent of discrepancies in the infrastructure location's capacity when impacted by threats. It is determined by geographic characteristics, indicators, and passive defense measures (Seydin et al., 2016: 336). Hence, the vulnerability of infrastructures in terms of spatial aspect can be determined by assessing the ability of geographical regions to withstand threats to infrastructure. Building upon this concept, the present study aims to measure and assess the spatial vulnerability of energy infrastructures on a regional scale.

2.2. Vulnerability Process Approaches

Numerous attempts have been undertaken to create models and techniques in order to examine infrastructure systems and their susceptibility. In terms of classifying the methods and models utilized in the realm of infrastructure vulnerability assessment, Johansson and Jonsson (2008) have divided them into two overarching groups: empirical and predictive approaches. The objective of empirical methods is to enhance awareness and comprehension of the infrastructure and its interactions by analyzing previous occurrences. Indeed, the objective of these practical methods frequently involves identifying patterns that could potentially be associated with political choices. One instance of this method is its ability to assess the trends in outcomes for a particular community or the effects of failures on other infrastructures (Johansson and Hassel, 2008: 16). Various studies by McDaniels, Chang, Peterson, Mikawoz, and Reed (2007), Zimmerman & Restrepo (2006), and Restrepo et al. (Restrepo, Simonoff, and Zimmerman, 2006) have provided practical examples of these experimental approaches (McDaniels, Chang, Peterson, Mikawoz, and Reed, 2007: 175), along with other related observations. However, typically, predictive methods focus on modeling and simulating infrastructure, particularly its interactions, which can lead to significant disruptions across various sectors of infrastructure. Numerous models have been utilized in diverse research studies within this discipline, including economic-computational models (Haimes and Jiang, 2001: 1). To simulate the behavior of infrastructures during different threats, there are various models and methods available. These include ecosystem dynamic models (Min, et

al., 2007: 57), agent-based models (Brown, Beyeler, and Barton, 2004: 108), network-based modeling (Apostolakis and Lemon, 2005: 361), and other similar approaches (Huang et al., 2014: 66). However, the difficulties in comprehending, organizing, categorizing, and representing these systems remain significant, and the current endeavors in this domain have not yet undergone the stages of development (Little, 2002: 110). However, there is a common factor in using and implementing these models. Studies that employ predictive methodologies focus on assessing the effects of infrastructure and its interactions through various models and viewpoints. It is important to note that there is no all-encompassing and universally applicable model for assessing infrastructure vulnerability. The choice of approach depends on the specific nature of the infrastructure being examined, the extent of analysis, and the geographical area under scrutiny. In some cases, conventional methods, such as experimental or predictive approaches, may be employed depending on the nature of the problem being investigated.

3. Research Methodology

The choice of research method typically depends on the nature of the subject and the objectives of each study. Considering these factors, the present research falls under the category of applied research in terms of its goal and is classified as descriptive-analytical research in regards to its methodology. The literature and theoretical foundations section of this study obtained the necessary information through the library and document method. This method primarily relies on utilizing books, both domestic and foreign scientific articles, reports, and other relevant sources. The following stage involved extracting the location data using the infrastructure database of the country. This study focuses on analyzing the infrastructure of Yazd province, specifically the electricity transmission network, power generation facilities, electric substations, gas transmission lines, gas pressure regulation stations, oil transmission lines, oil product transmission lines, as well as oil and gas storage facilities and gas stations, in terms of energy infrastructure.

The following step involves assessing the significance of each infrastructure component in relation to another infrastructure component. Hence, once the criteria relationship is established through the Dimetal model, we proceed to the phase of comparing infrastructure elements on a binary scale. This comparison was accomplished utilizing the network analysis process model, in which every infrastructure element of Yazd province was evaluated based on a specialized questionnaire compiled by experts and professionals. However, the key concern in this comparison lies in the evaluation standard, commonly known as the control criterion, within the model for analyzing networks. To accomplish this, understanding the roles of each infrastructure, classifying them appropriately, and precisely determining their scopes are crucial. Determining the desired outcome in this matter aids in categorizing and establishing priorities for the infrastructure, which is undeniably crucial in defining benchmarks for this objective. Factors such as strategic-political significance, economic significance, social significance, and defense significance can serve as appropriate indicators to assess the importance of each infrastructure. In this particular study, the questionnaire was developed by taking into account a set of criteria including strategic-political significance, economic importance, social importance, and defense significance.

The evaluator team was chosen based on their possession of expertise and being experts. They were selected from two communities, the passive defense organization and the academic community, who were well-versed in the concepts of passive defense, threat, infrastructure, and infrastructure vulnerability. A total of 34 questionnaires were obtained after distributing 50 initial questionnaires. Following the initial monitoring conducted to address the significant difference and lack of rationality, and the exclusion of two collected questionnaires, the analysis process

proceeded with 32 questionnaires that were deemed valid. The statistical population of respondents in this study comprised nine individuals from the expert community of the non-active defense organization and 23 individuals from the academic community.

Once the calculations in the network analysis process model are finished, the subsequent phase involves creating maps and information layers for every infrastructure component. This task is accomplished within the ArcGIS environment, where the final coefficients obtained from the network analysis process are applied to individual layers. Ultimately, the vulnerability map of the province is produced.

4. The Scope of the Study

Yazd province, situated in the central region of the Iranian plateau, holds significant strategic importance due to its location at the heart of the country and its proximity to the provinces of Fars, Kerman, Isfahan, and Khorasan. It is considered a key focal point and plays a crucial role in the country's strategic positioning. This province is divided politically and consists of 10 cities. The largest city in terms of size is Ardakan, which covers approximately 23 thousand square kilometers. On the other hand, the smallest city is Maybod, spanning about 1200 square kilometers. As per the 2015 census, the population of the province is estimated to be around 1138533 individuals (Yazd Governorate, 2016: 15). Additionally, Figure 1 displays the energy infrastructure of Yazd province.

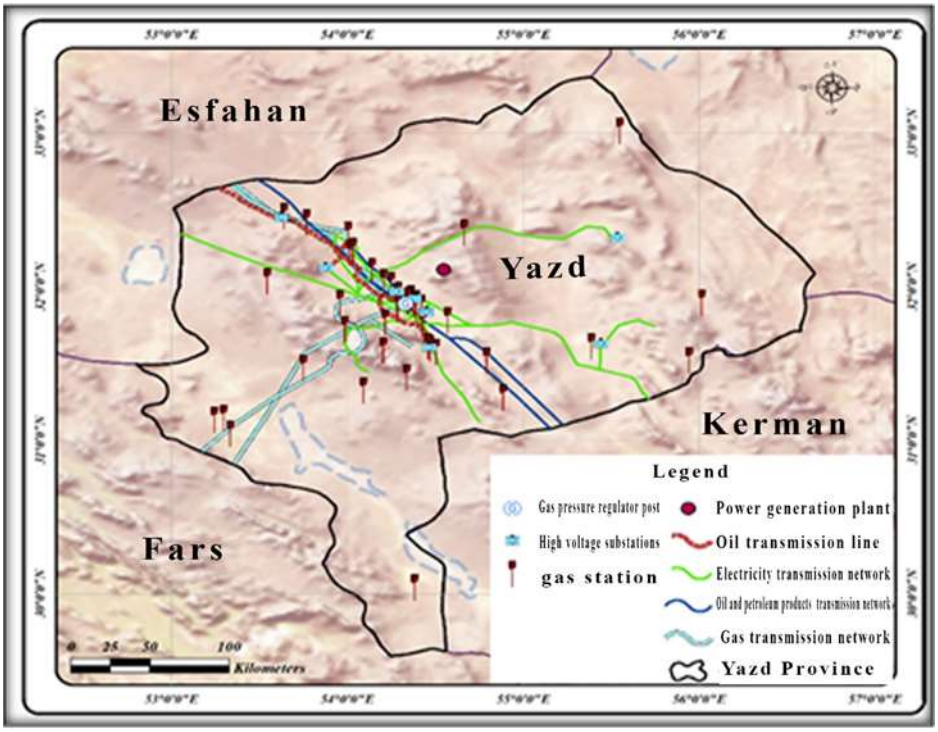


Fig 1 Energy infrastructures of Yazd province

5. Analysis

5.1. Analysis of the Attractiveness and Importance of the Infrastructures

Measuring the vulnerability of infrastructures and understanding their impact on the region is a crucial aspect when it comes to planning and implementing passive defense measures (Bernaffer et al., 2013: 163). Therefore, it is crucial to give importance to the infrastructures and evaluate their vulnerability to adversaries when carrying out this task. Multiple methods can be suggested and employed to accomplish this objective. In this study, the network analysis process model has been utilized to obtain more practical and effective outcomes. Subsequently, the practical execution of this model will be elaborated upon.

After establishing the framework of infrastructural components, experts conducted a thorough evaluation of each infrastructural element's effectiveness through pairwise comparisons. Now it is necessary to ascertain the nature of the relationship between these elements. To begin, we employ the DEMATEL model's table. The objective at this point is to assess the infrastructures in pairs and individually, taking into account their cause-and-effect relationship. Put simply, all the infrastructure components need to be compared individually regarding their effectiveness. This ensures that each element is considered both as an independent and dependent variable in the matrix. Experts and specialists in the field performed the assessment and analysis, assigning points ranging from 0 to 5 based on the relationship between the infrastructures. The score of 5 for an infrastructure element, considered as an independent variable, significantly affects another element, considered as a dependent variable, while the influence of the independent element gradually diminishes towards a score of zero. The least impact is represented by the number 1 in this range, while the number zero indicates no impact between the two elements. This process completes the comparison matrix of infrastructure elements. It is important to highlight that the matrix has a diameter of zero.

The matrix is completed by evaluating all infrastructure elements together, as shown in Fig 2. Once the questionnaires are distributed and collected, the results are calculated for each questionnaire. These results are then inputted into Excel software, and subsequently the average score of all the questionnaires needs to be calculated. In the following stage, the highest number of columns (43) and the highest number of rows (46) are identified by calculating the total of rows and columns in the average matrix. Subsequently, all the numbers in the average matrix are divided by the smaller number (43). The resulting matrix is then utilized in MATLAB software for further computations using equation 1 (refer to Fig 2).

$$T = D(I * D)^{-1} \quad \text{Eq. 1.}$$

T: the matrix anticipated for subsequent examination.

D: The matrix derived from the mean viewpoints of professionals.

I: identity matrix (a matrix with a diagonal of 1 and all other elements being zero).

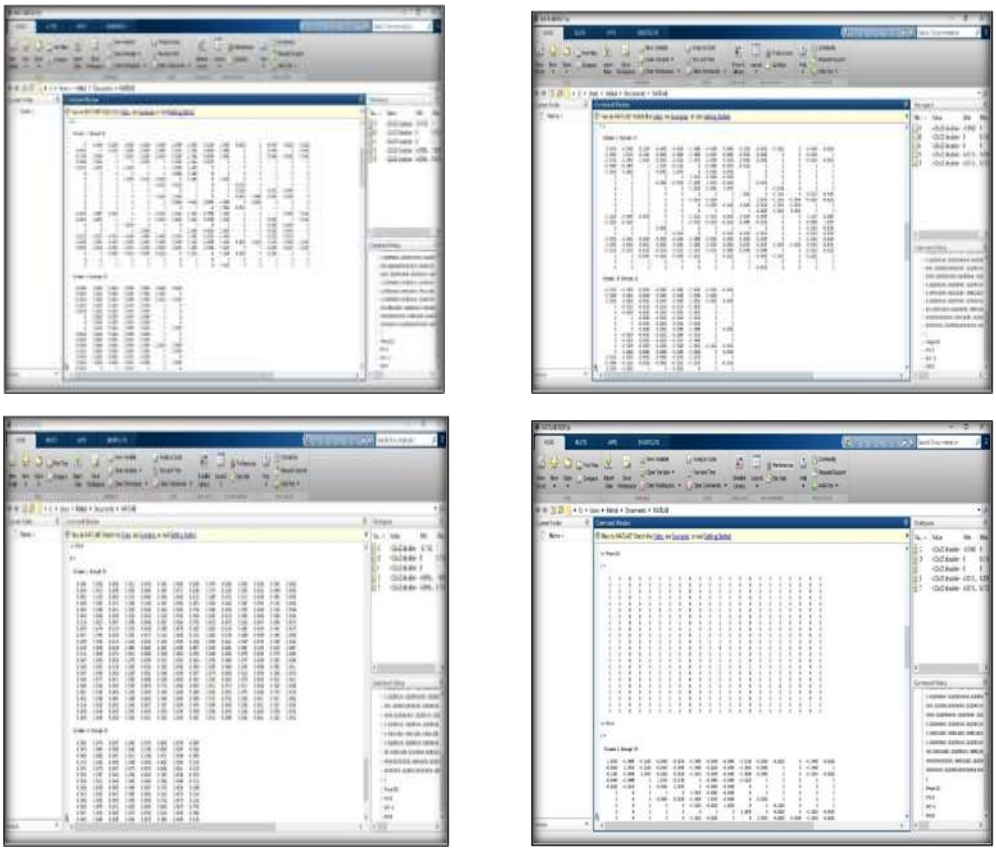


Fig 2 Steps to calculate the relationship between infrastructure elements in MATLAB software

Afterwards, the matrix obtained from the calculation in MATLAB software (Fig 2) is transferred to Excel software. Next, the entire matrix is averaged. In the final step, each cell of the matrix with a value greater than the average is replaced with the number 1 using the If operator. Conversely, any cell with a value lower than the average is replaced with the number zero in the matrix. Through the resulting matrix that contains values of zero and one, the linkages and interconnections among infrastructures are identified. Subsequently, this matrix aids in mapping out the relationships between infrastructure components in the network analysis model. The binary comparison process is then initiated within the network analysis model. Table 1 displays the outcomes of this computation. Hence, when examining the overlap between rows and columns, a value of 1 indicates that the element in the row of the matrix impacts the infrastructure element in the column. Conversely, if the value at this intersection is zero, it signifies that the row element does not affect the infrastructure element of the column, but the opposite scenario is feasible. In the case of the power transmission network, it impacts the power generation plant with a significance of 1, however, there is no connection between the power transmission network and bridges, with a significance of 0. The analysis extends to other elements of infrastructure and ultimately involves assessing interactions between infrastructures as one-way relations, bilateral relations, or no relations.

Table 1 The matrix resulting from the results of Dimtel's model

	Electricity transmission network	Power generation plant	High voltage substations	Gas transmission network	Gas pressure regulator post	Oil and petroleum products transmission lines	Oil and gas warehouse	gas station
Electricity transmission network	0	1	1	1	1	1	1	1
Power generation plant	1	0	1	1	1	1	1	1
High voltage substations	1	1	0	1	1	1	1	1
Gas transmission network	1	1	0	0	1	0	1	1
Gas pressure regulator post	0	0	0	1	0	0	1	1
Oil and petroleum products transmission lines	0	0	0	0	0	0	1	1
Oil and gas warehouse	0	0	0	1	1	1	0	1

Gas station	0	0	0	0	0	0	0	0

Once the final matrix has been computed to ascertain the correlation and infrastructure interactions, the subsequent stage involves implementing these connections to the components and alternatives. This task has been accomplished using the Super Decisions software.

In this stage, the clusters' comparison matrices and the interdependencies of infrastructure elements are constructed and their suitability is monitored. The evaluation of infrastructure elements using a 9-point quantitative scale based on total hours, following the same sequence as the hierarchical analysis process, was carried out by experts and professionals and then inputted into the software.

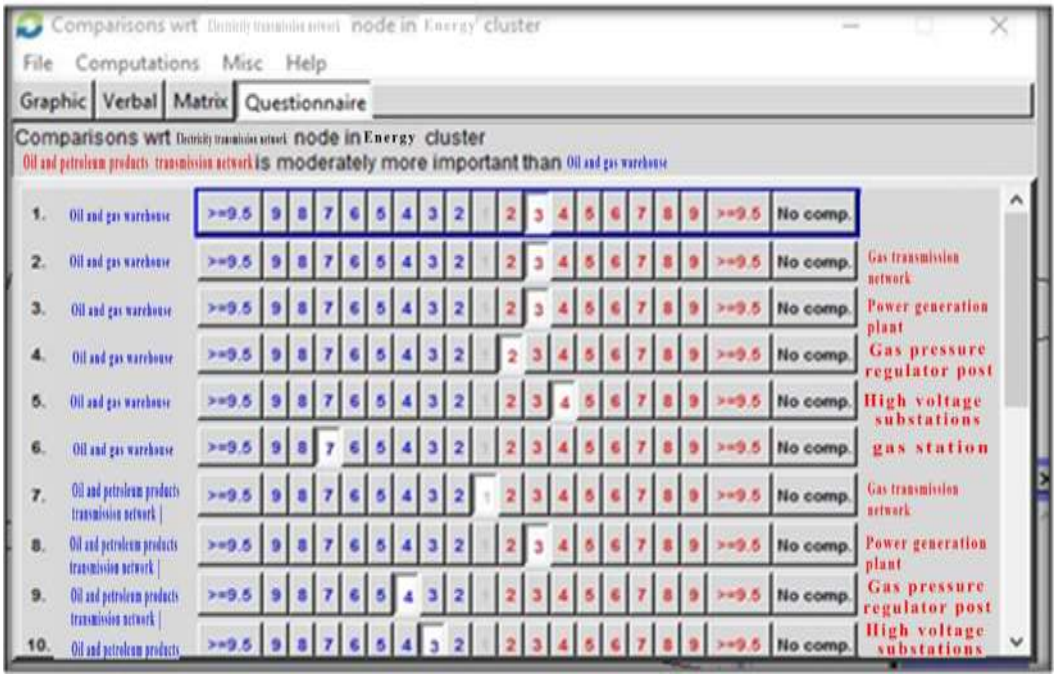
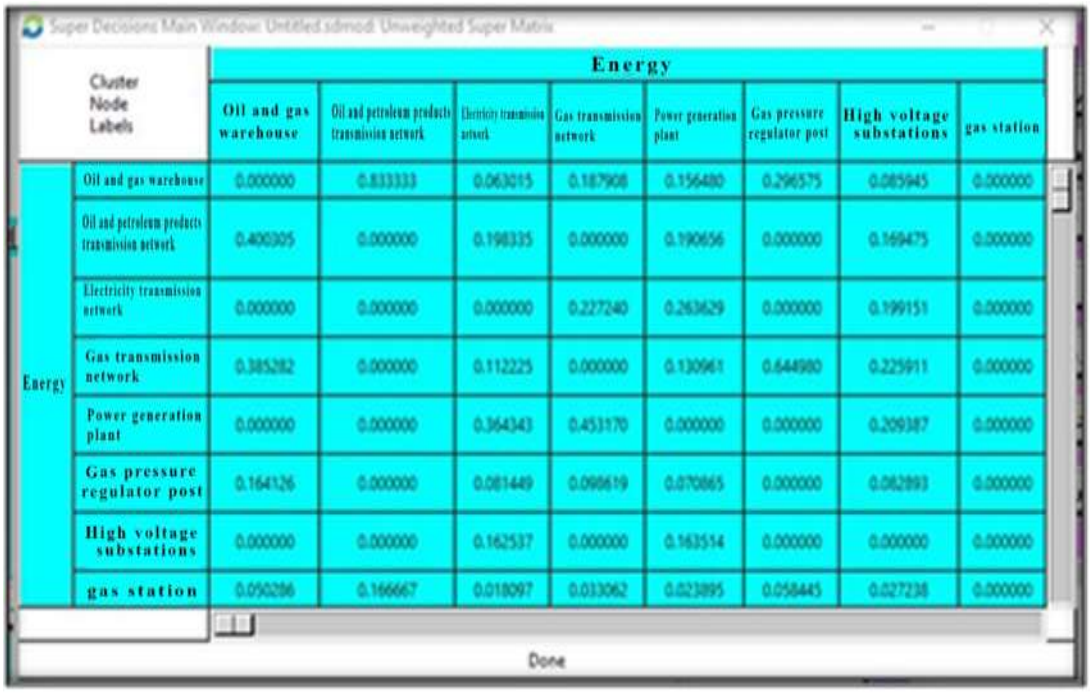


Fig 3 Evaluation matrix and binary comparison of infrastructural elements

The final stage in the process model of network analysis is the super matrix. The super matrix is a composite of individual matrices arranged together and merged in order to determine the ultimate importance and desirability of each infrastructure component. Considering that all comparative matrices are calculated in the unweighted supermatrix structure and their compatibility is also controlled, the ununweighted supermatrix is calculated as the first stage of calculations (Fig 4). The current task involves the conversion of the unweighted supermatrix into a weighted supermatrix, which should have column elements summing up to 1, as illustrated in Fig 5. This transformation requires multiplying the unweighted supermatrix with the cluster matrix, as the latter represents the impact of each cluster and infrastructure element. The subsequent task involves computing the limit supermatrix (Fig 6). In essence, the aim of maximizing the balanced super matrix is to ascertain the enduringly comparative influence of each infrastructure component on one another.


Super Decisions Main Window: Untitled.sdmod: Unweighted Super Matrix

Cluster Node Labels		Energy							
		Oil and gas warehouse	Oil and petroleum products transmission network	Electricity transmission network	Gas transmission network	Power generation plant	Gas pressure regulator post	High voltage substations	gas station
Energy	Oil and gas warehouse	0.000000	0.833333	0.063015	0.187908	0.156480	0.296575	0.085945	0.000000
	Oil and petroleum products transmission network	0.400305	0.000000	0.198335	0.000000	0.190656	0.000000	0.169475	0.000000
	Electricity transmission network	0.000000	0.000000	0.000000	0.227240	0.263629	0.000000	0.199151	0.000000
	Gas transmission network	0.385282	0.000000	0.112225	0.000000	0.130961	0.644980	0.225911	0.000000
	Power generation plant	0.000000	0.000000	0.364343	0.453170	0.000000	0.000000	0.209387	0.000000
	Gas pressure regulator post	0.164126	0.000000	0.081449	0.098619	0.070865	0.000000	0.062893	0.000000
	High voltage substations	0.000000	0.000000	0.162537	0.000000	0.163514	0.000000	0.000000	0.000000
	gas station	0.050286	0.166667	0.018097	0.033062	0.023895	0.058445	0.027238	0.000000

Done

Fig 4 Unweighted super matrix


Super Decisions Main Window: Untitled.sdmod: Weighted Super Matrix

Cluster Node Labels		Energy							
		Oil and gas warehouse	Oil and petroleum products transmission network	Electricity transmission network	Gas transmission network	Power generation plant	Gas pressure regulator post	High voltage substations	gas station
Energy	Oil and gas warehouse	0.000000	0.833333	0.030103	0.094193	0.074751	0.175469	0.041056	0.000000
	Oil and petroleum products transmission network	0.236840	0.000000	0.094746	0.000000	0.091077	0.000000	0.080959	0.000000
	Electricity transmission network	0.000000	0.000000	0.000000	0.113909	0.125937	0.000000	0.095136	0.000000
	Gas transmission network	0.227952	0.000000	0.053610	0.000000	0.062561	0.381601	0.107919	0.000000
	Power generation plant	0.000000	0.000000	0.174049	0.227160	0.000000	0.000000	0.100025	0.000000
	Gas pressure regulator post	0.097105	0.000000	0.038909	0.049435	0.033853	0.000000	0.039599	0.000000
	High voltage substations	0.000000	0.000000	0.077645	0.000000	0.078111	0.000000	0.000000	0.000000
	gas station	0.029752	0.166667	0.008645	0.016573	0.011415	0.034579	0.013012	0.000000

Done

Fig 5 Weighted super matrix

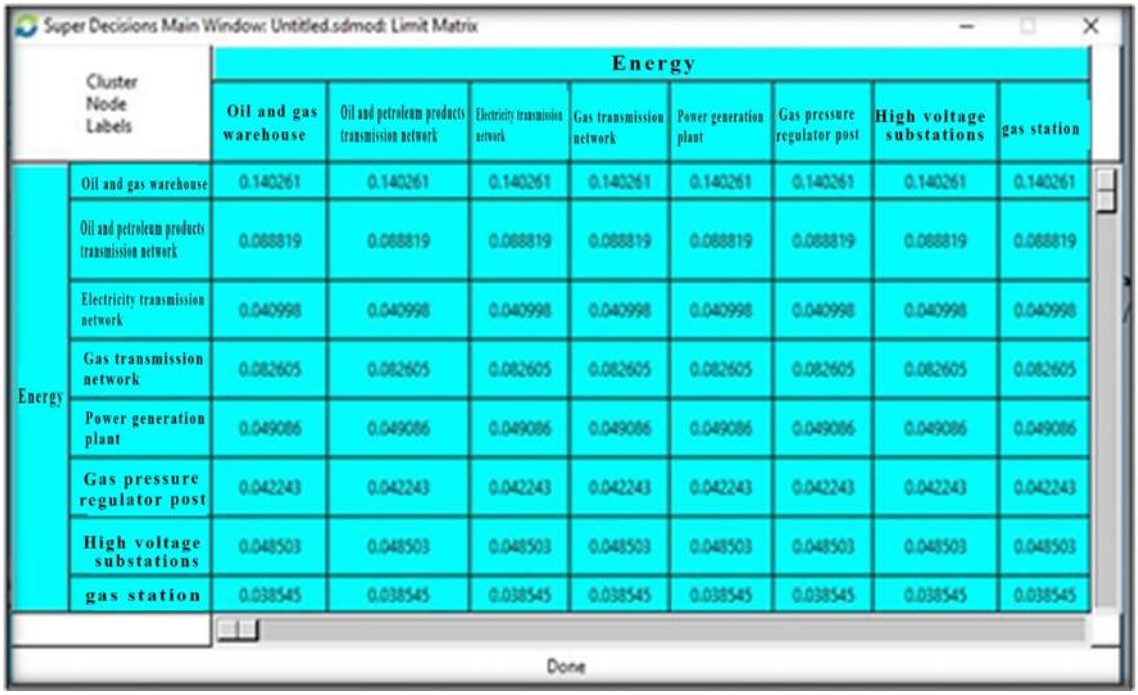


Fig 6 Limit super matrix

To ascertain the ultimate value and coefficient of clusters and infrastructure elements, the final step involves computing the outcomes of the cluster matrix and standardizing the coefficient of infrastructure elements within the limit super matrix.

After performing the calculations, the matrix coefficients of the clusters are normalized with the coefficients of the supermatrix. Consequently, the significance of the infrastructure in delivering services to the people and other infrastructures, as well as its appeal, is individually evaluated for each infrastructure element. The ultimate outcome is presented in Table 2. The significance of the gas transmission network is evident, with a value of 0.1003, while the transmission lines for oil and petroleum products have a slightly lower score of 0.0988. Similarly, oil and gas storages are also of relatively lesser importance, with a score of 0.0985. Lastly, gas stations hold the least significance among all energy infrastructures in the province, scoring 0.0485.

Table 2 The weight of infrastructure elements of Yazd province in terms of importance and attractiveness

Infrastructures	Normalized coefficients by clusters	Final weight
Gas transmission network	0.2831	0.1003
Oil and petroleum products transmission lines	0.2641	0.0988
Oil and gas warehouse	0.2613	0.0985
Power generation plant	0.2500	0.0926
Electricity transmission network	0.2320	0.0885
Electric high voltage post	0.2051	0.0694
Gas pressure regulator post	0.1988	0.0673
Gas station	0.1556	0.0485

5.2. Evaluation of the Vulnerability of the Energy Network

The vulnerability of the infrastructure in Yazd province is being assessed, including the electricity transmission network, power generation plant, high voltage substation, gas transmission network, gas pressure regulation substation, oil transmission lines, and oil and gas storage facilities, as well as gas stations. The Yazd province meets its electricity needs by generating power in its active power plants, such as the Yazd power plant and Tabas city power plants in Khorasan province, as well as through the national electricity network. The integrated electricity system, which encompasses electricity generation, transmission, and distribution, is a vast and intricate national and regional infrastructure. Its convenient production conditions, rapid transferability, and adaptability to other energy sources have attracted significant interest and attention from people. Furthermore, the significant expenses associated with investing in building and setting up production, transmission, and distribution infrastructure, as well as the costs of repair and maintenance, are compounded by the essential reliance of daily human activities on electricity. This dependence underscores the critical need for uninterrupted electricity supply during natural disasters, wartime conditions, and terrorist attacks. Based on the information from Fig 7 and Fig 9, the central areas of the province, which include Maybod, Yazd, Ashkazar, and to some extent Bafaq and Ardakan, are comparatively more at risk in terms of electricity distribution network and high voltage substations. Additionally, Fig 8 indicates that the central region of the province is more susceptible, taking into account the power plant's location.

Another crucial aspect of the energy infrastructure in Yazd province is the gas and oil infrastructure. Pipelines are a practical and cost-effective method for transporting hazardous and flammable materials like natural gas, crude oil, and its by-products, which cannot be transported via land or railway. In the Yazd province, the pipeline network is growing to accommodate the rising demand for oil and gas. This expansion necessitates the development of safe facilities and operations. Additionally, the presence of combustible materials in the transmission networks poses a natural risk of explosion and fire in the event of failure or leakage. Incidents such as fires, explosions, pollution, and financial losses can result from pipeline-related issues. These incidents can have widespread impacts on society and are attractive targets for sabotage. It is clear that pipeline incidents affect various aspects of production, including labor, equipment, and the environment. On one side, the economic impact of wasting valuable materials in our products or raw materials is undesirable, while on the other side, it results in significant costs for replacing damaged equipment, repairing and replacing pipelines, and cleaning up the environment, which companies have to bear.

As mentioned before, Yazd province does not have its own gas sources and relies on the national network for natural gas supply. As a result, the central and western areas of the province are at a higher risk due to this dependency. Additionally, as the gas reaches the consumption points, it must go through pressure reduction and measurement systems. Therefore, pressure regulation posts are crucial infrastructure. Fig 11 illustrates the vulnerability of the province in terms of gas pressure regulation posts and oil and gas storage.

Furthermore, despite the absence of oil refineries in Yazd province, the region's demand for oil and its products is met through two transmission lines. These lines supply oil and oil products to various cities in the province, including Mehriz, Yazd, Ashkazar, Meibod, and Ardakan, as depicted in Fig 14. Gasoline and diesel pumps are crucial infrastructures in every province and region, providing essential services to society. As depicted in Fig 13, the concentration of infrastructure in Yazd province is greater in the central areas, primarily because of the higher population density and

the presence of the north-south corridor. Consequently, the central parts of the province are more vulnerable from this perspective.

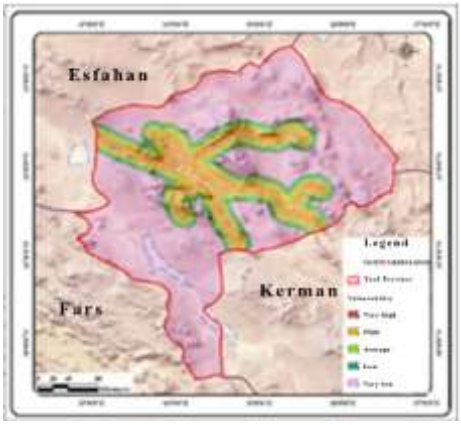


Fig 7 Vulnerability zoning map of electricity transmission network of Yazd province

Fig 8 Vulnerability zoning map of Yazd province power plant

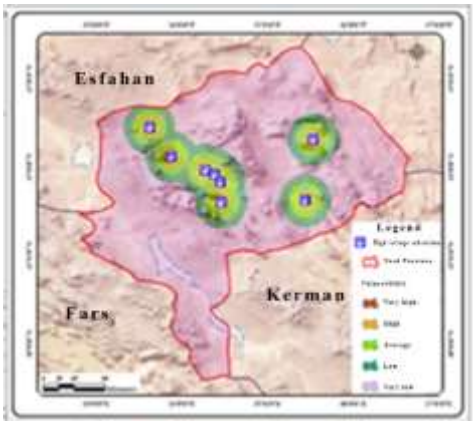


Fig 9 Vulnerability zoning map of high voltage substations in Yazd province

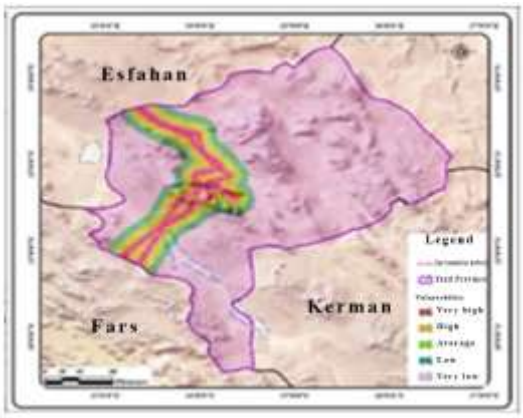


Fig 10 Vulnerability zoning map of gas transmission network in Yazd province

Fig 11 Vulnerability zoning map of oil and gas storage in Yazd province

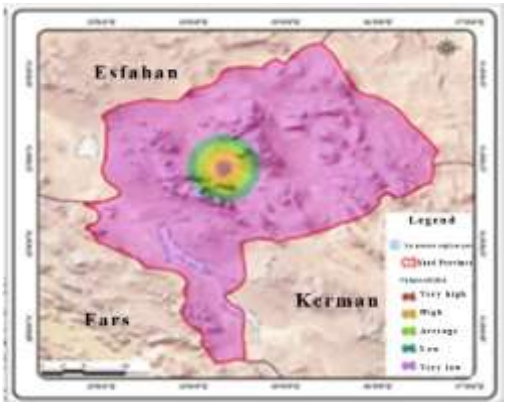


Fig 12 Vulnerability zoning map of gas pressure regulation station in Yazd province

Fig 13 Vulnerability zoning map of fueling centers (petrol, gas and diesel pumps) in Yazd province

Fig 14 Vulnerability zoning map of oil and oil products transmission network in Yazd province

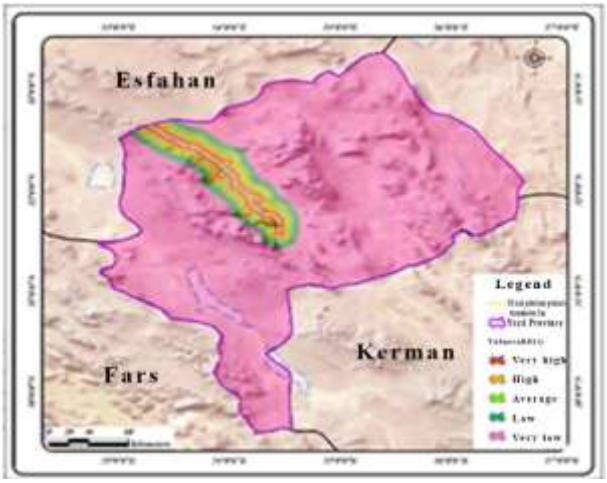
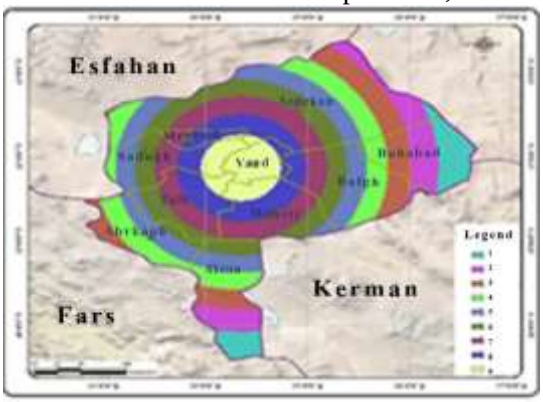
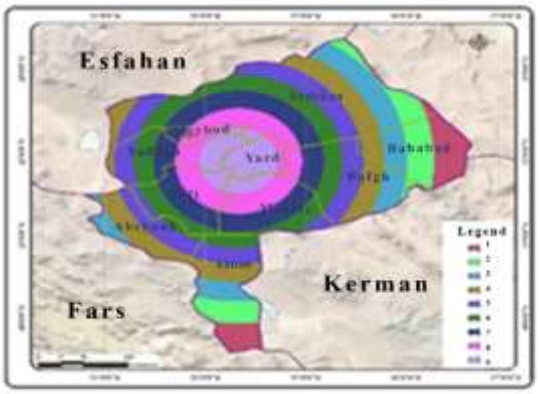


Fig 15 Vulnerability zoning map of oil and oil products transmission network in Yazd province

After reassessing the vulnerability of each infrastructure, the vulnerability of the energy infrastructure sector in Yazd province was ultimately determined using overlapping functions, as depicted in Fig 16. The central area of the province exhibits higher vulnerability attributed to the concentration and density of energy infrastructures, while the vulnerability decreases as we move towards the outskirts of the province, as illustrated in Fig 17.





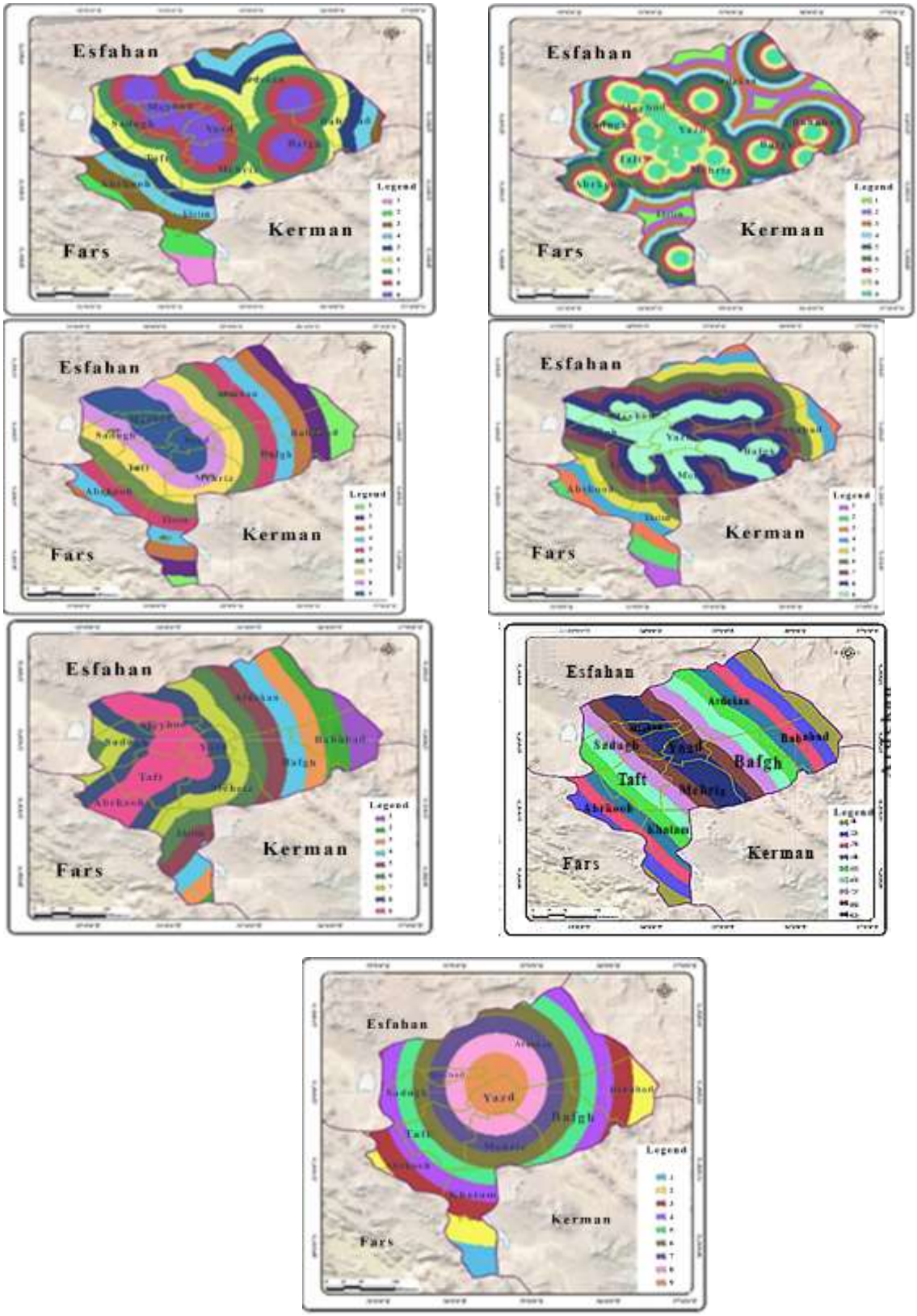


Fig 16 Reclassification maps of the vulnerability of the infrastructure of the energy network of Yazd province

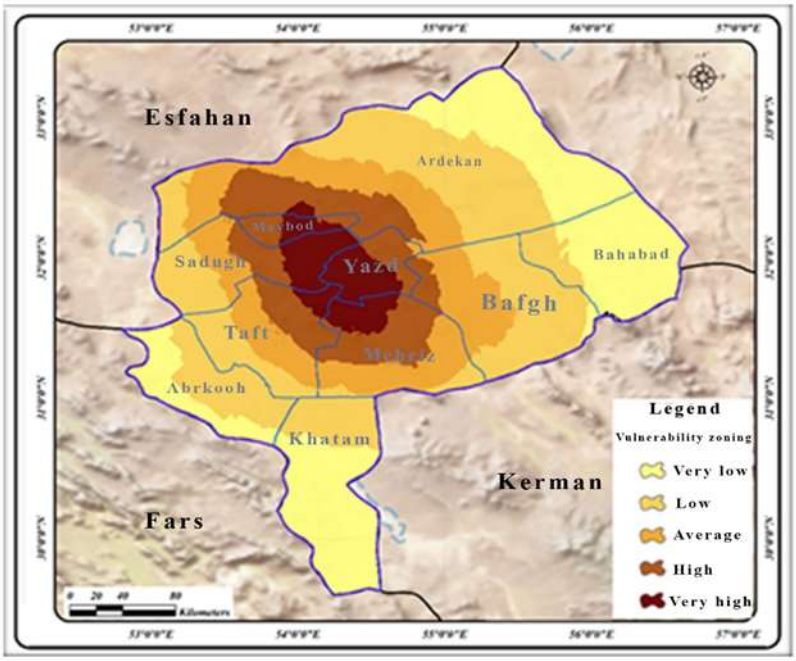


Fig 17 Vulnerability zoning map of energy network infrastructure of Yazd province

Based on the data in Table 3 and Fig 18, when analyzing the vulnerability of energy network infrastructure at the city level, it is evident that Yazd and Meibod are highly vulnerable, followed by Mehriz and Sedek, while Bahabad, Khatam, and Abarkoh exhibit lower vulnerability. This is attributed to the concentration of critical infrastructures in the central part of the province and in the cities of Yazd and Meybod.

Table 3 Vulnerability status of Yazd province in terms of energy network infrastructure by city

City	Pixel count	Min	Max	Average	Standard deviation	Mean	Total	Vulnerability
Abarkoh	2233	3.000	6.000	4.565	0.671	5.000	10194.000	Low
Ardekan	9805	2.000	9.000	5.664	1.634	6.000	55533.000	Average
Bafgh	3516	4.000	8.000	6.187	0.935	6.000	21752.000	Average
Bahabad	2811	1.000	6.000	3.229	1.094	3.000	9076.000	Low
Taft	2433	5.000	9.000	7.010	1.038	7.000	17056.000	High
Khatam	3363	1.000	6.000	3.607	1.300	3.000	12129.000	Low
Sadugh (Akezar)	2374	4.000	9.000	7.202	1.389	7.000	17098.000	High
Mehriz	2811	6.000	9.000	7.579	0.857	8.000	21305.000	High
Meybod	511	8.000	9.000	8.405	0.491	8.000	4295.000	High
Yazd	1040	7.000	9.000	8.567	0.549	9.000	8910.000	High

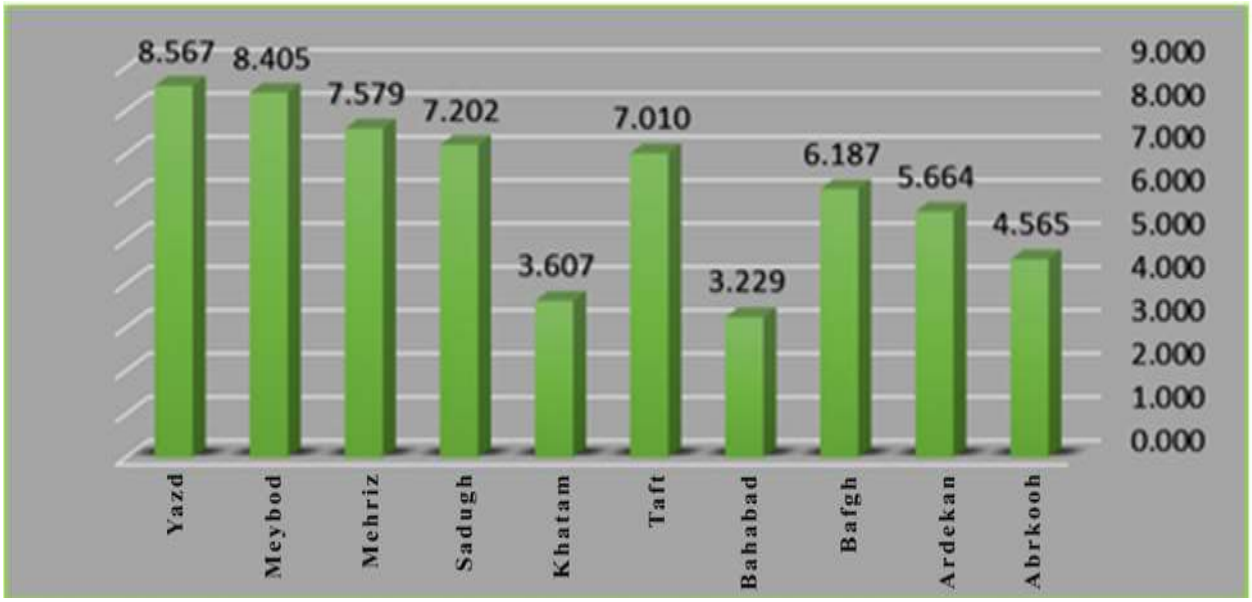


Fig 18 Average vulnerability graph of the cities of Yazd province in terms of energy network infrastructure

5.3. Assessing the Location of Energy Network Infrastructure in Vulnerable Areas

Following the assessment and analysis of the susceptibility of the energy network in Yazd province, the examination of infrastructure placement within each vulnerable zone represented in Fig 19 indicates that over half (55%) of the energy network infrastructure in Yazd province is in an extremely vulnerable zone. Additionally, 18% of the infrastructures are situated in an area characterized by a high level of vulnerability. In the meantime, both the Yazd combined cycle power plant and the oil and gas storage facilities in the province, which are considered critical infrastructure, are situated in highly susceptible areas. Each energy sector infrastructure and its position in vulnerable regions are illustrated individually in Fig 20.

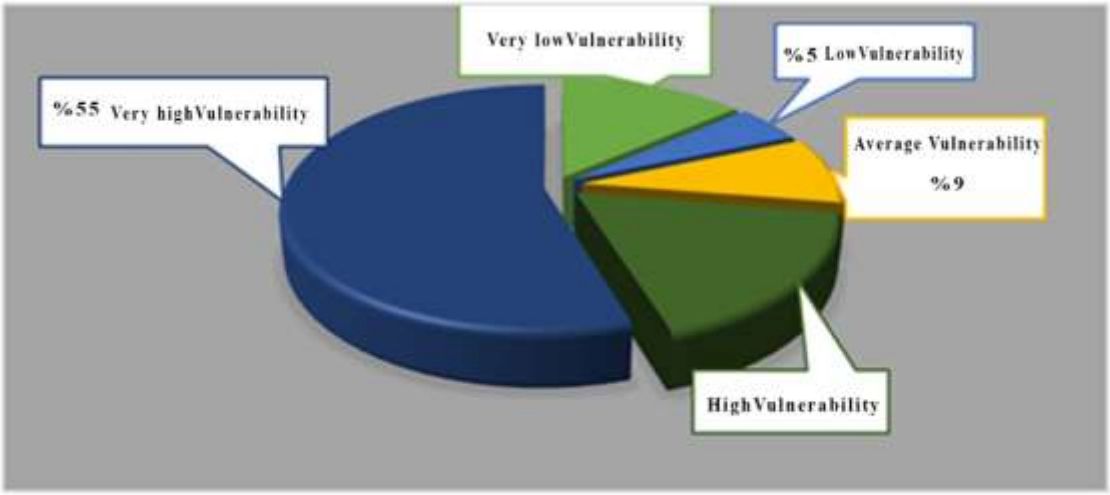


Fig 19 Diagram of the deployment status of Yazd province's energy network infrastructure in vulnerable areas

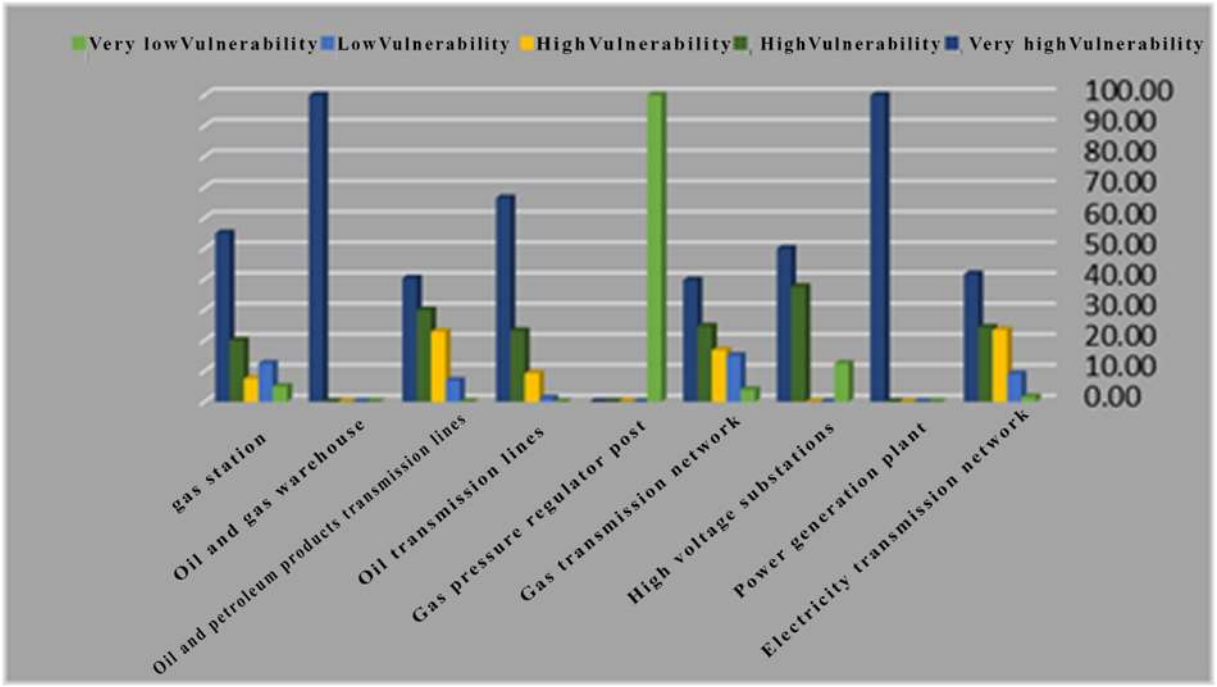


Fig 20 Distribution diagram of Yazd province's energy network infrastructure in the five vulnerability zones

6. Conclusion

Today, the significant importance of passive defense is closely associated with security at various levels, including local, regional, and national, due to its strong potential to enhance both the well-being of communities and their essential facilities and supports. According to this perspective, if a website or organization fails to adhere to the principles of passive defense, it becomes susceptible to risks. The level of vulnerability is directly proportional to the extent to which these principles are disregarded. Given the possible dangers posed to Iran and its important infrastructures within the region, it is crucial to prioritize the issue of passive defense for critical, sensitive, and vital facilities. This wise approach not only reduces costs but also prevents erroneous decision-making. Additionally, it enhances the efficiency and performance of these centers and avoids unnecessary depletion of resources, capital, and time. Vulnerability assessment is a comprehensive evaluation of the effectiveness of infrastructures and systems when confronted with potential risks. Its goal is to identify weaknesses in infrastructure and implement corrective measures to minimize their impact. It is important to note that achieving absolute vulnerability-free conditions is merely a theoretical possibility as stability cannot be guaranteed in the real world. Therefore, vulnerability assessment serves as a means to evaluate and quantify situations that can be monitored.

Vulnerability assessment is a comprehensive analysis of the effectiveness of infrastructures and systems when confronted with potential risks. Its objective is to identify weaknesses in infrastructure and implement corrective strategies to mitigate risks. It is important to acknowledge that achieving zero vulnerability is theoretically impossible. Absolute stability does not exist in the real world. Rather, vulnerability assessment allows for the evaluation and quantification of

situations that can be monitored. The research in question initiated an assessment of the vulnerability of the infrastructure within this specific province.

According to the research findings, the gas transmission network, with a value of 0.1003, along with the transmission lines for oil and petroleum products, with a score of 0.0988, and the oil and gas storages, with a score of 0.0985, hold the greatest weight and significance. Conversely, gas stations, with a score of 0.0485, are considered the least important. These infrastructures have demonstrated increased importance in comparison to other energy facilities within the province. According to experts, energy-related infrastructures, such as fossil and electric energy, hold greater significance in line with the country's resources and society's energy requirements. The susceptibility of the energy network's infrastructure, coupled with the increasing concentration of crucial infrastructures in the central area of the province and the cities of Yazd and Meibod, indicates a high vulnerability for Yazd, Meibod, and Mehriz, while Bahabad and Khatam fall within the spectrum of vulnerability. Thus, the findings indicate that the central region of Yazd province is at a higher risk due to the presence and concentration of energy infrastructure. Conversely, as we move towards the outskirts of the province, the susceptibility of the infrastructure decreases. Consequently, these findings validate the notion that the principle of dispersing infrastructure, which is a crucial aspect of passive defense in Yazd province, has been overlooked and neglected. As a result, this disregard has amplified the spatial vulnerability of the province.

Furthermore, the way in which people in Yazd province are distributed, both in urban and rural areas, highlights the significance of implementing effective strategies to ensure the safety of energy infrastructure. It is crucial to take necessary measures to prevent any harm to individuals and minimize potential casualties or injuries.

Reducing susceptibility and danger while ensuring consistent security involves adhering to systematic and practical approaches. While the primary focus of ongoing research is predominantly on the research methodology, recognizing the significance of implementing procedures based on the outcomes can lead to more favorable impacts and achievements. It appears essential to develop an all-inclusive plan for managing infrastructure at the national and provincial levels, taking into account passive defense principles. This plan should serve as a foundational document.

The principle of dispersion is a fundamental aspect of passive defense. It is crucial to prioritize this principle in order to ensure the safety of Yazd's critical and sensitive infrastructures. Particularly, considering the dispersion of certain infrastructures away from the central area of the province can effectively decrease the susceptibility of this region to potential threats. In the present circumstances, taking into account the significant expenses involved in relocating certain vital infrastructures in accordance with the dispersion principle, it may not seem practically justified. However, implementing alternative passive defense principles is warranted from a security, strategic, economic, social, and environmental standpoint. Furthermore, it is advisable to:

Using the principle of strengthening and fortification in critical and sensitive infrastructures, especially in the central part of the province;

Utilizing domestically developed technology, we employ efficient and secure advanced warning systems.

Physical protection and physical barriers are implemented to restrict and hinder unauthorized access to critical and sensitive infrastructures, such as the national gas network, transmission network for oil and petroleum products, and the high voltage electricity network within the province.

One way to ensure a backup system in case of infrastructure malfunction, particularly concerning electricity which plays a crucial role in society, is through parallelization and implementation of specific measures.

Ensuring the sufficient storage and provision of safe and reliable raw materials is crucial for the uninterrupted functioning of essential infrastructure systems and components in Yazd province.

Ultimately, it is anticipated that vulnerability can be diminished and harm can be prevented through the implementation of specialized training programs and workshops for managers, employees, and particularly crisis management leaders and provincial supply council heads. These initiatives aim to enhance the knowledge and skills of managers involved in sensitive and critical infrastructures.

References

Abedi, A., Gaudard, L., & Romerio, F. (2018). Review of major approaches to analyze vulnerability in power system. *Reliability engineering & System safety*.

Apostolakis, G. E., & Lemon, D. M. (2005). A screening methodology for the identification and ranking of infrastructure vulnerabilities due to terrorism. *Risk Analysis: An International Journal, 25*(2), 361-376.

Brown, T., Beyeler, W., & Barton, D. (2004). Assessing infrastructure interdependencies: the challenge of risk analysis for complex adaptive systems. *International Journal of Critical Infrastructures, 1*(1), 108-117.

Clark, G. E., Moser, S. C., Ratick, S. J., Dow, K., Meyer, W. B., Emani, S., . . . Schwarz, H. E. (1998). Assessing the vulnerability of coastal communities to extreme storms: the case of Revere, MA., USA. *Mitigation and adaptation strategies for global change, 3*(1), 59-82.

Cutter, S. L. (1996). Vulnerability to environmental hazards. *Progress in human geography, 20*(4), 529-539.

Dolan, M., Walliman, N., Amouzad, S., & Ogden, R. (2017). Forensic Disaster Analysis of Flood Damage at Commercial and Industrial Firms. *Flood Damage Survey and Assessment*, 195-209.

Faraji Melai, A., Zahedi, A., Hosseini Amini, H. (2014). Vulnerability of energy transmission network from the point of view of territorial defense with emphasis on passive defense. *Geography Quarterly, 13*(47), 197-210.

Ghafory-Ashtiany, M. (2005). *Earthquake risk management strategies: the Iranian experience*.

Haimes, Y. Y., & Jiang, P. (2001). Leontief-based model of risk in complex interconnected infrastructures. *Journal of Infrastructure Systems, 7*(1), 1-12.

Huang, C.-N., Liou, J. J., & Chuang, Y.-C. (2014). A method for exploring the interdependencies and importance of critical infrastructures. *Knowledge-Based Systems, 55*, 66-74.

Johansson, J., & Hassel, H. (2008). A model for vulnerability analysis of interdependent infrastructure networks. Paper presented at the *European Safety and Reliability Conference (ESREL)/17th Annual Meeting of the Society-for-Risk-Analysis-Europe (SRA-Europe)*.

Kundak, S. (2013). Cascading and unprecedented effects of disasters in urban system. *In Intelligent Systems and Decision Making for Risk Analysis and Crisis Response*. (pp. 743-748), CRC Press.

Little, M., Paul, K., Jordens, C. F., & Sayers, E.-J. (2000). Vulnerability in the narratives of patients and their carers: studies of colorectal cancer. *Health, 4*(4), 495-510.

Little, R. G. (2002). Controlling cascading failure: Understanding the vulnerabilities of interconnected infrastructures. *Journal of Urban Technology, 9*(1), 109-123.

McDaniels, T., Chang, S., Peterson, K., Mikawoz, J., & Reed, D. (2007). Empirical framework for characterizing infrastructure failure interdependencies. *Journal of Infrastructure Systems, 13*(3), 175-184.

Min, H.-S. J., Beyeler, W., Brown, T., Son, Y. J., & Jones, A. T. (2007). Toward modeling and simulation of critical national infrastructure interdependencies. *Iie Transactions, 39*(1), 57-71.

Ouyang, M. (2014). Review on modeling and simulation of interdependent critical infrastructure systems. *Reliability engineering & System safety, 121*, 43-60.

Razovian, M. T., Elian, M., & Rostami, H. (2017). Assessing the spatial vulnerability of infrastructures in Yazd province with passive defense approach. *Amash Sarmeen Quarterly, 10*(1), 31-63.

Restrepo, C. E., Simonoff, J. S., & Zimmerman, R. (2006). Unraveling geographic interdependencies in electric power infrastructure. Paper presented at the *Proceedings of the 39th Annual Hawaii International Conference on System Sciences* (HICSS'06).

Sarmi, H., & Hosseini Amini, H. (2018). Protection of urban facilities and equipment with optimal use of the inner city natural environment with passive defense approach (Case example of Borujerd city). *Quarterly Journal of Urban Management Studies, 3*(2), 52-67.

Saydin, Afshar., Amini Varki, S., Rostami, H., & Yazdani, M. H. (2016). Assessing the spatial vulnerability of Ardabil province infrastructures with passive defense approach. *Amash Sarzemin Quarterly, 9*(2), 333-362.

Soltani, A., Mousavi, S. R., & Zali, N. (2016). Analysis and risk assessment of regional infrastructure from the point of view of passive defense, case example: South Pars Industrial Zone. *Regional Planning Quarterly, 7*(25), 83-96.

Yazd Governorate (2016). *A selection of economic, social and cultural indicators of Yazd Province*. Management and Planning Organization of Yazd Province.

Zimmerman, R., & Restrepo, C. E. (2006). The next step: quantifying infrastructure interdependencies to improve security. *International Journal of Critical Infrastructures, 2*(2-3), 215-230.

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Examining the Components of Teaching Creativity in Architecture with an Emphasis on Semiotics

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Research Article

Abstract

The design process is a set of steps that a designer goes through consciously and unconsciously to achieve a solution to the design problem. What is more important than the design itself is the design process. The goal of a design is to achieve creativity that shows itself in a specific spatial or physical composition. By applying the science of semiotics in design, creativity can be increased in people and people's mental schemas can be strengthened to remember different spaces in people. This research aims to extract and categorize design education components based on semiotic opinions. The methodology is a combination of qualitative and quantitative nested types with quantitative analysis units. In the qualitative stage, semi-structured interviews were used to identify the variables after extracting the concepts, to conduct interviews to clarify the components of the

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The present article is extracted from the doctoral dissertation of architecture with the title "Presenting a model of creative education in the architectural design process based on semiotics to promote creativity; The research case is Basic Skill Courses, which was conducted in the Islamic Azad University of North Tehran, by the first author with the guidance of the second and third authors and with the advice of the fourth author.

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theoretical field effective in design education, and semi-structured interviews were conducted with 28 experts in this field. The results are entered into the ATLASTI version 9.1 software for ease of doing the work. The components were extracted and based on them, a questionnaire with a Likert scale was compiled and distributed among 384 architecture students. The data are analyzed in ORIGINPRO software version 9.9.0.225. The results show that the components of training to observe the principle of holistic view and training to create spatial levels with a value of (1.000) have the highest factor contribution and the least related to the use of different types of light with a value of 0.331.

Keywords: Components of Design Education; Architectural Design; Semiotics; Creativity in Architecture.

1. Introduction

The process of architectural education is assumed to be a fluid and dynamic process that also benefits from the scope of research and research related to the cognitive process of architecture. Therefore, it is not possible to make creative design possible without knowing and understanding the problem to be designed on the one hand and, on the other hand, creativity in the sense of its application in the process of architectural design in terms of form, function, materials and technology. Although there are many definitions for design, they mostly agree on the point that "design is the process of inventing physical things, the result of which is order, organization and a new physical form in order to respond to some human needs (Alexander, 1964). But since there is no formulation or pre-determined steps to convert performance into physical form and nature. They consider design to be more of an art than a science, and they consider design to be a repeatable process of trial and error, which relies heavily on knowledge, experience, and intuitive knowledge, and this intuition has become the basis of many design theories or black box theories. The imbalance between values in architecture has led to the separation of science and practice, and strengthening this attitude has caused architects to rely more on creativity (Boyce, 2003).

In the field of theoretical literature and regarding the process of problem solving in design and creativity in architecture, the category of creativity in architectural education is one of the new concepts that can be considered with the help of new educational technologies. The training of creative minds in architecture students for creativity in design has become one of the necessities and at the same time challenges of the higher education system in this field (Karbasi and Sadram, 2015: 17). Therefore, the development of creative teaching patterns and methods in architectural design is one of the main priorities in the architectural education system, and considering that professors should try to use effective teaching methods to create the basis for the emergence of students' actual abilities by fostering creativity and the use of suitable schemes in the design of providing facilities doubles the necessity of dealing with this issue (Redeemer, 2003: 115). Looking at the importance of cultivating creative power in students and the models related to architectural education, as well as the important role of the scheme in architectural design, it can be understood that according to the type and content of architecture education, a thinking model should be selected or designed for teaching skill courses in this field, including Conducted skill courses in practical workshops in schools, institutes and schools of architecture (Thaghafi et al., 2014: 83). Because recent experiences have shown that the types of thinking and the designer's thinking power during the design process have a direct role in achieving creativity and creativity in design, and the result will be clearly evident in creative architectural designs (Nikkar et al., 2012: 28). On the way

to reach this problem, design teachers and architectural planners should understand the characteristics of thinking, its dimensions and especially creative thinking, how to take advantage of students' hidden talents and take the necessary measures to achieve new educational and educational solutions. act This research seeks to extract and evaluate the effective components in teaching creative design with an emphasis on semiotics and tries to answer the question that what are the effective components in teaching architectural design based on semiotics?

2. Theoretical Foundation

2.1. Semiotics

Semiotics refers to the knowledge that examines the social function of signs and finds the mechanisms of meaning generation through sign systems (Sojodi, 2007: 132). In other words, the application of the science of signs with regard to all cultural manifestations in the form of layers beyond tangible and perceptible signs and paying attention to the implicit meanings and discovering the absence of the text is called semiotics (Dinah and Anne, 2001: 119). Architecture, like any other means of communication, in the conversation process of any social text, carries a message or a set of messages that are conveyed to the audience by means of semantic nodes and intertextual relationships. The audience also tries to receive the messages of the text or create meaning for the text according to the network forming the text and the layers and relationships within the text and through social conventions, issues and mental perceptions and the type of look and angle of view (Ahri, 2017: 401). Therefore, each text opens a system and network of meaning to the audience, and each of the components of this vast network points to another member (Boyce, 2003: 451). Each of these components is a sign that invites the audience to "reproduce" the text, so every text is a network of signs (Asgaripour, 2023: 26). These signs do not have a specific meaning in isolation and show their significance only in the context of the text network. As a result, in order to recognize, interpret, interpret and make meaning of the text, there is a need for a coherent knowledge that deals with the recognition of the micro elements of the text network and the internal relationships of the text and the interpretation of the meaning of the text; This knowledge is called semiotics (Dabbagh and Mokhtabad, 2010: 70).

In the European approach, the Swiss linguist Ferdinand de Saussure was one of the first to emphasize the importance of semiotics, so that he may be considered the founder of semiotics in its European approach. According to Saussure, semiotics is the science of researching systems of meaning (Ahmadi, 2008: 12). From this point of view, semiotics is a closed military and emphasizes the relationship between Dali and symbolic in its abstract form. On the one hand, Saussure's sign gave importance to the necessary relationship between the signifier and the signified, and on the other hand, he considered this relationship optional, which could not be justified from the point of view of the value system. Therefore, Saussure's symbolic sign describes the final and finished certainty (Sasani, 2009: 46).

The choice of the term sign-semantics for this science is related to the development of semiotics. This word was not chosen to make it look beautiful and modern (Shayiri, 2015: 1). The huge development in linguistics that started from Saussure's period, continued with the studies of Yilmazlev, Barthes and others and reached Grams. In fact, it was the same position that the study of meaning found in linguistics (Chandler, 2007: 52). These developments caused the term semiotics to replace semiotics in the field of the Paris school.

In Saussurean and even philosophical semiotics, signs are placed in a systematic and necessary relationship between the signifier and the signified and outside the linguistic process (Majdi and

Zarabadi, 2011: 51). In Peirce's intended semiotics, the relationship between the signifier and the signified is an asymmetric relationship. According to him, this relationship has a sensory-perceptual characteristic (Asadi Jafari et al., 2022). Because the connection between the object and the mental image of the same object is made from the point of view of the subject. Therefore, it is possible to consider the existence of a living presence that has both a look and an angle of vision and receives the sign in a dynamic process; But for two reasons, we still cannot speak of discourse semantics:

a) No place has been seen for the body as the base from which all sensory-perceptual activities are formed; b) Absence of value system; A system without which no intelligence can be attributed to the process of meaning (Majdi and Zarabadi, 2011: 89).

2.2. Dimensions of Semiotics

Sensory-perceptual dimension of semiotics

The semantic sign discourse is connected with various sensory, perceptual, emotional, aesthetic, physical events and tension flows. In literary creations, sign-meanings are formed as a result of human sensory-perceptual connection, so that feeling and perception can be considered as the origin of signs and meanings (Bagheri and Aini Far, 2015: 7). The problem that linguistic sciences such as phenomenology and sign-semantics are faced with is how meaning is formed through feeling and perception. The formation of meaning through feeling and perception is always faced with a fundamental problem, and that is that in literary discourses, there are sensory currents. There are things that Grems calls escape from reality (Asgari, 2022). Based on this fact, it remains hidden behind a curtain of appearance, and in order to compensate for the distance from the semantic reality and to achieve the foundations of sensory perception of signs and meanings, one must refer to phenomenology. Phenomenology makes it possible to achieve these foundations by creating zero knowledge, and such a concept means the study of meaning in the heart of life and in line with the reality close to it, for this reason today, the sign of semantics is to search for the contexts of creating meaning through the sensory and perceptual process.

Sensory-visual dimension

This type of sense has very wide dimensions compared to other types, and it has all the characteristics of other types of sense, such as interactive, transference, ambivalence, internal reflection, symbolic stage, simultaneity, and reversibility, but the most important feature of the visual sense type is that it precedes other senses. That is, the sensory-visual process can cause the stimulation and movement of the agitator and his connection with other sensory streams, or vice versa, it can cause the connection to be closed and the sensory activity to be interrupted. Therefore, this sensory type can be placed at the top of other sensory types and provide the basis for their expansion or disappearance. The sensory-visual dimension is the possibility, reproduction, reproduction, expansion and interaction between functional types or other sensory types (Fuladi and Jafari, 2012: 3). This kind of feeling with the ability to detach a shell can separate everything from its shell and reveal it with a new shell. Light is one of the elements that can change the skin of external species. Soft light, sharp light, dazzling light, reflected light, full light, transparent light, absorbing light, weak light, fixed light, moving light, all are effective in the detachment of the shell and cause semantic fluidity (Ahmadi, 2008: 127). The Table 1, shows some of the meaning-making factors in architecture in the form of various sensory qualities, formal qualities and the qualities that evoke signs.

Table 1 How signs appear in architecture (Falahat and Nouhi, 2013: 21)

Meaning (interpretation)	Example	Slab
Associations resulting from the principles of morphology and associations resulting from patterns	Configuration of architectural building -Use of symbolic forms in building components -Application of some symbolic factors in the direction of the designer's intentions Shaping the architectural space Shaping large and small spaces, scattered and dense, enclosed and open, vertical and horizontal	Formal quality
Associations resulting from patterns, repetition, reinforcement of cultural contexts	Use of architectural materials Symbolic use of materials	Sensory-perceptual quality
Associations resulting from cultural, religious and iconological principles. An association resulting from social principles and the process of repetition.	The use of light in architectural space Using natural light, artificial light, concentrated light or linear light and... The use of color in architectural space	

Creativity

Scientists have provided several definitions of creativity in different dimensions; Some of these definitions are as follows: Creativity means the recombination of ideas, thoughts, thoughts, imaginations and ideas that are already known to a person, but in a new and different way. Creativity is the creation of new thoughts and ideas that have social utility (Nick Kar, 2013: 106) according to Stephen P. Robbins, creativity means the ability to combine ideas in a unique way or create continuity between ideas (Mahmoudinejad, 2011). Another author considers creativity to be the creation of something that did not exist before and gives it a new nature, either in the mind or in the eye. There is something that has not been seen due to the mental blindness of habit. Creativity is a curious and exploratory look at an old phenomenon that finds and reveals it. Creativity is the use of mental abilities to create a new thought or concept. Creativity is the ability. Seeing things in a new and unusual way, seeing problems that no one else recognizes as existing and then providing new unusual and effective solutions for them (Keshtkar, 2013: 23).

1- Types of creativity:

Four types can be considered for creativity:

Practical creativity: Today, there is a need for people who have creative thinking instead of mere technical knowledge.

Mental creativity: Today, there is a need for a mind that can guide a person to new ideas.

Artistic creativity: Art, as one of the main pillars of human life, has a high place in everyone's work and profession. This type of creativity is not only used in the classification and painting of halls and building architecture, but also in industrial and technical design.

Non-verbal and imaginative creativity: In the organization, sometimes it is necessary to free oneself from the shackles of systematic and reasoning thinking and engage in imagination. Today, organizations need scientific and creative imagination in order to be ahead in the field of

competition. In this type of creativity, the human mind flies and flies to the unknown world and hunts for new theories. It puts forward new hypotheses and presents novel models. It may be safe to say that the most comprehensive theory of creativity was presented by Guilford, an American scientist. Guilford, with a lot of research, finally came to the conclusion that human intellectual abilities cannot be summed up in one dimension and call it intelligence or something like that. He found that human intellectual powers can be divided into 150 separate factors, each of which can be measured alone, in his opinion, some of these characteristics are directly effective in the emergence of creativity.

2.3. Teaching Architectural Design Courses

Architecture is the art of mediation; It mediates between the person and the society, personal behavior patterns and human institutions, public and private realms, past and future, etc. and takes over space, time and technology for the purposes of human life, in other words through the unbreakable link of architecture with individual, social and The cultural values of the people can be considered as one of the most significant cultural and artistic manifestations of the society, and also one of the important challenges facing the higher education systems in the third millennium is teaching, learning, how and its quality (Ahmadi, 2012: 11) Architecture is a multidimensional phenomenon that Nature itself is complex. Teaching architectural design to an entity that has complex mental-individual-personal and cultural-social dimensions is worthy of reflection. Architectural profession and consequently architectural education is a process that is strongly influenced by the cultural factors of each country. Since the basic course of architectural design covers an important part of the education course, it plays an important role in the formation of students' personality and their approach in relation to architecture and its related issues, including culture. Is. The importance of this category is due to the establishment of a relationship between two valuable issues in the architectural profession, i.e. theoretical issues on the one hand and executive and professional activities in design on the other hand; Therefore, paying attention to the teaching of architectural design courses is always a priority for the planners of the architectural education system.

The intellectual fields and the designer's thinking power during the design process are among the topics that are discussed today under the influence of cognitive psychology. The types of thinking and approaches adopted by the designer have a direct role in the thinking process from question to answer and its result can be seen in the design product. In the meantime, it is necessary for design teachers and educational planners in the field of architecture to get acquainted with the characteristics of thinking and how to use the talents of students and take action regarding the achievement of educational solutions. Architecture education is aimed at cultivating inner talents and transferring architectural concepts to educate creative and knowledgeable people in this field (Mahmoudi, 2007: 76). The structure of architecture education is formed around a core called design; the most important mission of architecture education is to form a comprehensive thinking that provides the ability to step into the architectural design process for the novice.

If we consider the goal of architectural education to be the training of architects who have talent and ability and master specialized knowledge and use this talent and knowledge in the right direction, it can be considered as ability (interests, capabilities, talents), knowledge (sciences and know-how), insight (applicability). introduced abilities and knowledge in the creation of architecture) as the three main foundations of architectural education. There are design courses in the associate, bachelor and master degrees, as the main focus of the course, which has been identified as the most important courses in the field of architecture education today, based on

various topics. Therefore, the necessity of paying attention to the topic of architecture and dealing with the effective factors in its learning provides valid and acceptable reasons for choosing it among other academic fields as in the previous speeches, from different perspectives such as environmental psychology and curriculum hidden and... the body of the educational space was mentioned as one of the influential components, it can be said that the educational space can influence the education by using the dynamic organization in its physical space and thus improve the quality of education.

2.4. Semiotics in Architecture

Studying to truly understand an architectural building, which is the same as its meaning, must understand the primary concept that created it. Understanding this relationship between the concept as the signifier and architecture as the signified depends on the knowledge of semiotics; Therefore, semantics in architecture has a close relationship with the science of semiotics, and it is necessary to address these two issues to better understand the relationship between semiotics and architecture. Based on the most important theoretical foundations of the semantic field, the effective factors in the definition of meaning are divided into the main areas of "architectural work", "work audience" and "work designer". The knowledge of semiotics is also active in three main single constructions on signs, relationships between signs and audience reading (Talischi et al, 2011: 18). Therefore, the sign is considered as one of the most fundamental factors affecting the perception and reception of the implicit meaning and as a factor in the field of characteristics related to the architectural work and the audience and the designer of the work. To consider the attention of the audience. Semiotics is the knowledge that examines the social function of signs and finds the mechanisms of meaning generation through sign systems. In other words, the application of the science of signs, taking into account all the cultural manifestations in the form of layers beyond the tangible and invisible signs, and paying attention to the implicit meanings and discovering the construction of the absence of the text, is called semiotics. Architecture, like any other means of communication, spread the conversation of any social text carries a message or a set of messages that are conveyed to the audience by means of semantic nodes and intertextual relationships. Social problems and mental perceptions and the type of view and angle of view strive to receive the messages of the text or create meaning for the text (Bagheri and Ainifar, 2015: 9).

Therefore, each text opens a system and network of meaning to the audience, and each of the components of this vast network points to another member. It is one of the signs, these signs do not have a specific meaning in isolation and only in the context of a diverse network, they show their indicative text. As a result, in order to recognize, interpret, interpret and make sense of the text, there is a need for a coherent knowledge that recognizes the micro elements of the network. the text and the internal relations of the text and the interpretation of the meaning of the text; This knowledge is called semiotics, practically semiotics deals with everything that can take the name of "sign" and this knowledge can be considered as understanding and receiving the phenomena of the world, which is obtained through reading and reciting the signs in it. and creates and produces meaning based on symbolic relations for social phenomena, semiotics searches for meaning through the discovery of layers.

This knowledge covers the entire reading of a text or phenomenon and includes all readings resulting from decoding or ideas. Semiotics in architecture is related to the design approach from performance to perception. The classification of signs is basically dependent on the way they are used and the specific contexts of their use. Signs in architecture can be separated into four categories (1) icon (tangible metaphor) (2) profile - intangible metaphorical icon) (3) metaphorical

profile (composite) and (4) the symbol of the icon itself into the sub-branches of diagram image and metaphor. It is noticeably divided. A large number of architectural buildings have a superficial and tangible meaning in appearance. This discovery of meaning in the appearance may be done in the external view of sections, plan or internal and external perspectives. The significant volume of buildings with this feature caused a separate category called profile-icon to be considered in semiotics. In order to describe the characteristics of the profile and the symbol, their characteristics are compared. The first characteristic of the symbol is its scope in architecture, which defines it only within the scope of architecture for perception, which means that symbolic architecture was not created for any specific function and the purpose of its creation is only its perceptual and semantic aspect. The second factor in recognizing the boundary of the symbol and sign is the strong dependence of symbolic architecture on the text and the context of its formation in order to show the meaning of the building as much as possible (Broadbent, 2015: 21).

The cultural background is one of these texts that does not have such a relationship between the building and the text. The third difference between profile and symbol in architecture is the plurality of meanings received by the perceiver of architecture. In this way, in symbolic architecture, there is a unity of perceived meaning, and in indexical architecture, there is a plurality of meaning received by the viewer. Semiotics is less arousing due to the conventionality of the type of relationship between the signifier and the signified, and has less clarity in conveying concepts, so the fourth difference between the profile and the symbol will be the degree of clarity and discoverability of meaning in them. In the symbol, the meaning is in more hidden layers, and entering the field of discovery is only with the knowledge of the contract that creates it. The symbolic meaning of the specific patterns of the built environment also depends on their spatial context. Charles Morris named three levels of meaning under the title of conceptual and functionalist syntax. Syntactic meanings result from how a building is placed in the surrounding environment. The conceptual level refers to the norms, ideas or attitude that an element presents or suggests. Functional meaning relates the symbol to the users of the environment (Ahri, 2017: 44).

2.5. Design Education with a Semiotic Perspective

In the field of architecture, one of the most important but obscure and unknown concepts is the concept of design. Design is an artistic phenomenon that occurs in the mind and has a multidimensional nature, and therefore it is necessary to know the processes and stages of its process. Architecture education is meaningful with design education (Zahakri, 2013: 32). The academic education of architecture has tended towards individuality from the beginning, but the education of architecture is naturally incompatible with the teacher-centered education of the university that originates from the objectivist educational design. For this reason, following the usual methods of university education cannot be beneficial for teaching architectural design (Antoniades, 2018: 33), so in studies aimed at the development of architectural design teaching methods, it is possible to take advantage of the developed capabilities of constructivist educational design approaches, because Constructivist educational design consists of providing environment, resources and support for learning processes (Khabanian, 2008: 51). It is also emphasized to pay attention to principles such as the active participation of the learner in learning processes, inclusion of learning in authentic and real contexts, solving learning problems on the basis of participation and social interactions, therefore, benefiting from audience-centered design training in the shadow of semantics with a semiotic perspective and the nature of a constructive educational environment. oriented and in the shadow of paying attention to the components of the method and content of housing design education, researching in design education requires research in a specific field of

uses, because education processes require different methods and stages based on the content of the subject. In the meantime, dealing with residential space is a priority; Because the residential spaces occupy about half of the city levels and it is the crystallization place of culture, tradition, life form, technology and civilization of any society. On the other hand, most of people's lives are spent at home (Arjamandi, 2013: 25).

Designers analyze the data and discover and extract aesthetic aspects from the perspective of the audience of the design platform and develop ideas based on it (Beamish, 2002: 134). Ideation is formed based on observing psychological dimensions along with aesthetic aspects, and then it creates an effect in the form of designing form, body and space, and after the visualization of the idea, it is evaluated (Mahmoudi, 2007: 76). Evaluation does not mean what is implemented today at the level of design education based on the taste of professors, which means the evaluation of the audience community based on their perception of signs that express the aesthetic views of users in the form of design. The cycle of the process of identification of the substrate and the application of signs in the direction of aesthetic and psychological satisfaction in the form of design, as well as the evaluation of signs by the audience, are the most important aspects of communication between the factors affecting the education of housing design (Alexander, 2013: 271). Psychological aspects mainly influence ideation in the process of design and education, but aesthetic aspects, in addition to influencing ideation, directly affect the design of spatial relations and the evaluation of signs. Another partial cycle in the education process is formed between the stages of form and body design and spatial relationship design, which emphasizes the need for professors to pay attention to the adaptation and harmony of body and space in students' design. The cycle of research-based analysis - ideation - design of spatial relations - evaluation of the collective reading of signs also points to the need to guide students to the realization of ideas in the form of designing spatial relations in line with the satisfaction of the audience (Lawson, 2007: 36).

In the Figure 1, the theoretical consensus of the theoretical foundations is depicted:

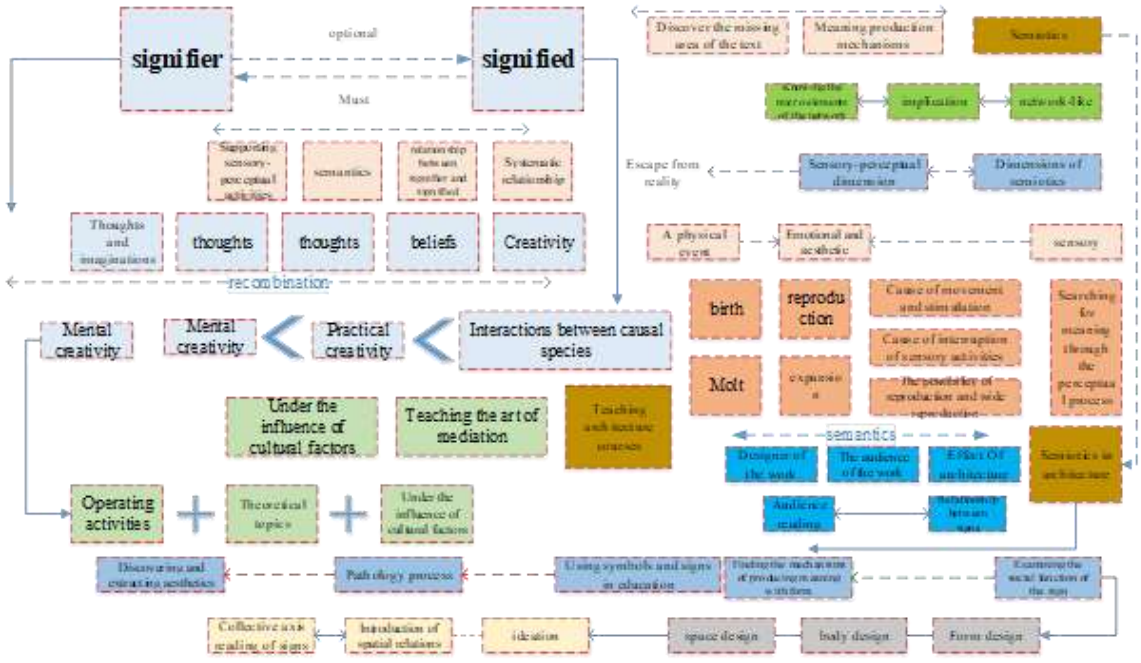

Fig 1 Opinion summary diagram

3. Research Methodology

In terms of developmental-applied type, this research has a nest-to-nest combination in terms of method. To answer the research question, qualitative research method is used in nest-to-nest quantity. In the qualitative method, the system of semi-structured interviews with researcher-made criteria is used to extract and verify the components of education in architectural design with emphasis on semiotic opinions. Research questions are used on the basis of extracting and developing the main research questions. The results of the questionnaires are entered into the NVivo software in the form of textual data and are subjected to open coding with a description and interpretation approach. The results are extracted in the form of spider diagrams. The 24th person repeated. Then, based on each component, a question based on what it is and 5 Likert scales is designed and given to 76 students. The statistical population is 95 fourth-year architecture students. The results are entered into the Grapher 19 software and the results are analyzed with numerical and graphical inferential statistics. For the correctness of the qualitative questions, it is checked and scored by experts using the Delphi method. The validity of the questionnaire using the CVI formula is 0.78 and the reliability is 0.72 using Cronbach's alpha. For convenience, a pre-designed coding table is used. Interview analysis is done using Atlas T software and using open and axial coding.

4. Research Findings

4.1. Qualitative Findings

Based on the interviews conducted with experts, 41 people were interviewed, and from the 24th person onwards, the data is not saturated and repeated. First, 35 codes were extracted, which were limited to 25 codes after summarizing the data. The most prominent code is related to creating an image and image in the mind of the audience with a prominence of 23, and the least related to teaching light design with a prominence of 8.

Fig 2 Extracted codes in the form of components and spider diagram

4.2. Descriptive Statistics

In this section, one question has been formulated for each variable. The questions are closed with a Likert scale that has answers from very high to very low. To convert them in the JMP software, they are given a range of 1 to 5 points. Based on the general questions, it is determined that the largest number is related to the group of men with the number of 56 people and women with the number of 39 people, the age groups are between 22-25. The highest frequency is related to the training of integration and cohesion with the value of 471 and the lowest is related to the training of using light with the value of 198. The support of the moving average of the data distribution shows the high accuracy of the measurement.

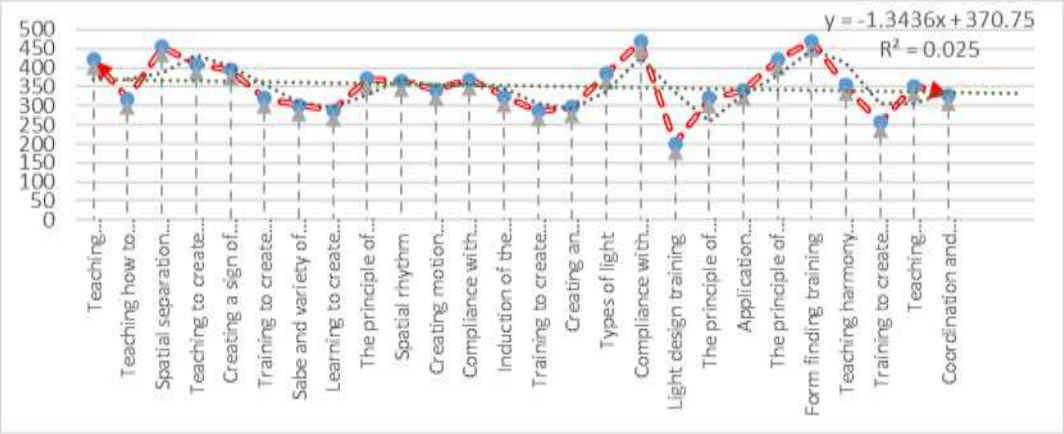

Fig 3 Frequency chart of design education components based on semiotics

4.3. Inferential Statistics

Two-Sample Kolmogorov-Smirnov Test is used to check the parametric and non-parametric type of data.

Table 2 Kolmogorov-Smirnov test to check the normality of decorative pattern variables (Source: Authors)

p	Z Kolmogorov Smirnov	Standard Deviation	Average	Variable
0.585	0.893	28/5	25/41	Design education components based on semiotics

As can be seen in the table above, the Kolmogorov-Smirnov test is not significant (p=0.585), and therefore, the design education variables based on semiotics do not have a normal distribution, and non-parametric analyzes can be used for them. Based on the data correlation results, it is determined that the highest correlation is related to the education of creating order and unity with a value of 0.920 and the lowest is related to the principle of alignment with a value of 0.265.

Table 3 Pearson's correlation coefficient of design education variables based on semiotics (Source: Authors)

Variable	Correlation coefficient	Meaningful
Teaching compliance with the principle of holism	0.883	0.001
Teaching how to use materials	0.619	0.007

Spatial separation training	0.836	0.006
Teaching to create order and unity	0.920	0.006
Creating a sign of focus and emphasis using the design teaching method	0.654	0.004
Training to create an image in the audience's mind	0.625	0.002
Sabe and variety of components	0.546	0.004
Learning to create a light hierarchy	0.681	0.008
The principle of alignment	0.265	0.007
Spatial rhythm	0.429	0.001
Creating motion cues using design tutorials	0.623	0.009
Compliance with the aesthetic principle	0.685	0.003
Induction of the principles of psychology	0.621	0.004
Training to create behavioral diversity	0.652	0.002
Creating an invitation through design education	0.612	0.003
Types of light	0.381	0.008
Compliance with coherence and continuity	0.484	0.005
Light design training	0.464	0.001
The principle of personalization	0.421	0.007
Application Release, Break, Pass	0.631	0.004
The principle of spatial proportionality	0.124	0.002
Form finding training	0.311	0.006
Teaching harmony proportions	0.325	0.002
Training to create spatial hierarchies	0.425	0.011
Teaching transparency and spatial continuity	0.223	0.021
Coordination and integration	0.529	0.024

4.4. Regression

To use the type of linear or multivariate regression, the internal correlation matrix diagram of creativity education variables is used. After drawing the correlation matrix diagram, it was found that the factors have no linear relationship; Therefore, it is correct to use multivariate regression.

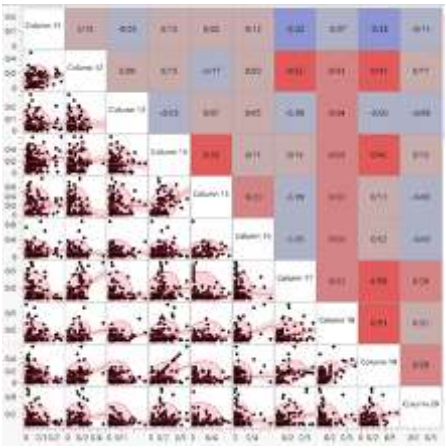

Fig 4 Internal correlation matrix of variables (Source: Authors)

Based on the results of multivariable regression, it is determined that the components of training to observe the principle of holistic view and training to create spatial levels with a value of (1.000) have the highest factor contribution and the lowest is related to the use of different types of light with a value of 0.331.

Table 4 Multivariate regression of design education components with emphasis on semiotics (Source: Authors)

Variable	**t**	β	F	Meaningful	Coefficient of determination
Teaching compliance with the principle of holism	522.46	623.643	222.527	0.001	1/000
Teaching how to use materials	152.42	683.849	122.405	0.007	0.920
Spatial separation training	223.40	603.349	343.217	0.006	0.803
Teaching to create order and unity	239.38	945.184	943.199	0.006	0.746
Creating a sign of focus and emphasis using the design teaching method	958.8	748.276	612.201	0.004	0.681
Training to create an image in the audience's mind	134.11	943.199	623.643	0.002	0.816
Sabe and variety of components	441.18	034.499	683.849	0.004	0.650
Learning to create a light hierarchy	144.19	034.523	603.349	0.008	0.846
The principle of alignment	173.49	258.147	945.184	0.007	0.814
Spatial rhythm	963.47	564.321	748.276	0.001	0.546
Creating motion cues using design tutorials	226.46	371.492	943.199	0.009	0.795
Compliance with the aesthetic principle	228.47	658.471	034.499	0.003	0.243
Induction of the principles of psychology	288.25	987.650	034.523	0.004	0.895
Training to create behavioral diversity	256.45	960.542	258.147	0.002	0.978
Creating an invitation through design education	552.41	362.214	564.321	0.003	0.462
Types of light	356.21	0.401	371.492	0.008	0.331
Compliance with coherence and continuity	321.58	0.411	222.527	0.005	0.745
Light design training	694.19	0.421	122.405	0.001	0.752
The principle of personalization	879.24	0.589	343.217	0.007	0.920
Application Release, Break, Pass	587.44	0.521	943.199	0.004	0.803
The principle of spatial proportionality	566.48	0.542	612.201	0.002	0.746
Form finding training	522.46	0.545	623.643	0.006	0.681
Teaching harmony proportions	152.42	0.411	683.849	0.002	0.816
Training to create spatial hierarchies	223.40	0.309	603.349	0.011	1/000
Teaching transparency and spatial continuity	239.38	0.517	945.184	0.021	0.846
Coordination and integration	958.8	0.517	748.276	0.024	0.814

Based on the regression findings, it is determined that the highest factor contribution is related to geometric shapes with a value of (1.000) and the lowest is related to Maher tiles (0.215).

4.5. PN Modeling

In PN modeling, it was found that the biggest contribution to answer the questionnaire questions individually is related to teaching how to use materials, and the answers indicate the accuracy of the results and data accumulation to 95% in the answers, also to increase the maximum efficiency for the application. The components of design training are used from the following combination:

Teaching how to use materials, coordination and assimilation, teaching to create spatial levels, the principle of spatial proportions---> 26%

Teaching spatial rhythm, teaching harmony proportions, teaching creating order and unity, teaching spatial separation, teaching form finding--->16%

Kinds of light, teaching to observe the principle of holistic view, teaching to create order and unity, teaching to create spatial diversity--->9%

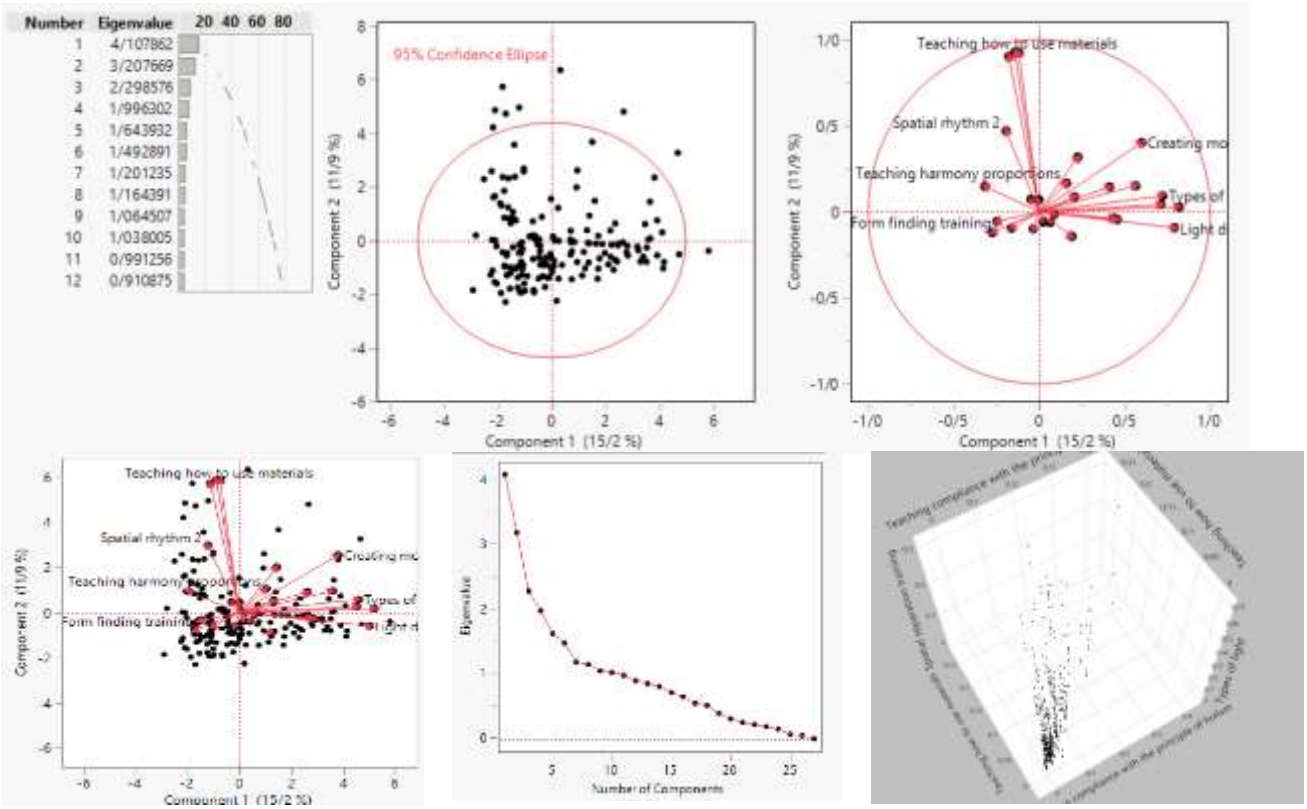

Table 5 PN modeling of design education components (Source: Authors)

Based on this, the simultaneous use of 10 components can significantly improve students' creativity. The three-dimensional model of its distribution indicates that the effectiveness of the components is increasing and over time it plays a more significant role in creating students' creativity. It seems that teaching objective aspects derived from semiotics have a more decisive role than mental components in promoting creativity.

5. Discussion

In the qualitative part, a number of 25 components were extracted, the most prominent of which was related to the training of creating an image and image in the mind of the audience, which seems that the experts put a lot of emphasis on creating an image and illustrating the display of data in the mind of the audience based on symbols and signs. Torrance's questionnaire was used to measure students' creativity (Torrance, 1970). According to them, creating a mental schema is a mental illustration and slideshow of events in relation to environmental components and attention-grabbing symbols in educational spaces. According to them, light design education has very little influence on the formation of students' creativity, perhaps on this basis, objects by experts play a more prominent role in sign-based education.

The results of descriptive and inferential statistics have significant differences with each other, and inferential statistics should be used for data analysis of the results. Descriptive statistics show that when the pillars in the space have integrity and coherence, it is easier to play a role in people's minds as a symbol or sign. Continuity and cohesion in design for students in the field of body and space design training and creating harmony between them emerges, if they are based on order and unity in design, it has a double effect on other components to achieve an increase in creativity. It acts separately and has less impact on other components. In the regression results, it is re-emphasized to create unity among all objective and non-objective elements in the design by students. Also, creating detail in the design of space for students and creating quiet spaces is a main factor in It is to promote people's creativity. Light and how to deal with it in design, due to its lack of physical nature, cannot encourage students to design creatively.

6. Conclusion

The final goal of teaching architecture to students is to encourage and increase their ability to achieve creative design by using the elements of a building in the form of a coherent phenomenon and in a single shell. The sign and productivity of it can encourage students in a way that they can use different methods to depict meaning in the form of a physical work in several different ways. This research showed that different elements can be extracted from the components of design education in sign, which will lead to the education of students based on increasing creativity, and at least 10 of them should be used together. This research showed that there are different elements of education that should be paid attention to. Below are some strategies for teaching architecture;

- Teaching theoretical concepts on the same basis as design concepts and how to illustrate and illustrate based on the physical nature of objects in the design of various buildings.
- Rereading the concepts of signifier and signified and conceptual semantics based on spatial elements and conceptual narrating of a unified and coordinated body.
- The use of natural and spatial elements in the design of the architectural education environment, such as stairs, fountains and green spaces that encourage students to gather and talk, which is considered as the center of a space.
- The use of students' opinions in developing creative lesson plans based on conceptual convergence and eliminating the difference between the degree of importance of the components of creativity in architecture education based on signs
- Typology of the objective and subjective aspects of the elements of the space and how they are symbolized by interpreting multiple meanings in the intermediate spaces.

References

Ahmadi, B. (2008). *Text structure and interpretation*. publishing center, Tehran.

Ahmadi, F. (2012). *The position of the discussion group in the creative process in architectural education*. Doctorate dissertation, Faculty of Art and Architecture, Tarbiat Modares University.

Ahri, Z. (2017). The application of Charles Morris method in the study of urban architectural signs. *The collection of articles of the third semiotics of art*, 1-15.

Antonias, A. (2018). *Architecture Boutique, first volume, subtle strategies towards architectural creativity* (Reza Ai, A. Trans.). Soroush Publications, fourth edition.

Arjamandi, H. (2013). *The spiritual and psychological effects of light and color of traditional Iranian houses on the residents* (Mir Lo, M. M., & Samia Asadzadeh, H. Trans.). Marafat Information Journal, (69), 25-30.

Alexander, V. N. (2013). Creativity: Self-Referential Mistaking. Not Negating. *Biosemiotics, 6*, 253-272.

Asadi Jafari, N., Etesam, I., & Habib, F. (2022). Explain the Role of Transforming the Problem Components on Increasing Creativity in Architectural Design Competitiveness. *International Journal of Applied Arts Studies, 6*(3),7-20.

Asgari, A. (2022). Evaluation of University Education in Architecture at the Undergraduate Level from the Viewpoint of Professional Needs and Employment. *International Journal of Applied Arts Studies*, *7*(1), 33-48.

Asgaripour, Sh., Farmahini Farahanib, R., & Nikkhah Shahmirzadi, M. (2023). The Role of the Environmental Components of the Corridors of Educational Spaces in Increasing the Design Learning of Architecture Students. *International Journal of Applied Arts Studies*, *8*(4), 25-44.

Bagheri, S., & Ainifar, A. (2015). Scrutiny and limitation of the scope of inclusion and manifestation of signs in architecture. *Arman Shahr Journal, 17*, 1-10.

Beamish, A. (2002). Strategies for international design studios: using information technologies for collaborative learning and design. *Architectural education today: Cross cultural perspectives Journal*, 133-142.

Boyce, P. R. (2003). *Human Factors in Lighting*. (2th.). London: Taylor & Francis.

Broadbent, G. (2015). A simple guide about the theory of signs in architecture, *Iranian Architecture Quarterly Journal*, *21*, 16-21.

Chandler, D. (2007). *Fundamentals of semiotics* (Parsa, M. Trans.). Sore Mehr Publishing Company, Tehran.

Dabbagh, A. M., & Mokhtabad, M. (2010). A new framework for the study of contemporary Tehran mosques. *Naqshjahan Journal*, 4(2), 22-35.

Dinah, S., & Anne, M. (2001). *An introduction to semiotics*. Mozaffar Kahraman, Question publication.

Falahat, M. S., & Nouhi, S. (2011). The nature of signs and its role in enhancing the sense of place in architectural space. *Fine arts-architecture and urban planning Journal, 1*, 17-25.

Fuladi, V., & Jafari, F. (2012), comparative comparison of lighting of contemporary architecture and traditional architecture (case example of Khan Shiraz School and Saadi 15th grade primary school in Shiraz). *Architecture and Urban Planning Studies, 14*(5), 1-15.

Khabanian, A. (2008). *Creativity in the architectural design process*. Tabriz, Mehrman Publications, first edition.

Karbasi, A., & Sadram, V. (2015). Teaching an architect or training an architect: a reflection on the mission of an architectural design instructor. *Soffeh Journal, 26*(73), 5-20.

Keshtkar Qalati, A. (2013). *Re-editing the teaching method of graduate architecture studies based on a systemic approach*. Master's thesis, Faculty of Art and Architecture, Tarbiat Modares University.

Lawson, B. (2007). *How designers think, demystifying the design process* (Nadimi, H. Trans.). Tehran, Shahid Beheshti University Press, second edition.

Mahmoudi, A. S. (2007). Challenges of architectural design education in Iran. *Fine Art Journal,* 70-79.

Majdi, H., & Zarabadi, S. Z. (2011). A survey in urban semiotics. *Armanshahr Journal, 3*(4), 49-56.

Mahmoudi-Najad, H. (2011). *Explaining the basics of teaching creativity in bio-based architecture*. PhD thesis, Faculty of Art and Architecture, Tarbiat Modares University.

Nikkar, M., Hojjat, I., & Yazidi, A. A. (2012). Investigating the target structure and its application in creating motivation in architectural novices. *Iranian Architectural Studies, 2*(3), 85-106.

Redeemer, T. (2003). *Evaluation in the service of education*. Tehran: Menadi Tarbiat Cultural Institute.

Sassani, F. (2009). *Meaning analysis: towards social semiotics*. Alam Publications, Tehran.

Shayiri, H. (2015). The study of the role of artistic discourse in replacing signs and changing their semantic function (a study of photography of tattoos), the collection of articles of the second consensus on art semiotics, under the care of Hamidreza Shayiri, Tehran: *Farhangistan Honar Journal,* 133- 150.

Sojudi, F. (2007). *Applied Semiotics.* Science Publications, Tehran.

Thaghafi, M., Mozafar, F., & Mousavi, M. (2014). Investigating the effect of teacher-student direct participation teaching method on the learning process in the introductory course of architectural design. *Restoration and architecture in Iran Journal, 5*(10), 79-90.

Talischi, G., Izadi, A. A., & Ainifar, A. (2011). Cultivating the design ability of beginner architectural designers, designing, applying and testing a constructivist learning environment. *Journal of Fine Arts-Architecture and Urbanism, 17*(4), 1-18.

Torrance, E. P. (1970). *Creative learning and teaching*. New York: Dodd.

Zakari, S. M. H. (2013). *Background-based knowledge in design: searching for a model to use in architectural design education.* Doctoral Dissertation. Architecture group. Faculty of Fine Arts. University of Tehran.

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The Role of Enigmatic Architectural Components of Museums on Audience Perception (Case Study: Museum of Contemporary Arts in Tehran)

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Research Article

Abstract

The process of transferring information in the Museum of Modern Art History is based on the representation of the evolution of culture over time. The more information there is, the more possibilities are available to the audiences, but this rule is usually not followed by contemporary art museums because in the architecture of these types of museums, attention is not paid to the process of attracting the audience. This research tries to investigate the role of the enigmatic architectural components of museums on the perception of the audience in the Contemporary Arts Museum in Tehran. The research method was a nest-by-nest combination to achieve this goal. The data collection method in the combined research (library and field). First, in the qualitative part, the components of enigmatic architecture from the theoretical research literature were extracted. Then the code table were compiled. Interviews were arranged, based on interviews, the variables of the role of the enigmatic architecture of museums on the perception of the audience in the museum of contemporary art were presented. In the quantitative part, questionnaires were used for verification. The sample size is 46 interviews in the qualitative phase and 384 people in the quantitative phase. The results show that discovery and surprise are the most important factors, the dynamic and

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horizontal arrangement of elements in space is the second factor, and the harmonious relationship between space and light is the third factor affecting the perception of the audience in the enigmatic design of the studied museum.
Keywords: Museum; Enigmatic Architecture; Audience Perception; Contemporary Art Museum.

1. Introduction

A museum is a historical-cultural space that can itself be an ambiguous, enigmatic space full of different questions regarding the past. Considering the importance of the destination and the preservation of culture and preservation of cultural artifacts, it is very important to comply with some standards in the museum (Pir Babaei and Anuri, 2012: 8). Therefore, in today's architecture, architects should not use visual stimuli in design. In this case, the ambiguity feature of the stimulus can be effective as this feature makes it impossible to have a superficial impression of the design or building in question, which causes a kind of persuasion in the interpretation of today's critics, a kind of participation of the viewer with the said architecture to create new meanings. This capability is considered an attraction for the work in architecture and an important part of the building depends on it (Pirzadi and Alaei, 2018).

It is always necessary to analyze and investigate the existing architecture to establish and establish a relationship between architecture and man, and from another point of view, to create a lasting architecture to achieve amazing architecture, and finally to reach favorable conditions so that people's needs are met. In this direction, identifying and determining the necessary parameters for museum design, understanding sensory design techniques, archetypes, and the use of enigmatic architecture in museum design should be used (Fen and Sal, 2010). Also, to clarify the issue of architecture in the future, there is a great and deep need to know the visual stimuli in architecture, so it is necessary and necessary to express these stimuli to create a desirable and worthy human atmosphere to improve the quality. This research seeks to investigate the role of enigmatic architectural components and creating a desirable and worthy human atmosphere on the audience's perception.

According to the extensive search in domestic and foreign sources, the description of which is described in detail in this research, research called the role of the enigmatic architectural components of museums on the perception of the audience is done for the first time, and the researcher is not in any of the scientific and academic bases and scientific institutions. , research and education both inside and outside the country could not find a similar example until the completion of this article; Therefore, to investigate and explain the effective components of enigmatic architecture on the audience's perception, it tries to answer the following question: How do the enigmatic architectural components of museums affect the audience's perception?

2. Theoretical Framework

2.1. Dictionary Definition of a Museum

The word museum is adapted from the Greek word "mozin", which means the abode of "mouse", the goddess of arts and crafts in ancient Greek mythology, which is pronounced museum in English and museum in French (Kaplan, 1976) around the decade of 1261 A.H. The French pronunciation of "Museum" also found its way into the Persian language (Golledge, 1999: 124). The International Council of Museums affiliated with the Organization, Cultural, Scientific and Educational Organization of the United Nations, in paragraphs 3 and 4 of its statutes, which is the most

comprehensive definition of a museum, says that a museum is a permanent institution without a material purpose whose doors It is open to everyone and works to serve society and its progress (Pirzadi and Alaei, 2018). The purpose of museums is to research the works and evidence left by man and the environment, to collect, preserve, and create connections between these works, especially to display them to examine spiritual productivity (Weisman, 1981: 189-204). The definition of a museum from the Omid dictionary is a collection of antiquities, a building where antiquities are kept or exhibited. In ancient Greece, it was the name of a place where they studied crafts and sciences, and it was also the name of a hill in Athens, where they built a place of worship and a special place for several of your gods that came into being and the muses were the daughters of Jupiter, who were considered the gods who inspired science, literature, art, music, and sculpture (Peponis et al., 1997: 341-358).

2.2. Duties of Museums

Every museum has three basic tasks - preservation and maintenance - 2 research and search; 3- communication (Dehghan, 2013). Preservation includes selecting and collecting cultural works and taking care of them. Research and search are the preparation of documents, which is considered a necessary platform for research and search. are taken, and among them, we can mention educational programs intended for different age groups, holding exhibitions, launching publications, creating websites, multimedia programs, etc. (Pir Babaei and Anuri, 2013: 8).

3. Characteristics of Museums

3.1. Complexity and Mystery

Complexity in an environment can affect arousal and performance in that environment. Excessive stimuli cause distraction and increase the fatigue of students, just as excessive simplicity is boring and destructive. Classrooms have more goals than just learning, so maintaining a balance of complexity will be the best approach (Klonk, 2009).

3.2. Signs

One of the most familiar problems in museum design is the pattern used for interior spaces. Some of the principles of sign design include the following: Using signs in prominent and important places throughout the building; Using specific colors to provide orientation information; Use some sort of tokenization system that gives visitors a sense of control over the environment, rather than relying on employees to answer their questions (Koseoglu and Onder, 2011: 1191-1195).

3.3. Navigation in the Museum

The complexity of museum environments is one of its inherent characteristics because they aim to display as many galleries as possible. One of the ways to overcome this complexity is inherent in creating signs for navigation in the museum because most people prefer to use signs rather than asking employees (Hart and Moore, 1973).

Fig 1 Examples of signs and routing maps (Klonk, 2009)

3.4. Exploration and Tourism

Another important topic is the way visitors explore and tour the museum. Visitors are biased towards the right side and as soon as they enter the gallery, they start looking and moving around from the right side (McQuail and Windall, 2009: 73).

At first, visitors see all the galleries, but as time passes, they become more selective and stop to visit fewer galleries (Weisman, 1981: 189-204).

People tend to use the first output they see, so people only see part of each gallery. Researchers call this pull of exits "exit stimulus" (Klatzky, 2003: 310-325).

Museum fatigue

Visitors miss many galleries without stopping to take a look. As a result, they will also miss many things that can be gained from visiting the museum (Porco, 2010).

Robinson used the term museum fatigue to express this phenomenon. Fatigue is caused by mental saturation as much as it is caused by physical activity (Weiss, 2013).

When visitors focus on a few galleries for a long time, they become so saturated with the museum environment that the galleries will become boring and boring (Levine et al., 1984: 139-157).

Fig 2 Museum fatigue in museum visitors (Weiss, 2013)

When excessive excitement is received from the museum environment, the effort is to ignore less important details and signs to pay attention to more important signs. This is a phenomenon that

happens in museum fatigue. Audiences become saturated with complex information and spend less and less time looking at museum details (Macleod, 2012).

Robinson believes that this fatigue can be reduced by creating a discontinuity in the gallery design. Discontinuity means a change in the rhythm of movement. For example, you can use a sculpture or furniture to make a space between the paintings in a gallery. Or who reduced the number of paintings exhibited (Hormuz, 2001: 42). Also, a label with large letters and an explanatory description would be helpful. In the case of interactive exhibitions, it will be effective to encourage visitors to participate in the show (Russell et al., 1989: 499-502).

Fig 3 (right) label with capital letters and descriptive description (Uebele, 2007)

Fig 4 (Left) Spacing between the works of a gallery with a space to pause and sit (Uebele, 2007)

The surrounding space is one of the best solutions in attracting the attention of visitors (Haq, 2001: 13). That is, the space that surrounds the displayed components of visitors can be increased when visitors spend time in a gallery by adding factors such as interactive components, stimuli involving several senses simultaneously, better lighting and texts that are more readable (Saegert, 1973: 254-260).

Fig 5 Examples of spaces containing the environment (Weiss, 2013)

3.5. Museum Audience

McQuail is one of the professors in the field of mass communication and media and one of the greatest theorists of mass communication and audience studies. He was born in London in 1935 and

his published scientific works are more than 15 book titles and dozens of scientific research articles. Among his works, his book Theories of Mass Communication was more popular and his world fame is from it (Mc Quail, 2006). So that in 2010, this work with the new title "McQuail's Theories of Mass Communication" reached the sixth edition and still has a special place in the publishing market. In an interview in 2009, McQuail expressed his interest in studying mass communication under the influence of the writings of Raymond Williams and Richard Hogarth mentions that four works of MacQuail have been translated into Persian (McQuail and Windall, 2009: 73).

Audience Studies written by Dr. Mehdi Montazer Ghaem in 2001, An Introduction to Theories of Mass Communication written by Dr. Parviz Ajjali, in 2003 and Models of Mass Communication translated by Goudarz Mirani in 2009 (Ajjali, 2009), and of course, An Introduction to the theories of mass communication by Dr. Hormoz Mehrdad in 2001, which is a free adaptation and translation from the second edition of McQuail's Theories of Mass Communication (Hormoz, 2001). Research in various fields can benefit from the audience's point of view. In this research, the target audience is the person addressed by the researcher. In general, in two or more communications, the person or persons to whom something is said is called the audience, the audience of the media is often not visible except in a scattered and indirect way, but in the present research, the audience of the researched media (the museum) is available and can be evaluated and it is a poll, according to what has been said, the audience can be defined as the audience is someone who voluntarily turns to the content of a certain media (Bakhshi and Davodiroknabadi, 2022). Audiences are classified into different types based on various indicators (A) Audience classification based on demographic characteristics This category consists of age, sex, occupation, number of family members, individual's position in the life cycle, family income, education, geographic location, religion, race and nationality. b) Categorizing the audience based on beliefs. On this basis, the audience perceives the world in different ways depending on their experiences, the effects of the environment, mental beliefs, etc. (Rasouli et al., 2023: 98). A phenomenon may have different meanings for different people and groups (Passini and Arthur, 2002).

4. Research Background

Ghobishavi, Kabuli in 2021 in the article on designing the interior architecture of the Abadan Museum with the approach of identity and inspiration from traditional architecture reached the following results: This study was carried out to design the interior architecture of the Abadan Museum with the approach of identity and inspiration from traditional architecture. In this research, it has been collected both by field method (questionnaire and library method). The measures of this research are questionnaire - field studies - documentary and library studies and experimental observations. To analyze the information, the methods (diagram-table-statistical, descriptive, and inferential) related to the topic of data have been used. The analysis shows that some of the original concepts of Iranian traditional culture and architecture have directly and indirectly influenced the design of the contemporary art museum in a way that these concepts overlap with the concepts of building formation.

Taheri, Rahimi Mehr in 2021 in the article "Museum design criteria with traditional architecture approach" said: Museums display some of the components of material culture and the objects in museums may not belong to that city only, so choosing a city to create A museum can have different reasons, but in general, the variety of works and objects in museums can indicate the growth of the civilization of that country. The main goal of the current research is to provide museum design criteria with a traditional architecture approach. The method of this descriptive-analytical research and the type of data collection is the library. In this way, to examine the concept,

characteristics, definitions, type, and style of museum design, as well as studies in the field of research approach, i.e. traditional architectural concepts, information was collected in the form of a documentary and field library, and this information was collected from various sources such as related books, research articles, Databases, etc. were extracted. According to the objectives of the research and investigations, based on the research findings for each of the principles of traditional Iranian architecture, including moderation in decorations, use of functional decorations, moderation in the size of the building, creation of multi-functional spaces, prohibition of aristocracy, etc.

In 2018, Pir Zadi and Alaei, in their article investigating the role of ambiguity in architecture, reached the following results: since the late 1980s, when postmodern and deconstruction topics were developed, postmodern architecture this time by accepting fundamental changes and new horizons from the perspective of visual stimuli such as; they found ambiguity and complexity. Thus, now in the 21st century, a new end has been opened. A new beauty is emerging in this world. Replacing the complex buildings instead of the silent and static buildings of the classical era, the architecture of the world, like this world itself, is becoming creative, self-changing, and unpredictable. Ambiguity in architecture in the modern and postmodern era was seen in the works of Peter Eisenman and Frank Gehry. In today's architecture, architects should not use visual stimuli in design. In this case, the ambiguity feature of the stimulus can be effective, which makes it impossible to get a superficial impression of the design or building in question; Which causes a kind of persuasion in the interpretation of today's critics, a kind of participation of the viewer with the said architecture to create new meanings. This ability in architecture is considered an attraction for the work and an important part of the building depends on it. On this basis, this research is investigated clearly and ambiguously. The method of conducting this research is library and internet research and analysis and interpretation of related materials.

Pir Babaei, Anuri in 2012 in their article "Mystery and Ambiguity in Islamic Architecture" stated: "The journey through the beauty created in Islamic architecture requires a spiritual journey to its mysterious valley." Where every pattern and color is a solid code of existential truth. A code that the audience reflects in the mirror of their existence, and the perceiver and the perceived seek unity. To understand the architectural concepts of this land, one must know and understand the cultural perspectives in which these concepts were created. In this regard, it is necessary to pay attention to the stability of essential concepts hidden in phenomena over time and to be inspired by them. The purpose of writing this article is to get familiar with the concept of mystery and ambiguity in literature, philosophy, and architecture, as well as to examine its relationship with human nature and its manifestations in Islamic architecture so that designers and perceivers can get closer to truth high values.

McLeod, Suzanne in 2012 in the book Making the Museum concluded that: In recent decades, many museums, galleries, and historical sites around the world have made an unprecedented large-scale investment in the infrastructure of their cultural sites, especially museums in terms of building renovation. And they have done the interior. The creation of numerous purpose-built new museums shows that there has been a fundamental re-evaluation of the processes of designing and shaping the museum space. The interior space of the museum and its interior architecture need to examine the formation of its architectural infrastructure to organize them in the museum through the examination of the elements of the interior space and direct its potential to connect to the deepest level of communication with human perception and imagination.

Klonk, Charlotte in 2009 in the book Spaces of Experience: Interesting Studies on Art Gallery Interiors explores the changing ideals and design practices of museum gallery interiors in Europe and North America from the 18th century to the end of the 21st century, provides detailed

information on the display methods in these spaces, which include: background wall color, light, furniture, height, and space creation to display artworks. The researcher shows that scientists such as Hermann von Helmholtz and Wilhelm Wundt, according to the theories of perception, consider the new ways of creating spaces for exhibitions and museums as important as the changing ways of exhibiting in art galleries and museums. As Michael Bazandal called one way of seeing elements in the space, due to the effect of this new method in interior decoration, information display showcase.

5. Research Methodology

Considering that the current research methodology is a mixed methodology, which means that first a qualitative method is used to calculate the dimensions and components of the research, and then a quantitative method is used to measure the enigmatic architectural components of museums in the perception of the audience, the research paradigm is also a paradigm Pragmatism governs the combined methods. The present research method is developmental-applied in terms of type and has a nested combination method in terms of method type. To answer the research questions, the nest-to-nest research method of qualitative and quantitative type is used.

In this research, in the qualitative part, open and semi-structured interviews were used in the form of direct questions and indirect questions. The semi-structured nature of the interview is due to the approach of this research.

The interview with the professors first started with general questions and gradually progressed based on data analysis with deep persistent and clarifying questions regarding the role of the enigmatic architectural components of museums on the audience's perception. The basis of the design of the questions was the criteria extracted from the subject literature, and the productivity of the questions was evaluated in a pilot study. The interviews were conducted individually. The interview time was from 10 to noon and from 18 to 21 in the evening in the summer of 2022. In qualitative research, interviews with people continue until information saturation is reached; Therefore, the coding steps of the interviews were done immediately after each interview; This means that the process of interviewing and analyzing the role of enigmatic architectural components in the design of museums was zigzag. In this research, the maximum number of participants was 46 people, and the ceiling of the sample size was not determined at the beginning of the work; The basis for completing the research was information saturation, which was not added to the number of research participants due to the saturation of information from the interview of the 46th person. All the conducted interviews were implemented and analyzed individually with qualitative content analysis methods, and the results were compiled by Atlas ti version 8 software. The characteristics of the interviewees are given in Table 1.

Table 1 Expertise of interviewees

Interviewees	Number	The cumulative frequency	Accumulation percentage
Professors of architecture	16	34.8	34.8
Professors of landscape architecture	9	19.5	54.3
Professors of interior architecture	12	26.2	80.5
Urban design professors	9	19.5	100
Total	46	100	-

A questionnaire with a 5-point Likert scale is compiled in a small part of the obtained variables and distributed among 384 space users (addressees and visitors). Sampling to determine cluster age groups and in each age group is random. A cluster includes age groups 20-40, 40-60, 60-80. The

features and characteristics of space users are listed in the table below. For the adequacy of the sample, the upper limit of the Morgan table, which is 384, has been used. At the beginning of the overall goals (the goal of realization and review) and the goals of the component (the goal of posing each question), the concepts, themes, specialized categories, and keywords of the research are specified and the explanation of each of them is attached to the space users (audiences and visitors) was placed. Then, if there was no ambiguity about these specialized words for the respondents, a closed-ended questionnaire was given to them, which included questions about the purpose and research question. The questions of the questionnaire were designed in a general way, far from being sophisticated and detailed.

Table 2 Characteristics of space users to whom the questionnaire was assigned (source: authors)

Number of sample people	384 people according to Cochran's formula	The number of people in the community
frequency (percentage)	Number	Those questioned
22.66	87	Female
77.34	297	Man
Male (person)	Female (person)	Gender of each group
71	57	20-40
66	62	40-60
81	47	60-80
education		
%	Number (all age groups)	section
3.12	12	High school
9.63	37	diploma
33.6	129	Bachelor's degree
40.1	154	Master's degree
13.55	52	PH. D.

The validity of the tool is used with the formula CVR=0.76 and Cronbach's alpha for reliability with a rate of 0.78.

6. Study Area

The location of the Museum of Contemporary Arts is on the street where most of the embassies in the capital are located. This museum is located on Africa Street, 22 embassies. The presence of an embassy in a place increases the traffic of foreign people in it, because ambassadors, businessmen, employees, and their family members live in the embassy during their mission and are constantly in the neighborhood for diplomatic affairs, official meetings, and daily affairs. are. On the other hand, foreign tourists and businessmen sometimes need to go to the embassy of their country during their stay in Iran to do various things, and this will increase the number of their visits. In the macro-politics of museums, tourists and people from other countries always have an important position among museum visitors, and this is intensified in the case of art museums because:

In most people, there is an inherent desire to visit the cultural and artistic works of other countries. The ability to turn each one of them into ambassadors to promote Iran's rich art in their own countries. People's increasing desire to watch and buy modern works of art. Ease of group visits that are usually arranged by schools' educational centers and tourism institutions. The possibility of transferring information and using the facilities and capacities of museums in the region, to increase productivity at educational levels, restoration of works, sampling, storage, simultaneous presentation, exchange of specialists, determining the originality of works, etc.

Fig 6 Museum of Contemporary Art

7. Research Findings

7.1. Qualitative Findings

Summarizing all the codes extracted from the interviews conducted in connection with the role of the enigmatic architectural components of museums on the audience's perception was done as follows.

a. Open Coding

At this stage, the researcher tries to recognize the hidden concepts by reviewing the collected data set. Finally, the information obtained from the interviews with professors and experts, and 27 concepts related to the role of the enigmatic architectural components of museums on the audience's perception were extracted through open coding. The main parts of the resulting space became the basis of the discussion regarding the dimensions of the role of the enigmatic architectural components of museums on the perception of the audience and the questions raised in this regard. Then, the classes formed in open coding were compared with each other, and the relationship with their subclasses was checked. Similar classes were merged and grouped into one central class.

b. Extraction of Descriptive-Interpretive Codes in Open Coding

At this stage, first, the text of the interview was studied in detail and word for word in search of themes related to the research questions, and at every point of the interview where a theme was found, that part of the interview was selected and a descriptive theme was attributed to it. And after the descriptive coding of the interview text, their meanings were interpreted. Below is the descriptive and interpretive coding of some interview texts.

Table 3 A selection of conceptual codes extracted from the text of the interviews (source: authors)

Propositions taken from the text of the interview and interpretation	Extracted conceptual code
The time visitors spend in a gallery can be increased by adding factors such as interactive components, stimuli involving multiple senses at the same time, better lighting and texts that are more readable.	readability of space
Discontinuity means a change in the rhythm of movement. For example, you can use a sculpture or furniture to create a space between paintings in a gallery. Or the one who reduced the number of exhibited paintings. In the gallery, the object that is displayed in the best place has a special priority and from the perspective of architecture, it may be relied on more, so it should be noted that architecture is a determining factor in the environment and it should not have a marginal role. It is believed that the existing relationships between multiple objects and between objects and space create a set of shapes and sizes, proportions and distances... which are basically subject to the same criteria of design psychology that art objects follow.	Distances of works and objects
Spatial flexibility and organization of man-made space and change in it to achieve new conditions, needs and applications should exist in museums.	Flexibility of space
Creativity is done in the connection and combination between two small components of the space or two large sets alike. In this architecture, spaces do not lose their independence when combined while being dependent. The plan and purpose of the composition are already known and it is clear that the building is a museum. In other words, since the pattern is known, the task of the components in the composition is known. Iranian architecture has pre-prepared physical elements and forms for various spaces. The conditions of the spaces may be as follows.	Creativity in how to connect spaces to each other
The museum can be considered an example of sociology, because in a society that has special rules and offerings, the museum is one of the few environments available for free presence. Since sociology deals with human relationships and these relationships are often so complex that it is very difficult to identify their nature, the best we can do is to consider a few main axes and classify these relationships within their framework in order to identify patterns and Get 3D practical elements.	Addition of three-dimensional elements
Basically, architectural design depends a lot on people and their spatial needs. Humans have different body dimensions due to differences in their age, sex, and body structure or due to disabilities, which usually average human dimensions are used for design. Appropriate design depends on having correct statistics of human body sizes and determining the range of their changes during various activities. Objects have different states at different heights, and because usually the viewer always looks at the object while standing, they place the objects at eye level.	Proportions and spatial scale
Not only the appearance in the architectural design of the museum, but also its interior decorations should be completely consistent with the common architectural methods in the society, and at the same time, the museum building should also include aspects of the art and history of the society according to the rules of the museum architecture design.	The way of communication between decorations and the mentality of people
In the architectural design of the museum gallery, rooms with equal dimensions become too	Graphic

uniform. By creating diversity and proportionality in dimensions, as well as by using different colors on the walls and floors, unconscious motives can be created to attract the visitor's attention. The color and material of the wall and flooring in the exhibition halls are very important in the architectural design criteria of the museum. In the past, they chose white color for the walls, because they believed that objects show their nature better against white color. But today, experts believe that the works look darker against the white color. Therefore, colors are chosen for the walls that show their nature better against the white color. To deal with the uniformity of the halls, you can use lighter colors in the places where the light is less or make the wall where the light shines on it a little brighter. The material of the walls of the architectural design criteria of the museum should also be in accordance with local and climatic building conditions. Choosing the right flooring is also one of the important points in the architectural design criteria of the museum, because the visitor is on the move all the time. In general, in the design of movement paths, it is necessary to observe two things: 1) avoiding restrictions with interruptions; 2) Avoiding high level differences.	capabilities of the floor spaces
Designing spaces in a straight-line causes uniformity, so it is suggested not to place a window in front of the door; Because the visitor will be dazzled as soon as he enters. Regarding the shape and size of the rooms, in order to attract everyone's attention, their size should be different and proportional to the dimensions of the exhibition. The dimensions of the rooms should be proportional to the lighting system. Ceiling lighting has more variety, because the lighting can always be adjusted according to the size of the room.	Harmonious relations of space and light

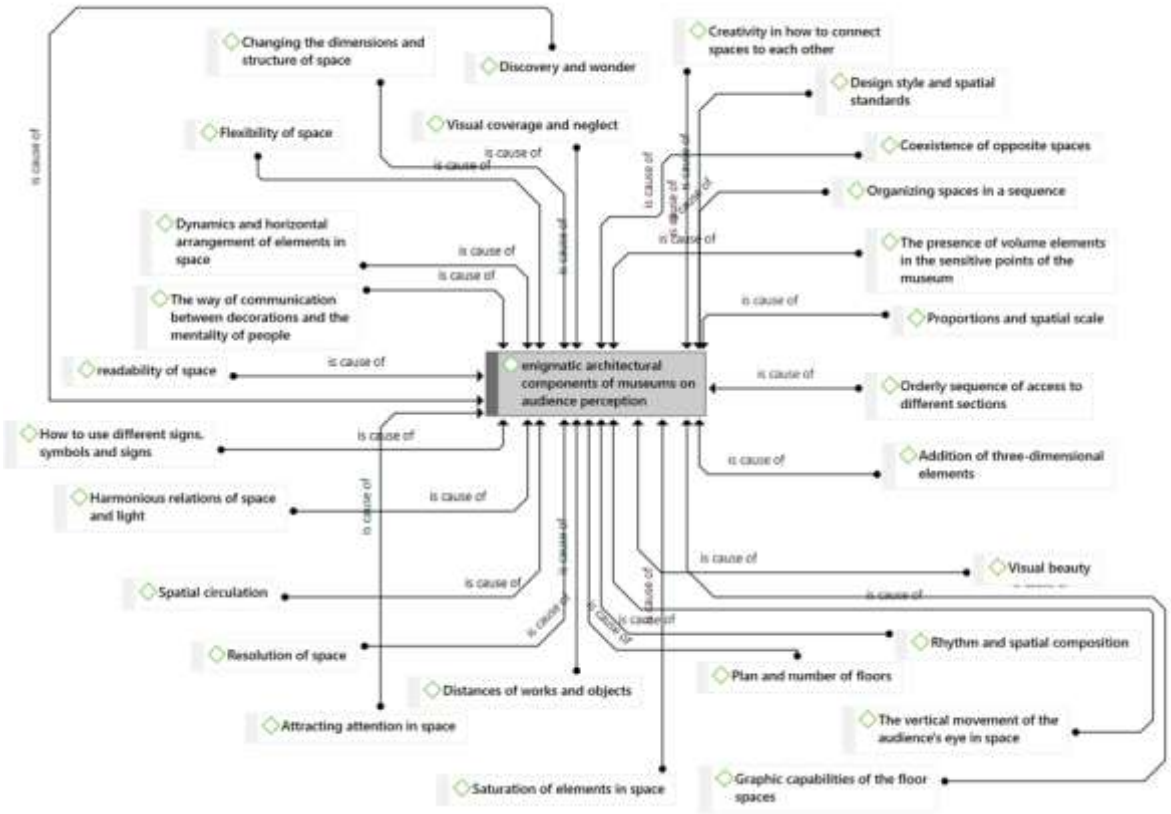

Fig 7 Components extracted from the interview text

7.2. Quantitative Findings

a. Multivariate Regression Analysis

A correlation matrix is used to determine which type of regression is required for this type of variable data. The results show that there is no linear relationship between variable data. In Figure 8, each house of the correlation matrix of the factors shows how the data is distributed in different situations. If these components have a linear interface, the points in all houses follow the same shape. As it is known, this matrix follows several distinct multilinear, linear, and parabolic states.

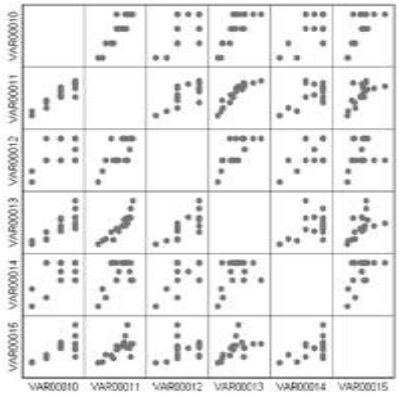

Fig 8 Correlation matrix of factors

In the multivariable regression, the step-by-step method has been used to enter all the independent variables to explain the role of the enigmatic architectural components of the museums on the perception of the audience. Durbin-Watson's statistic value is equal to 1.99, which shows that the residuals are not correlated and are independent.

Table 4 Step-by-step regression model of independent variables to explain the role of enigmatic architectural components of museums on audience perception

Model	Correlation coefficient (R)	R Square	F test value	T test value	Significance level	Constant
Step by step	0.372	0.138	37.224	2.884	0.000	1.955

According to Table 4, the correlation coefficient of the step-by-step regression model of the studied variables to explain the role of the enigmatic architectural components of museums on the audience's perception is equal to 0.372. The value of F indicates that the regression model of the research is a suitable model for explaining the dependent variable (audience perception). Also, the amount of constant value shows that if the influence of independent variables is controlled, the base value of audience perception is equal to 1.955. It should be noted that surprise and discovery were the first variables that entered the model and are most closely related to the museum's enigmatic architecture. The organization of spaces in a sequence was the last variable that entered the model and has the least relationship with the enigmatic architecture and the effect of this design on the audience's perception. The t value and the significance level indicate the relative importance of the presence of each variable in the model. Thus, if the absolute value of t value is greater than 2.884, its error level will be smaller than 0.01. As a result, the desired variable has a statistically significant effect in explaining changes in the dependent variable. Based on this, the variables

included in the model have a significant effect on the role of the enigmatic architecture of museums on the audience's perception, and the effects of other variables are almost constant. In the following, we will seek to what extent each of the enigmatic architectural variables and also the simultaneity of the two will affect the audience's perception. In Table 5, it is shown for each variable that the coefficient of determination indicates the contribution of each variable in the desired dimension, and this number varies between 0 and 1.

Table 5 Step-by-step regression of the enigmatic architectural components of museums on audience perception

	Variable	R Square	F	B	β	T	meaningful	Degrees of freedom
The components of the role of the enigmatic architectural components of museums on the audience's perception	Harmonious relations of space and light	0.467	527.222	1.000	0.781	46.522	0.000	453
	The vertical movement of the audience's eye in space	0.615	405.122	1.000	0.732	42.152	0.000	453
	Coexistence of opposite spaces	0.383	217.343	1.000	0.662	40.223	0.000	453
	Dynamics and horizontal arrangement of elements in space	0.746	199.943	1.000	0.648	38.239	0.000	453
	Changing the dimensions and structure of space	0.762	201.612	1.000	0.664	8.958	0.000	453
	Visual coverage and neglect	0.946	643.623	1.000	0.662	11.134	0.000	453
	Attracting attention in space	0.952	849.683	1.000	0.652	18.441	0.000	453
	Saturation of elements in space	0.846	349.603	1.000	0.665	19.144	0.000	453
	Distances of works and objects	0.657	184.945	1.000	0.483	49.173	0.000	453
	Design style and spatial standards	0.546	276.748	1.000	0.464	47.963	0.000	453
	Flexibility of space	0.795	199.943	1.000	0.452	46.226	0.000	453
	readability of space	0.893	499.034	1.000	0.463	47.228	0.000	453
	Visual beauty	0.658	523.034	1.000	0.472	25.288	0.000	453
	Discovery and wonder	1/000	147.258	1.000	0.661	45.256	0.000	453
	The presence of volume elements in the sensitive points of the museum	0.462	321.564	1.000	0.452	41.552	0.000	453
	Orderly sequence of access to different sections	0.896	492.371	1.000	0.401	21.356	0.000	453
	How to use different signs, symbols and signs	0.745	471.658	1.000	0.411	58.321	0.000	453
	Resolution of space	0.245	650.987	1.000	0.421	19.694	0.000	453
	Rhythm and spatial composition	0.455	542.960	1.000	0.589	24.879	0.000	453

	Spatial circulation	0.654	214.362	1.000	0.521	44.587	0.000	453
	Proportions and spatial scale	0.756	752.382	1.000	0.542	48.566	0.000	453
	Graphic capabilities of the floor spaces	0.645	699.301	1.000	0.545	23.658	0.000	453
	Addition of three-dimensional elements	0.425	421.115	1.000	0.411	12.231	0.000	453
	Plan and number of floors	0.415	411.325	1.000	0.309	16.897	0.000	453
	Creativity in how to connect spaces to each other	0.311	161.415	1.000	0.517	36.458	0.000	453
	The way of communication between decorations and the mentality of people	0.145	568.211	1.000	0.607	24.564	0.000	453
	Organizing spaces in a sequence	0.265	475.214	1.000	0.619	29.325	0.000	453

b. Correlation

Two-Sample Kolmogorov-Smirnov Test is used to check the parametric and non-parametric type of data.

Table 6 Kolmogorov-Smirnov test to check the normality of the variables of the role of enigmatic architecture of museums on the audience's perception.

Variable	Average	The standard deviation	Z Kolmogorov Smirnov	p
The role of enigmatic architecture of museums on audience perception	27.77	3.23	0.793	0.485

In Table 6, it can be seen that Kolmogorov-Smirnov's test for audience perception score is significant (p=0.555) and therefore the enigmatic architectural variables do not have a normal distribution and non-parametric analysis can be used for them. In Table 7, in the correlation section between the components of the enigmatic architecture, discovery and surprise with a value of (0.883) and the dynamics and horizontal arrangement of elements in space with a value of (0.873) and the harmonious relationships between space and light (0.871) An increase of one unit of these components can increase the other components by the amount of the mentioned numbers (correlation coefficient).

Table 7 Spearman's correlation of the enigmatic architectural components of museums on audience perception

	Variable	The correlation coefficient	meaningful
role of the enigmatic architectural components	Harmonious relations of space and light	0.871	0.000
	The vertical movement of the audience's eye in space	0.481	0.000
	Coexistence of opposite spaces	0.745	0.000
	Dynamics and horizontal arrangement of elements in space	0.873	0.000
	Changing the dimensions and structure of space	0.846	0.000
	Visual coverage and neglect	0.871	0.000

	Attracting attention in space	0.831	0.000
	Saturation of elements in space	0.853	0.000
	Distances of works and objects	0.873	0.000
	Design style and spatial standards	0.623	0.000
	Flexibility of space	0.536	0.000
	readability of space	0.620	0.000
	Visual beauty	0.465	0.000
	Discovery and wonder	0.883	0.000
	The presence of volume elements in the sensitive points of the museum	0.715	0.000
	Orderly sequence of access to different sections	0.711	0.000
	How to use different signs, symbols and signs	0.843	0.000
	Resolution of space	0.711	0.000
	Rhythm and spatial composition	0.662	0.000
	Spatial circulation	0.711	0.000
	Proportions and spatial scale	0.451	0.000
	Graphic capabilities of the floor spaces	0.465	0.000
	Addition of three-dimensional elements	0.546	0.000
	Plan and number of floors	0.245	0.000
	Creativity in how to connect spaces to each other	0.788	0.000
	The way of communication between decorations and the mentality of people	0.421	0.000
	Organizing spaces in a sequence	0.365	0.000

8. Discussion

According to the findings of the research, discovery, and surprise are the most important factors, dynamics and horizontal arrangement of elements in space is the second factor, and the harmonious relationship between space and light is the third factor affecting the perception of the audience in the enigmatic design of museums. The basic principle of spatial composition, unplanned perception of space, and people's analysis of the morphology of presence and encounter in the study museum, significantly allows people to seek a sense of wonder and discovery higher than the planned space that the museum is for adapting to meet them and it leads to searching for the mysterious effects of museum collection space related to galleries and in the sequence of galleries. Also, what creates the mysterious feeling of the space is the distinction based on the geometric features of the interior spaces of the museum. In the studied contemporary art museum, a network should be created so that a regular order of viewing cannot be created. These findings are similar to Klatzky's study in 2003 (Klatzky, 2003). Also, there should not be the same conceptual arrangement of objects. As a result, it maximizes random events in the movement pattern and surprise; Because the arrangement of space and objects in one direction support each other, and by doing this, they strengthen the addition of the message and reduce the unexpected to effectively convey the desired concept; Therefore, it can be argued that in these cases, the space shows rather than presents, the way the objects are placed together represents something other than the objects themselves. This follows that in museums with a long path model, through the arrangement of spaces and objects, the designer controls the information and reduces the exploratory aspects of the meeting both in terms of 3D perception and intellectually.

Arousing the audience's sense of exploration of the works of museums, increasing their interest in improving their level of knowledge about the works, discovering and recognizing various values, and the desire for emotional values in the definition of this category of historical works, all show the audience's reaction to discovering hidden meanings and messages about each It is the effect of

museums that the ultimate goal of establishing museum spaces and the mission of carrying out any conservation intervention.

What defines a museum as a type of space is two spatial elements that are repeated enough to be recognized as representative themes: the first is the spatial organization in the visual sequence and the collection space, and the second is the return space in the sequences. These important spatial aspects create two types of interfaces that characterize this museum as a type of building: on the one hand, between visitors and curators, and on the other hand, among visitors. Organizing spaces in a sequence is one of the principles of museum design and a tool to create the movement of visitors as well as the arrangement of objects.

In museum architecture, light has a function beyond illuminating the space and is considered by designers as one of the main components. Light is one of the most important qualitative and symbolic factors and has a special place in museum architecture in terms of practical function. However, light is used symbolically by using architectural genius and paying attention to the three factors of aesthetics, concept, and meaning, which we call lighting.

9. Conclusion

Museums are not just galleries for viewing objects and historical works, and today in the famous museums of the world, various techniques are used to introduce objects, museums are the most obvious display and exhibition of human cultural heritage. Considering the importance of the destination and the preservation of culture and preservation of cultural artifacts, it is also very important to comply with some standards in the museum. In the proposed topic, new solutions were presented for how to organize the interior space of museums so that more audiences can be attracted to these cultural and artistic places, and it has been mentioned as a suggestion for its application in the interior architecture of museums, which has received enough attention so far. has not been the basis of the above theory and the inspiration of the researcher is the capabilities and aspects of the interior spaces of museums, which have been considered differently from the previous learnings and existing sources, and prompted the researcher to propose a new way in the art of interior architecture and design while examining these aspects. The interior of museums should be effective through organizing the interior space. In the studied museum, it has been concluded that creating a sense of discovery and wonder by the audience in the work of art stimulates feelings and emotions in the perceiver, and these various effects together with the objective elements of the work of art form a unified and uniform experience.

The arrangement, order, and arrangement of elements and forms in the interior of museums is an effective factor in attracting and quantity audiences. In this way, the order of the display objects depends on the visitors and the characteristics of the display objects. In the relationship between visitor and display object, the lower the ratio of visitors to display objects. The possibility of concentration and that every visitor can communicate freely with the display object increases. Also, in a group visit, it is not possible to come in close contact with the shown object without causing trouble for the other members of the group. Visitors should be placed around the display object in such a way that all their distance to it is equal and can attract their audience.

A major part of the impact of a museum's work is due to the correct use of its lighting. In museums, lighting is more than shining light on objects, just to show them off. Lighter and darker parts within the frame help to build the composition of each shot, thus directing the audience's attention to specific objects and actions. A part of the work that receives more light can draw the viewer's eye to an important point, while the shadow hides the details. Lighting helps to bring out the texture of the work of art: the lines on a work, the decorations used, the subtleties, the textures,

the brightness of a piece, etc. Also, lighting shapes the overall composition of the work. Lighting can affect the audience's sense of the shape and texture of displayed objects.

References

Ajjali, P. (2009). *An Introduction to the Theory of Mass Communication*. Tehran: Media Studies and Planning Office Publications (Media Studies and Research Center).

Bakhshi, F., & Davodiroknabadi A. (2022). Investigating the Impact of Video Mapping on Environmental Graphics and Audience Attraction: A Case Study of Successful Executive Video Mapping in Iran. *International Journal of Applied Arts Studies, 7*(4), 87-94.

Dehghan, S. (2013). *Explaining the characteristics of the environmental graphics of museums to optimize the museum space in Iran with an emphasis on the study of the ancient Iranian museum*. Master's thesis, supervisor: Abdolreza Charei, Faculty of Arts, Shahid University of Tehran.

Fen, T., & Sal, A. (2010). *The Integration of New Media Technologies into the Wayfinding System of a Museum Environment*. Doctoral Dissertation, National Institution of Design, Swinburne University of Technology, Melbourne Australia.

Ghobishavi, A., & Babli, A. (2021). Designing the interior architecture of Abadan Museum with the approach of creating identity and inspiration from traditional architecture. *7th National Conference on Architecture, Urban Planning and Tourism, Applied Researches and New Solutions*, 1-14.

Golledge, R. G. (1999). *Wayfinding Behavior: Cognitive Mapping and Other Spatial Process*. Baltimore: Johns Hopkins University Press.

Haq, S. U. (2001). *Complex Architectural Setting: an investigation of spatial and cognitive variable through wayfinding behavior*. Doctoral Dissertation, Atlanta: Georgia Institute of Technology.

Hart, A., & Moore, G. T. (1973). The Development of spatial configuration: A review. In *R Downs and D. Stea (EDS). Image and environment*. Chicago: Aldine.

Hormoz, M. (2001). *Introduction to: theories and concepts of mass communication*. Tehran: Faran Publications.

Kaplan, S. (1976). Adaptation, structure, and knowledge. In *Moore, G. T., & Golledge, R. G. (Eds), Environmental knowing: theories, research, and methods*, (pp. 32-45). Stroudsburg: Dowden, Hutchinson, & Ross.

Klatzky, R. (2003). Representing Spatial Location and Layout from Sparse Kinesthetic Contacts. *Journal of Experimental Psychology: Human Perception and Performance, 29*, 325- 310.

Klonk, C. (2009). *Spaces of Experience - Art Gallery Interiors from 1800 to 2000*. New York: Yale University Press.

Koseoglu, E., & Onder, D. (2011). Subjective and objective dimensions of spatial legibility, *Procedia - Social and Behavioral Sciences, 30*, 1191 - 1195.

Levine, M., Marchon, I., & Hanley, G. (1984). The placement and misplacement of you are here maps. *Environment & Behavior, 16*(2), 139-157.

Macleod, S. (2012). *Museum Making: Narratives, Architectures, and Exhibitions*. London: Routledge.

Mc Quail, D., & Windall, S. (2009). *Models of mass communication* (Mirzaei, G. Trans.). Tehran: Radio Research Office Publications.

Mc Quail, D. (2006). *Audience Analysis* (Liu, Y., Li, Y., & Yang, Zh. Tans.). Beijing: China Renmin University Press.

Passini, R., & Arthur, P. (2002). *Way finding: people, signs and architecture*. London: Focus Strategic Communications.

Peponis, J., Ross, C., & Rashid, M. (1997). The Structure of urban space, movement and co-presence: the case of Atlanta. *Geoforum, 28*(3-4), 341-358.

Pir babai, M. T., & Anuri, M. R. (2012). Mystery and ambiguity in Islamic architecture. *The second national conference on Islamic architecture and urban planning*, 11-11.

Pirzadi, M., & Alaei, A. (2018). Examining the role of ambiguity in architecture. *The fourth international conference on new horizons in civil engineering, architecture and urban planning*, 1-8.

Porco, M. (2010). *Wayfinding 101*. *Sound and Video Contractor*. Retrieved January, 2016. from http://www.svconline.com/news/corpo-rate/wayfinding-101/394961

Rasouli, B., Jamali, M., & Bakhtiarian, M. (2023). Examining the Characteristics of Performance Art in the Works of Marina Abramovic from the Point of View of Experts and General Audiences. *International Journal of Applied Arts Studies, 8*(2), 87-108.

Russell, J. A., Weiss. A., Mendelsohn, A., & Gerald. B. (1989). Affect grid: a single-item scale of pleasure and arousal. *Personality and social psychology, 57*(3), 499-502.

Saegert, S. (1973). Crowding: cognitive overload and behavioral constraint. environmental psychology program. *New York, 3*(10), 254-260.

Taheri, M., & Rahimi Mehr, V. (2021). Museum Design Criteria with Traditional Architecture Approach. *8th Annual International Congress on Civil, Architecture and Urban Development*, 1-14.

Uebele, A. (2007). *Signage systems & information graphics*. London: Thames & Hud- son, Ltd.

Weisman, O. (1981). Evaluating architectural legibility: way-finding in the built environment. *Environment and Behavior Journal, 13*(2), 189-204.

Weiss, A. (2013). *Museum Signage Design and Implementation*. Master's thesis, California polytechnic state university, California, MA.

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Designing Creative Baby Organizers with Special Features

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Research Article

Abstract

When it comes to designing baby organizers, creativity and functionality are key factors. It is important to create a product that not only helps parents keep their baby's belongings organized but also offers additional benefits. One innovative approach is to incorporate anti-inflammatory properties into the design. By using materials that have anti-inflammatory properties, such as certain fabrics or coatings, the baby organizer can help prevent irritation and discomfort for the baby. This can be particularly beneficial for babies with sensitive skin or conditions such as eczema. By combining creativity, functionality, and anti-inflammatory properties, designers can create baby organizers that not only serve their primary purpose but also provide added value for parents and their little ones.

Keywords: Organizer; Baby; Designing; Art.

1. Introduction

Humans don't always keep their clothes in the closet. And since the beginning, the first humans didn't need to store their own clothes because they only had a few clothes in order to organize their clothes. As clothing and textiles evolved, production became easier, and decorative quality increased, more people began to own more than one or two sets of clothing, and the need for a

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storage solution arose. This varied in different cultures. For example, the ancient Egyptians kept their clothes in reed baskets.

Very wealthy people chose alabaster chests, and the ancient Greeks, who had ample access to wood, stored their clothes in chests. And the history of these closets and organizers goes back to Roman times, however, Roman soldiers, with the invention of armor, took the first step to invent modern closets and objects to organize their tools and weapons. A simple wooden box used to safely transport your weapons and armor from one camp to another. During most of the medieval period, this box became the boxes of elaborate silk clothes that were used by the rich to protect their expensive clothes from rats and moths that might destroy them. Over the next few hundred years, these chests gradually became armories (Aghakhani, 2007).

Fig 1 An ancient example of an organizer

So, the purpose of closets and organizers was only to store assets, treasures and clothes. Simply put, the history of clothing storage is a reflection of a particular time. People made do with what they had. But regardless of where you look in history, one thing remains constant throughout the ages: people know how to appreciate clothes.

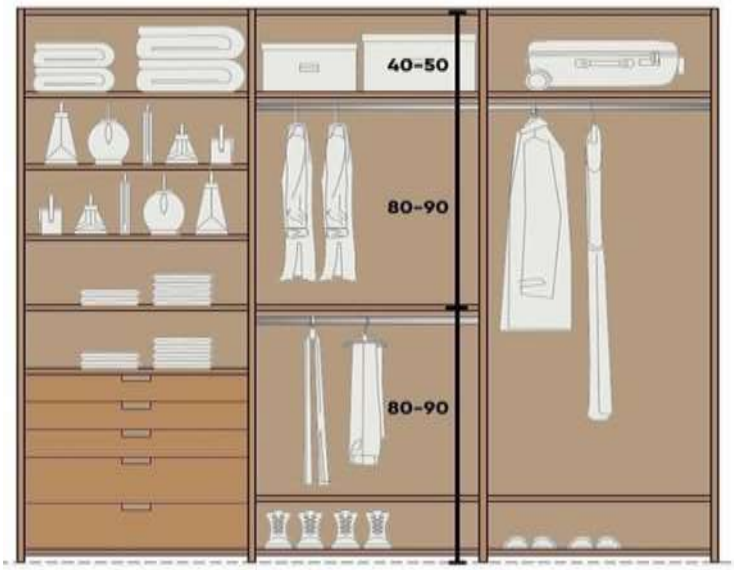

Fig 2 Schematic of an organizer sample

Over time, drawers were added to closets as a storage and organizing solution. And these organizers, who in different times and eras used chests, wooden baskets... to store their things and clothes, as we said, became closets, the word closet appeared in the early 14th century. This word originates from the old French words, wardrobe, in which warder means maintenance and guard and robe means clothes. In the 19th century, the dresser began to evolve into its modern form, sometimes with a hanging wardrobe on each side for more separation and space..., a press on the top, a central section, and drawers below. Sliding doors were first used in Roman houses in the first century. Sliding doors are a great addition to any closet, giving clothes a sense of separation and order and by the 18th century, these pieces had become the most common way for the wealthy to store their clothes and along with shelves and drawers, there was usually a hanging area for cloaks and other long garments. And they formed the initial advance of today's wall cabinets (Amiryan, 2018; Dundeby, 2010; Hashemi, 2019; & Nami, 2010).

In the 1870s, the hanger rod was first incorporated into wardrobes, and the first hangers soon followed. According to its original French definition, a wardrobe is a piece of furniture that protects clothes. It may also include drawers and mirrors. During the Middle Ages, these cabinets had beautifully designed works of art or carvings.

Fig 3 Newer organizer sample

These closets were rooms for prayer, study and other activities before they became storage or organizers for clothes, shoes and accessories. From the beginning, these closets and organizers did not end only with clothes, bags, shoes, etc., but for their jewelry, there were boxes that have been an integral part of human civilization for centuries. which served as both a practical storage and organizing solution, and a symbol of personal adornment. Early civilizations realized the importance of protecting their valuable ornaments and began to create elaborate boxes to protect them. Egyptians and Mesopotamians used boxes made of wood, bone or metal to keep their jewelry

safe. These boxes, which were only for their jewelry, made them more orderly and safer, as each of the items had their own specific space and place. The Victorian era was a turning point in the sentimental value of the jewelry box. Incorporating hidden compartments and intricate motifs, these boxes became more than storage containers, they became containers for expressing love and affection. They combine tradition, art, emotion and performance in one exquisite package.

The history of jewelry boxes and organizers is a testament to humanity's deep connection and appreciation of personal adornment. Throughout ancient civilizations, the Middle Ages, the Renaissance and the Baroque, jewelry boxes evolved not only in design and materials, but also in their symbolism and significance. From a display of status and wealth to a means of expressing love and emotion, these boxes have served as both functional storage units and treasured keepsakes. These boxes also had locks or hidden compartments to protect valuable jewelry from theft or unauthorized access. As an important accessory, the jewelry box served not only for practical storage, but also showed people's social status and another reason for making these boxes besides organization and more security... Egyptian people believed in life after death. And they wanted to make sure that their treasures accompany them when they die. And at that time, these boxes are decorated with precious stones and intricate carvings, which show a lot of attention to the contents and display of these jewelry boxes.

The clothes rack is a key element in the design of the hallway and helps to logically choose a place for things in a small space. We believe that this element of the salon is something obvious and normal. The clothes rack, which creates more space and organizes clothes, was invented by the French in the 16th century and became a comfortable piece of furniture. There was no iron and things were stored in boxes, where they were awkward and therefore inconvenient. But someone with a bright head came up with the idea to sort the clothes in purgatory and put the boxes vertically. The merit of this idea was appreciated and implemented by contemporaries. Jalbas, a subset of organizers, had become a convenient and accessible way to store wardrobe contents, and they quickly spread across the country. Of course, the wardrobe of that time is different from the current models, but its purpose remains completely unchanged (Sadatnouri, 2015; Tanabian, 2011).

Few people know that the clothes hook is a patent issued to certain Norton in 1989. And in 1903, Artaus, an employee of the wire factory, that such a hook is not enough, designed a twisted hanger. For us, the clothes rack is normal and familiar. And it has gone through certain stages of improvement for the time of its existence, when the innovative discovery of Ver, was considered truly brilliant. A clothes rack is exposed to fashion trends and changes under the influence of your desire. It can be adjusted to adapt to growth, provide it with wheels that are used as a separate design element of the room. Hanger for any clothes: outerwear, clothes and coats, pants, ties, belts, socks, underwear, may be different. And as we said, from the beginning, there were different methods and methods for organizing.

Organizing clothes can also be difficult, because there is no one-size-fits-all wardrobe solution, and because of this, different types of clothing require unique organizational methods for effective storage. For example, socks, underwear and other accessories are better to be kept in drawers or bins or in their own organizers and organizers, which means that we should classify the clothes according to their gender, style, and usage. Clothes that wrinkle and need to be ironed, such as coats, dresses, jackets and pants, or clothes that we wear every day, should be hung in the closet. Use these tips on how to organize clothes to keep your wardrobe organized and ready to wear. Unlike closets or dresser drawers, bookcases and open shelves allow you to quickly see and retrieve what you need. This system is suitable for organizing clothes for jeans, t-shirts, jackets and other

clothes that do not need to be hung. And also hang the best clothes such as elegant blouses on hangers. These big and strong hangers help the clothes pieces to keep their shape in the warehouse. This type of sorting and using organizers is also very necessary for children's rooms. One of the key items in children's rooms is the closet, and keeping it organized can make a big difference in keeping a functional and clutter-free children's room. slow One of the most effective ways to organize a child's closet is to divide the drawers into categories and assign a specific category of children's items to each drawer. An easy way to ensure that all of the children's items have a place is to group them by type. For example, there may be a drawer for clothes, a drawer for diapers, and wet wipes, accessories... and they can also use organizers and organizers inside the drawer to allocate more space. This keeps children's things neat and tidy, and makes it easy to find what they need. Organize for children's items should have proper dividers and shelves to help children put toys, clothes, etc. This feature helps children to find the objects they need more easily and to maintain order and organization in their room (Dadkhah Tirani, Davodiroknabadi, and Zohoori, 2018; Soltani, Zohoori, and Davoodi Rokanabadi, 2022).

Fig 4 Organizer sample

2. Artistic and Practical Work Process

In this article, zinc nanoparticles have been used to desensitize fabrics used in fabric organizers. In this way, the fabrics were hypoallergenic in the laboratory using ultrasound (Monavari, Zohoori, and Davodiroknabadi, 2022).

After studying the theory parts and getting information about the world of fabric art; First of all, a storyboard was prepared from the textures and applications of organizer and samples of textures

were prepared by designing and taking into account the coloring, efficiency, elements such as the roots of the work, prominent texture, landscape designs and it was shown in the format of the storyboard; After creating a set of some linear etudes of design, selected designs were completed (Figures 5-6).

Fig 5 The initial sketches

In this type of design, the outer space of the bag is designed with several zippered pockets, so that essential baby items such as medicines, bottles, diapers, are available, and the inner space is suitable for children's clothes and toys... and the use of dark colors is suitable for children's bags because We are going to carry this baby bag everywhere.

Fig 6 Final designs

In this type of design style, the baby bag can be used both as a backpack, which is more convenient for parents, and as a hand bag. And at the bottom, the bag can be separated using a zipper (for more space and order) and there is also a special place for a baby's pacifier like a key ring.

3. Conclusion

In recent years, there has been a growing demand for baby organizers that not only provide a practical solution for storing and organizing baby items, but also offer additional benefits such as anti-inflammatory properties. Designing creative baby organizers with anti-inflammatory properties can be a game-changer in the baby products industry. These organizers not only help parents keep their baby's belongings in order, but also provide a soothing and calming effect on the baby's delicate skin. The concept of incorporating anti-inflammatory properties into baby organizers is innovative and unique. By using materials that have natural anti-inflammatory properties, such as organic cotton or bamboo fabric, these organizers can help prevent skin irritations and reduce inflammation caused by certain skin conditions. This is especially beneficial for babies with sensitive skin or those prone to allergies. Moreover, the design aspect of these baby organizers should not be overlooked. Creative designs and patterns can make organizing baby items a fun and enjoyable task for parents. From playful animal prints to vibrant colors, these organizers can add a touch of style to any nursery or baby's room. In conclusion, designing creative baby organizers with anti-inflammatory properties is a great way to meet the needs of modern parents who are looking for practical and innovative solutions for their babies. By combining functionality with the added benefit of anti-inflammatory properties, these organizers can provide a safe and comfortable environment for babies while making the task of organizing baby items more enjoyable for parents. With the right materials and designs, these organizers have the potential to revolutionize the baby products industry.

References

Aghakhani, H. (2007). *Intermediate visual arts 1 (art major)*. First edition, Payam Noor University, Tehran.

Amiryan, A. (2018). *Designing women's evening wear using tapestry texture*. Thesis for receiving a bachelor's degree, Hazrat Ruqiyeh College, Yazd.

Dadkhah Tirani, A., Davodiroknabadi, A., & Zohoori, S. (2018). Combining Traditional and Modern Art to make Fabric using Poly Vinyl Alcohol Material. *International Journal of Applied Arts Studies (IJAPAS)*, *2*(4). Retrieved from http://ijapas.ir/index.php/ijapas/article/view/111

Dundeby, D. (2010). *Fundamentals of Visual Literacy* (Sepehr, M. Trans.). 4th edition, Soroush Publishing House, Tehran.

Hashemi, N. (2019). *Basic book of visual arts in shoe design*. with an introduction by Hasna Naseri.

Monavari, M., Zohoori, S., & Davodiroknabadi, A. (2022). Anti-inflammatory and bactericidal effect of keratin/harmaline/ginkgo biloba electrospun nano fibres as band aid. *Micro Nano Lett. 17*, 210–215. https://doi.org/10.1049/mna2.12125

Nami, Gh. (2010). *Fundamentals of visual arts*. Third edition, Tos, Tehran.

Sadatnouri, H. (2015). *Effect of Aesthetics on the Consumer's Lifestyle of a Case Study of Paten Jameh Clothing in Tehran Province*. Master's Thesis in Business Management, Department of Management, Islamic Azad University.

Soltani, B., Zohoori, S., & Davoodi Rokanabadi, A. (2022). Design of Portable Fabric Pots by Hydroponic Method. *International Journal of Applied Arts Studies (IJAPAS)*, *6*(4), 71-78. Retrieved from http://ijapas.ir/index.php/ijapas/article/view/350

Tanabian, Sh. (2011). *Investigation of fabric texture and its application in evening and party wear*.

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Innovative Approaches to Designing Necklaces with Exceptional Qualities

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Research Article

Abstract

The laboratory-produced fabric has been finalized with Limonene nano capsules that possess the capability to gradually release fragrance. Conversely, for the Choker design, our aim was to incorporate linear patterns that evoke a feeling of serenity. Additionally, through the application of color science in these designs, we have successfully created an anti-anxiety and calming effect for the audience.

Keywords: Choker; Necklace; Designing; Art.

1. Introduction

A choker is a close-fitting necklace, usually 14 to 16 inches long, worn around the neck. Chokers can be made of various materials including velvet, plastic, beads, latex, leather, metal, such as silver, gold or platinum, etc.

Whether a wealthy Victorian lady or a 1990s punk rocker, chokers have long been a staple of women's fashion. The history of chokers dates back to at least 2500 BC as of the 1990s. Sumerian jewelers were making chokers for thousands of years before they became part of the youth subculture. Additionally, nearly all early civilizations on the planet used chokers as part of their cultural identity. The ancient Egyptians, Sumerians, and Minoans all left evidence of their use of strangulation in their respective societies (Heather, 2019).

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The chokers worn by these people were usually made of gold, and examples have been discovered that feature lapis lazuli - a stone that was widely used in ancient civilizations. Based on what is known today, these civilizations strongly believed that necklaces like these could provide protection as well as power. Chokers were originally used for this purpose and are also used as accessories today.

Although it has been confirmed by archaeologists that the choker was used in some form by various ancient civilizations, the choker has only been comparable to today's chokers for a few hundred years. The most prominent person we know of who wore a choker was Anne Boleyn. In her most famous portrait, she is depicted wearing a pearl pendant with a "B" pendant. As Anne Boleyn lived in the early 1500s, it's safe to assume that chokers have been associated with royalty and fashion for centuries. Fast forward several centuries, chokers had a divisive reputation in the 1800s.

The royals had a great influence on popular styles, and chokers were very fashionable among the upper classes of the Victorian era due to their popularity among the royal family. In the late 19th century, the choker was commonly worn by ballerinas and served as part of their costume. However, chokers were also heavily associated with prostitutes at this time. The difference in styles was clear, as the upper classes wore elaborate chokers set with precious stones, pearls, and precious metals, and prostitutes wore simple red or black ribbons.

At the end of the 20th century, the popularity of chokers continued with the influence of Queen Alexandra. The Queen regularly wore chokers of various styles to cover the scar on her neck. Alexandra's influence meant that the popularity of chokers - particularly pearl chokers - continued into the 1910s (Heather, 2019; Amiryan, 2018; Dundeby, 2010; Aghakhani, 2007; Nami, 2010; and Sadatnouri, 2015).

Fig 1 An ancient example of necklace

In the 1920s and 1940s, chokers were popular as a somewhat rebellious accessory. Young women in these decades wore chokers called "clairs de chine" or "dog collars". These chokers were made with more delicate materials than the Victorian period, such as lace and velvet. These chokers were limited to young women of the social elite, as the best examples were custom made to fit the neck and very expensive items were made for them.

The hippie culture and music movement of the 1960s and 1970s revived the choker necklace style. The choker became a unisex accessory that was particularly popular among men at the time.

Iconic rock stars such as Mick Jagger and Jimi Hendrix could be adorned with chokers, beads or studs or even feather detailing during performances.

In the late 20th century, in the early 1990s, chokers became popular again. As in the 1940s, these chokers were worn as an act of rebellion. These chokers were not made from the same luxury materials as their predecessors, many were made from stretchy plastic that allowed for mass production. Although chokers became fashionable at the turn of the century, they became popular again in the 2010s. Today, chokers are not strongly associated with rebellious subcultures. They are no longer associated with royalty and are often not considered glamorous unless they are made of precious gemstones such as pearls and diamonds.

Many styles of jewelry are typically in and out of fashion. Chokers may fall out of fashion temporarily, but they always rise in popularity once again (Heather, 2019; Amiryan, 2018; Dundeby, 2010; Aghakhani, 2007; Nami, 2010; Sadatnouri, 2015; Tanabian, 2011; and Monavari, Zohoori, and Davodiroknabadi, 2022).

2. Nano Technology

Nanotechnology refers to a branch of science and engineering that is dedicated to the design, production, and use of structures, devices, and systems by manipulating atoms and molecules at the nanoscale, that is, having one or more dimensions of 100 nanometers (100 millionths of a millimeter) or less.

In the natural world, there are many examples of structures with dimensions of one or more nanometers, and many technologies have incidentally involved such nanostructures for years, but only recently has it become possible to do so intentionally.

Many applications of nanotechnology involve new materials that have very different properties and novel effects compared to similar materials made at larger sizes. This is due to the very high surface-to-volume ratio of nanoparticles compared to larger particles and effects that appear at that small scale but are not observed at larger scales.

The applications of nanotechnology can be very beneficial and have the potential to have a significant impact on society. Nanotechnology has already been embraced by industrial sectors such as information and communication sectors, but it is also used in food technology, energy technology, as well as in some medical products and pharmaceuticals. Nanomaterials may also offer new opportunities to reduce environmental pollution.

3. The Science of Smell

How small particles can bring us happiness. As we smell a scent, the molecules travel to the back of our nose where they hold the sensory cells. This is where we "feel" the smell - basically, this is where our brain decodes the smell. When our brain decides what a scent is, it decides whether the smell is positive or negative. Since the 'smell zone', 'emotion zone' and 'memory zone' are all located in close proximity to each other, our emotions play a large role in determining whether or not a particular scent is positive.

When we smell a fragrance, that olfactory information is transmitted directly to our limbic system and hypothalamus, creating profound emotional and behavioral changes. Studies have linked the smell of oranges to improved emotional and immune responses, from antidepressants to energizing and restorative agents. In fact, a 2000 study in a dental office found that patients experienced less anxiety during visits when orange oil was diffused.

Exotic citrus scents like lemon or orange have been proven to give us a little bit of happiness. These happy scents have spicy aromas and stimulate serotonin (happy hormone) in our brain. Moreover, they stimulate our alertness while boosting our brain power

The effect of smelling orange scent on human psycho-physiological functions

Calming effect of orange - lower level of state anxiety, more positive mood and higher level of relaxation

Orange is also historically and symbolically important. Originating in China, oranges are considered by Chinese culture to symbolize good luck and fortune. Oranges are also associated with wealth in China, as the Chinese term "orange" rhymes with the term "gold". For this reason, they are very popular during Chinese New Year and are freely shared around the country to encourage wealth and good luck. Oranges are also round, so they are associated with the pure and endless cycle of a circle, and are considered a symbol of wholeness as well as providing bright and positive energy to any space. Even now, oranges and other citrus fruits are used to brighten up food and visual effects on the plate.

Chemical compounds of oranges

In terms of chemical compounds, oranges are rich in vitamin C. In its skin, an essential oil is found that contains di-limonene, dicyclic aldehyde linalool, dl-terpineol and... Its fresh leaves contain L-stachydrin, glycoside and hesperidin

4. Limonene

Limonene is a chemical substance found in the skin of citrus fruits such as lemons, Shirazi lemons, and especially orange peels, and it constitutes about 97% of the essential oils in it.

Limonene, also known as d-limonene, belongs to the family of terpene compounds, these compounds protect the plant against the attack of external factors due to their strong aroma.

Limonene is one of the most common terpenes in nature and has many properties, including anti-inflammatory, antioxidant and anti-stress properties, and reduces the risk of many diseases.

4.1. Common Uses of Limonene

Limonene is one of the most popular food additives and is used as a lemon flavor in products such as soft drinks, desserts, and candies.

This oil is extracted by hydrostatization, a process in which the skin of the fruit is soaked in water, after which the compound is heated and its volatile molecules are released through steam, compressed and separated.

Limonene has a special place in the production of cosmetics and cleaning and hygiene products such as soap, shampoo, lotions, perfumes, detergents and air fresheners, and because of its strong aroma, it is used in the preparation of pesticides, including insecticides.

Limonene oil is also used as an aromatic and relaxing oil in aromatherapy, and because of its health benefits, it is usually produced and sold in the form of capsules and soluble supplements.

Properties and benefits of limonene

Based on animal studies, limonene oil has anti-inflammatory, antioxidant and anti-cancer properties and protects the body against heart diseases, although more human research is needed in this field.

1.Anti-inflammatory and antioxidant

Some studies have shown that limonene helps reduce inflammation.

Short-term inflammation is actually the body's natural response to pressure and stress and is beneficial for health, but since chronic inflammation is dangerous and the source of many diseases, it is very important to deal with it.

Limonene appears to help reduce the inflammatory symptoms associated with osteoarthritis and reduce nitric oxide in cartilage cells. Nitric oxide is an important cause of inflammation in the body. According to animal studies, ulcerative colitis is another inflammatory disease on which the consumption of limonene has been effective and has reduced the inflammation and damage of the colon. Limonene also has antioxidant properties that counteracts the activity of free radicals - especially in leukemia cells - and prevents the occurrence of oxidative stress and inflammation.

2. Anti-cancer

According to some studies, people who consume citrus peel are less susceptible to skin cancer than people who only eat citrus fruit or juice.

Also, regular consumption of limonene seems to help reduce tumor cells in women's breast cancer.

The results of animal studies have also shown that the use of limonene along with the anti-cancer drug doxorubicin reduces the common side effects of the drug, including oxidative damage, inflammation and kidney damage.

3. Heart health

Limonene reduces the risk of heart disease by reducing some risk factors such as blood cholesterol, blood sugar and triglycerides.

Some animal studies suggest that limonene reduces the accumulation of fat in the liver and lowers blood pressure.

4. Other benefits of limonene

Other properties of limonene include the following:

Loss of appetite; The aroma of limonene is useful for reducing appetite

Reducing stress and anxiety; Limonene can be used in aromatherapy as an anti-stress and anti-anxiety aromatic oil.

Improve digestion; Limonene prevents stomach ulcers.

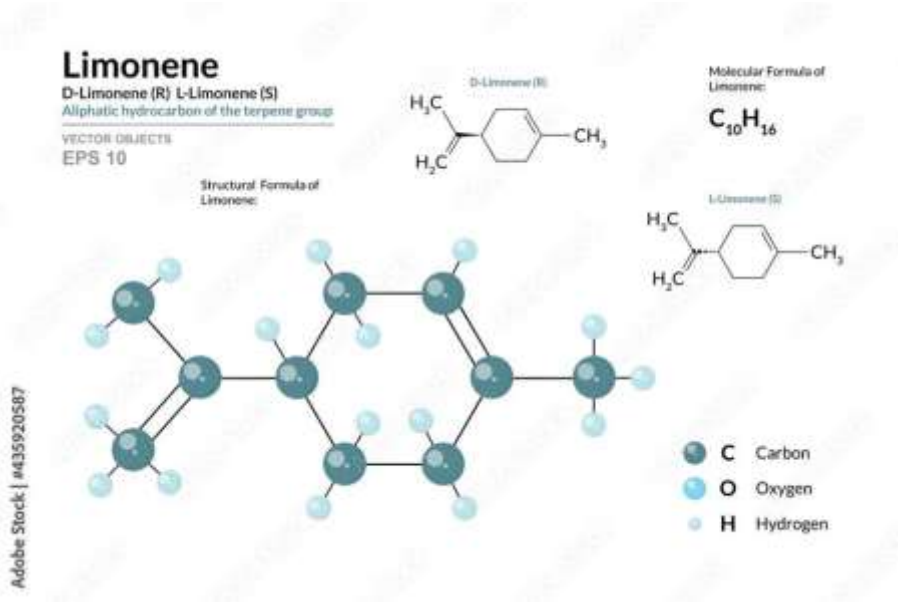

Fig 2 Schematic of Limonene

In this choker, the symbol of happiness is well used in several places, the fabric is curved and the metal hanger is made of jade stone in orange and green colors, which apart from its anxiety and happiness properties, can also show the appearance of an orange (Sadatnouri, 2015; Tanabian, 2011; Monavari, Zohoori, and Davodiroknabadi, 2022; Dadkhah Tirani, Davodiroknabadi, and Zohoori, 2018; and Soltani, Zohoori, and Davoodi Rokanabadi, 2022).

5. Artistic and Practical Work Process

A total of 21 compounds were identified in orange peel essential oil, the main compounds of which are limonene (94.3%), myrcene (1.5%), linalool (0.9%), decanal (0.5%), alpha-pinene (0.4%) and octanol (was 0.3%). After the deterpenization process, which was done by partial distillation and using a vacuum pump, various changes occurred in the orange peel essential oil.

In this article, Limonene Nano capsule have been used to desensitize fabrics used in fabric organizers. In this way, the fabrics were hypoallergenic and have been sent in the laboratory using ultrasound.[8] After studying the theory parts and getting information about the world of fabric art; First of all, a storyboard was prepared from the textures and applications of Choker and samples of textures were prepared by designing and taking into account the coloring, efficiency, elements such as the roots of the work, prominent texture, landscape designs and it was shown in the format of the storyboard; After creating a set of some linear etudes of design, selected design was completed (Figures 3-4).

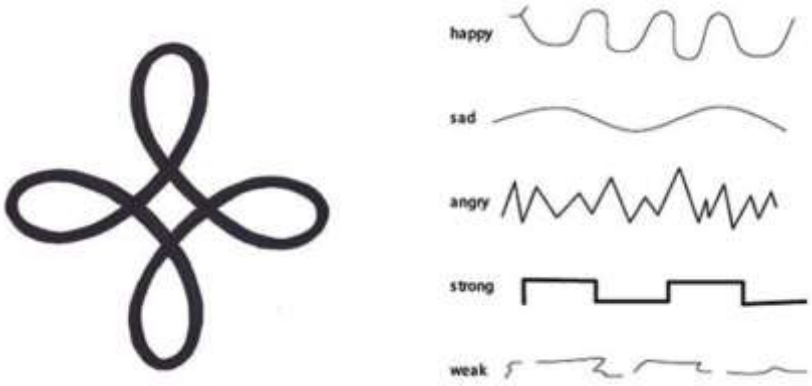

Fig 3 The initial etudes

Fig 4 The final design

6. Conclusion

The fabric prepared in the laboratory was completed by Limonene nano capsules, which will have the ability to spread the scent over time. On the other hand, in the design of Choker, we have tried to use linear motifs to induce a sense of peace. On the other hand, by using the science of color in these designs, we were able to achieve a design that is anti-anxiety and induces calm to the audience.

References

Aghakhani, H. (2007). *Intermediate visual arts 1 (art major)*. First edition, Payam Noor University, Tehran.

Amiryan, A. (2018). *Designing women's evening wear using tapestry texture*. Thesis for receiving a bachelor's degree, Hazrat Ruqiyeh College, Yazd.

Dundeby, D. (2010). *Fundamentals of Visual Literacy* (Sepehr, M. Trans.). 4th edition, Soroush Publishing House, Tehran.

Dadkhah Tirani, A., Davodiroknabadi, A., & Zohoori, S. (2018). Combining Traditional and Modern Art to make Fabric using Poly Vinyl Alcohol Material. *International Journal of Applied Arts Studies, 2*(4). Retrieved from http://ijapas.ir/index.php/ijapas/article/view/111.

Heather, W. (2019). *Investigating The Reasons Women Wear Choker Necklaces*. https://www.researchgate.net/publication/337926447_Investigating_The_Reasons_Women_Wear_Choker_Necklaces.

Monavari, M., Zohoori, S., & Davodiroknabadi, A. (2022). Anti-inflammatory and bactericidal effect of keratin/harmaline/ginkgo biloba electrospun nano fibres as band aid. *Micro Nano Lett. 17*, 210–215. https://doi.org/10.1049/mna2.12125.

Nami, Gh. (2010). *Fundamentals of visual arts*. Third edition, Tos, Tehran.

Sadatnouri, H. (2015). *Effect of Aesthetics on the Consumer's Lifestyle of a Case Study of Paten Jameh Clothing in Tehran Province*. Master's Thesis in Business Management, Department of Management, Islamic Azad University.

Soltani, B., Zohoori, S., & Davoodi Rokanabadi, A. (2022). Design of Portable Fabric Pots by Hydroponic Method. *International Journal of Applied Arts Studies, 6*(4), 71-78. Retrieved from http://ijapas.ir/index.php/ijapas/article/view/350.

Tanabian, Sh. (2011). *Investigation of fabric texture and its application in evening and party wear*.