International Journal of Applied Arts Studies

Volume 10, Issue 2

May – June 2025

Islamic Azad University, Yazd Branch, Iran

Acknowledgement

IJAPAS would like to thank the following people for their contributions in this volume.

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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 2025.

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
International Journal of Applied Arts Studies (IJAPAS)
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IJAPAS

International Journal of Applied Arts Studies

Print ISSN: 2588-4506 Online ISSN: 2588-4670

Homepage: www.ijapas.ir

Islamic Azad University
Yazd Branch

Evidence-Based Design in Medical Centers and the Effects on Patient Satisfaction (Case Study: Kasra Hospital in Tehran, Iran)[1]

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Article Info

Article type:
Research Article

Article history:
Received September 25, 2024
Received in revised form March 06, 2025
Accepted July 05, 2025
Published online August 15, 2025

Keywords:
Medical centers,
Evidence-Based design,
Patient satisfaction,
Kasra hospital

ABSTRACT

Evidence-based design (EBD) is a design approach that emphasizes using valid data to examine its effect on the design process. This approach is an important and growing movement towards creating a safe environment to take care of patients.

The purpose of this study is to improve design principles in hospitals and medical centers based on the EBD and put patients at the center of this approach to achieve patient satisfaction.

The research method is based on the bibliography studies, field observations, and data collected through the Delphi technique and questions asked from five experts in the architecture of medical spaces of Kasra hospital in Tehran, Iran using ASPECT software.

According to the obtained results, threshold rate of 6, the average factors of views (3.646), nature and outdoors (3.472), comfort and control (3.913), Legibility of place (3.900), facilities (3.079) and staff (3.594) has a relatively higher average than the average, The average of privacy and participation (2.769) and interior design (2.896) is lower than average, indicating low satisfaction with the mentioned factors. Also, the average of architectural features, Interior design features, and Mental and social features are reported as 3.166, 3.309, 3.073, and 3.817, respectively, and the total average score of the number It is almost favorable, and in general, the patients' opinion about the condition of the hospital is less than satisfactory.

Cite this article: Sadeghi, A., Shahcheraghi, A., Daneshjoo, Kh., & Hosseini, S. B. (2025). Evidence-Based Design in Medical Centers and the Effects on Patient Satisfaction (Case Study: Kasra Hospital in Tehran, Iran). *International Journal of Applied Arts Studies*, *10*(2), 07-26.

Publisher: Islamic Azad University, Yazd Branch.

[1] The present article is derived from the first author's doctoral dissertation entitled "A Conceptual Model for Improving the Architectural Quality of Evidence-Based General Hospital (EBD) with an Emphasis on Patient Satisfaction", which is being developed under the supervision of second and third author, and the advisor of the fourth author at the Islamic Azad University, Science and Research Branch, Tehran.

Introduction

Evidence-based research methods were founded in 1965 worldwide. These research methods were introduced to the architecture of hospitals in Britain in 1970. Few studies have been done on EBD since 1980. A health-based design center was founded in 1992 then more and better studies have been done on EBD since then. Huge research EBD projects began in 2000 to improve patients' outcomes and continued until 2004. Findings of around 1000 methods were analyzed up to 2008, and valuable results were obtained. These results indicated that we can improve patients' outcomes and safety by implementing some interventions (Labibzadeh and Sadeghi, 2021: 2).

EBD approach in medical centers is an important and growing movement towards the creation of a safe environment for taking care of patients. Compared to evidence-based medicine (EBM), EBD is a relatively new study field but numerous academic studies have established the foundations of this emerging major in the previous decade (Rashid, 2020).

As a modern approach to medical center design, EBD emphasizes the importance of using valid data to examine its effect on the design process. In therapeutic architecture, this approach is known as "an attempt to improve the well-being of patients and staff, the treatment process of patient, safety, and stress reduction." EBD is a relatively new research field that has adopted its terminology and ideas from various scopes, including environmental psychology, architecture, behavioral economics, and neurology (Tahouri and Sadeghi, 2021: 2).

EBD is defined as "the process of deciding on planning, designing, and constructing medical centers based on the valid evidence to achieve the best possible outcomes". EBD is influenced by the EBM. These two contexts are overlapped. This attitude provides design advice based on the causal relationships between characteristics of the designed medical environment and desired outcomes. Identification and application of psychological components and criteria in the interior design, including proper light and color, adaptable spaces, natural elements, and vegetation are effective in enhancing the quality of medical centers and designing a safer environment with more peace and less stress, which improves the medical performance (Hamzeloo and Sonboli, 2021: 1).

EBD Process

Rosalyn Cama defines the EBD as a process that can be used in the following cases: Design and construction of a new building or a renovation project Gathering a balanced group of employer representatives, investors, and design-related majors, including relevant researchers, design and analysis of a project based on an interdisciplinary method. Concentration on strategic guidelines that can improve outcomes through analysis of functional information of previous buildings and designs.

Confirming a tested design component or creating a creative idea to improve a certain outcome doing research projects after constructing a building to reveal the success or failure of the assumed outcome publication in a review and criticism journal (Figure 1) (Cama, 2009: 8).

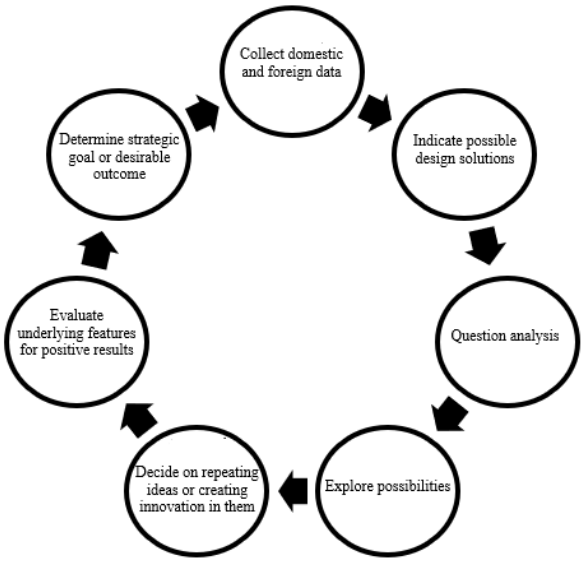


Figure 1. EBD process cycle (Cama, 2009: 9)

A research project by Ulrich and Zimring (2004) (2008) identified all common studies with improved outcomes and the physical environment of medical centers and hospitals. This study classified all environmental factors that can result in positive therapeutical outcomes if investment and studies are done for them. These factors are divided into four categories:

1. Stress reduction, improved quality of life and health for patients and their companions.
2. Decrease stress and pressure on the personnel, increase medical care and their effectiveness.
3. Improve safety and quality of treatment for patients.
4. Overall improvement in healthcare and reduced costs (Cama, 2009: 77 & 78).

Research Methodology

This descriptive-analytical study uses library studies and field surveys to gather data from patients hospitalized at the Kasra Hospital of Tehran; thus, data were analyzed to provide appropriate solutions to the problems. This study has been done based on the novel findings in environment psychology, behavioral sciences, and architectural design of medical environments.

Statistical Population

The statistical population of this study consists of patients at the Kasra hospital, who totaled 254 people.

Sample Volume

The Cochran formula was used to determine the sample volume.

Research Tools

The tool used in this study is an ASPECT-based questionnaire, as SPSS26 software is used to extract diagrams and descriptive data.

Research Limitations

Since the tool to gather data in this research was a questionnaire, this scale has problems, including subjects' shortage of time, boredom and consequently carelessness in answering some questions. Also, due to the inability of the elders and other illiterate people in filing on the scale, most questionnaires were asked in the form of an interview.

Data analysis method

Consistent with the nature of the research and its results, data analysis was performed via logical reasoning and inductive method. Descriptive statistics were used to analyze the data. In this study, 96 male and female hospitalized patients aged 15-80 years were surveyed face-to-face about "satisfaction with the hospital." The answers to the questions were entered in the ASPECT software. The results were weighted on a 6-point Likert scale ranging from 0-6, with 0 = unanswered, 1 = totally disagree, 2 = disagree, 3 = somewhat disagree, 4 = somewhat agree, 5 = agree, 6 = totally agree. The eight parts of the ASPECT software were privacy, company, dignity, views, nature and outdoors, comfort and control, place legibility, interior appearance, facilities and staff.

The questionnaire was again categorized based on the healing environment characteristic, and more results were elicited. The results were entered into the SPSS26 software, and the following figures were determined.

Research steps

Step 1: project description

The first step in the research process is the description of the project. This study measures the satisfaction rate of the expert panel with the quality of spaces in Kasra Hospital and uses the most appropriate idea and solution for designing and improving the quality of space based on the confirmed authenticated evidence.

Step 2: Evaluation of the current situation

Designed and planners would evaluate the current situation in this step of the process. Evaluation of the existing environment (current situation) is vital for finding opportunities for further development of the medical center.

The eight sections used for assessment through ASPECT software are as follows: privacy and company, view, nature and outdoor, comfort and control, legibility of place, interior design, facilities, and staff.

The results obtained from ASPECT software were analyzed based on these 8 sections. The results are reported here in.

Step 3: Find the ideal status

This part of the process determined the ideal status. The relevant standards, academic evidence, and published results must be reviewed to detect the distance between an existing medical center and its ideal status (Mardomi et al., 2013: 96 & 97). ASPECT software is a tool used to assess the ideal situation, which is based on the database results of 600 studies examining the effects of the medical environment on the satisfaction of patients and staff, medical outcomes of patients, and staff productivity. The results obtained from answers given to the ASPECT questions indicate the weaknesses and strengths of the design of available buildings (Table 1, & 2).

Table 1. Statistical indicators of satisfaction of patients in Kasra Hospital by the eight sections of ASPECT.

A Staff and Patient Environment Calibration Tool (ASPECT) NHS

Project details: Title

s

Workshop details: Location Date

Results summary:

C1:	▶ Privacy, company and dignity	2.7	5 of 5 scored
C2:	▶ Views	3.6	5 of 5 scored
C3:	▶ Nature and outdoors	3.4	3 of 3 scored
C4:	▶ Comfort and control	3.9	6 of 6 scored
C5:	▶ Legibility of place	3.9	6 of 6 scored
C6:	▶ Interior appearance	2.8	8 of 8 scored
C7:	▶ Facilities	3.0	8 of 8 scored
C8:	▶ Staff	3.5	6 of 6 scored

1 2 3 4 5 6

NOTE: A filled traffic light dot [●] in the table above indicates a valid average score, a hollow dot [○] indicates that one or more statements have been marked as 'unable to score'.

Table 2. The mean and standard deviation of the eight sections of ASPECT of patients admitted to Kasra Hospital

Factors	Average	Standard deviation
C1: Privacy, company and dignity	2.769	1.030
C2: Views	3.646	1.001
C3: Nature and outdoors	3.472	0.939
C4: Comfort and control	3.913	0.928
C5: Legibility of place	3.900	0.646
C6: Interior appearance	2.896	0.689
C7: Facilities	3.079	0.695
C8: Staff	3.594	0.858
ASPECT overall score in Kasra hospital	**3.299**	**0.482**

The mean and standard deviation of the eight sections of ASPECT of patients admitted to Kasra Hospital are reported in (Table 1 & 2). It can be seen that the total average is 3.299, which is more than the theoretical average value of 3, which indicates a relatively better satisfaction with the eight factors of Kasra hospital. Also, the data shows that the average factors of views (3.646), nature and outdoors (3.472), comfort and control (3.913), Legibility of place (3.900), facilities (3.079) and staff (3.594) has a relatively higher average than the average, which means the relative satisfaction of the hospitalized patients with regard to the mentioned factors. The average of the components of Privacy, company and dignity participation (2.769) and interior appearance (2.896) is lower than average, indicating low satisfaction with the mentioned factors. The important point is that, in Kasra Hospital, the average answers of the patients in none of the eight ASPECT factors exceeded the number 4, and this office expresses a very high level of dissatisfaction with the mentioned factors. It is necessary to explain that the standard deviation of the answers given in the eight factors of ASPECT have small fluctuations with favorable numbers and indicate that the data is more focused on the average and are a seal of approval on the results.

Eight sections of assessment through ASPECT Software

- ***Privacy, company and dignity:*** Everybody's privacy is a feeling about their dignity, autonomy, and personal space (Heidari et al., 2011: 645).
- ***Views:*** The view of natural landscapes is seen in stress reduction and patients' recovery as a set of positive emotional, psychological, and physiological changes (Ulrich, 1984: 420).
- ***Nature and outdoors:*** The design and application of green spaces in hospitals do not cost as much as manufacturing hospital equipment. These spaces provide the following advantages: reducing the stress of patients, staff, and visitors, alleviating the pain of

patients, decreasing depression, enhancing the quality of life for permanent patients, improving routing ability, increasing the physical activity of patients, and strengthening their sense of autonomy (Mardomi et al., 2013: 64 & 65). The design of healing green space tends to create open space to meet the medical needs of patients. The garden is indeed the place and tool used to treat various patients; for instance, green space for rehabilitation, green space for patients suffering from Alzheimer's and other impaired senses, and green space for cancer patients (Tahouri and Sadeghi, 2021: 6).

- ***Comfort and control:*** The term "subjective comfort" is attributed to individuals' judgments about their situations. There is a high relationship between subjective comfort and enough knowledge about the disease, the close relationship between patient and physician, social support, and spiritual aspects that all are coping strategies (Siegrist, 2003).
- ***Legibility of place:*** Most clients of medical centers have fewer sensory, physical, and cognitive sources due to disease and stress, so it is difficult for them to find the route and be present in a complicated and stressful space (Mollerup, 2009). Legibility of place means creating a space in which, visual information is simply organized to create a coherent basis for the action and movement of individuals in the environment (Mardomi et al., 2011: 51).

- ***Interior design***
  - ***Light:*** natural and artificial illuminance must satisfy the following needs: occupational efficiency, comfort, psychological needs, aesthetics, visual well-being, human relationships, hygiene, and safety (Ministry of Health, 2013: 270). Available studies confirm that natural light can reduce depression in patients with seasonal disorder and bipolar depression (Benedetti et al., 2001), shorten the treatment period and improve sleep status (Joseph, 2006), alleviate emotion, and relieve pain (Lacgrace, 2002) (Hosseini et al., 2022: 30).
  - ***Color:*** color plays an underlying role in improving the environment, acquiring knowledge, and routing (Dalke et al., 2004: 3). Accurate application of color in medical centers not only fosters morality and makes the space happy but also can be effective in treating many diseases by influencing the body and soul of patients (Hosking & Haggard, 2003: 120).
  - ***Sound:*** sound pollution or noise in medical centers may cause negative effects, such as insomnia, anxiety, hypertension, and considerable need for reliving pain, disorder in processes and activities, and disturbing comfort of patients, companions, and staff (Ministry of Health, 2013: 283). "The noise that causes discomfort would hurt the patient. Too much noise is the cruelest kind of inattention," Florence Nightingale explained it for the first time in the book "Note on Nursing." (Nightingale, 1969: 47).
  - ***Positive Distraction:*** positive distraction is anything that can distract a person's attention creating a positive feeling response in them. When proper positive distractions are selected in the medical space, the stress of patients can be reduced and a sense of security is created for them (Kaiser, 2007: 8) (Ulrich, 1993: 7). Music can decrease stress and distract the patient's mind from paying attention to the adverse side of the disease. Music has an instant physiological effect due to the body's autonomous neural system (Kemper & Danhauer, 2005) (Mardomi et al., 2013: 48). Music can also leave a numbing sense (Malkin, 1992: 19).

- ***Beauty:*** consideration of interior architecture components in medical centers based on the aesthetics approach and creating a healing space would improve the quality of medical spaces. Beauty can reduce stress, and increase the satisfaction of staff, patients, and companions (Mardomi et al., 2013: 41). There are specific features of spatial arrangement and environmental design in hospital spaces or workplaces that affect the outcomes, which must be considered in further studies (MacAllister & Zimring 2016, 1).
- ***Facilities:*** Single-bed hospital rooms, and replacing multiple-bed rooms with single-bed rooms have been a debatable issue in developed countries over recent decades. There is now a considerable willingness to use single-bed hospital rooms (Hosseini et al., 2022: 30). Two features of several beds and the landscape observable through the window are correlated with the hospitalization period of patients (Nikabadi et al., 2021: 87). Single-bed hospital rooms providing many confirmed advantages, such as reducing hospital infections, decreasing medical errors, physical injuries and possible falling, improving sleep, increasing patients' satisfaction, respecting privacy, and improving the relationship between staff, patients, and companions would improve safety of patients (Nikabadi et al., 2022: 98) (Hashemnejad et al., 2011: 41).
- ***Staff:*** Medical centers' staff are responsible for making patients familiar with doctors and nurses, access to physicians and members of medical groups, meeting the religious and educational needs of patients, and taking consent letters signed by the patient on medical, diagnostic, research, and risky therapeutical measures (Figure 2 & 3).
- ***Results assessment***

  Results assessment must be continuous and permanent. The most significant assessment or results is done by selecting a solution and after using a new medical center. To do the two phases mentioned above, some investigations such as patient satisfaction rating, measuring care quality, and clinical outcomes before and after hospitalization must be compared to find the effect of design solutions on the hospitals.

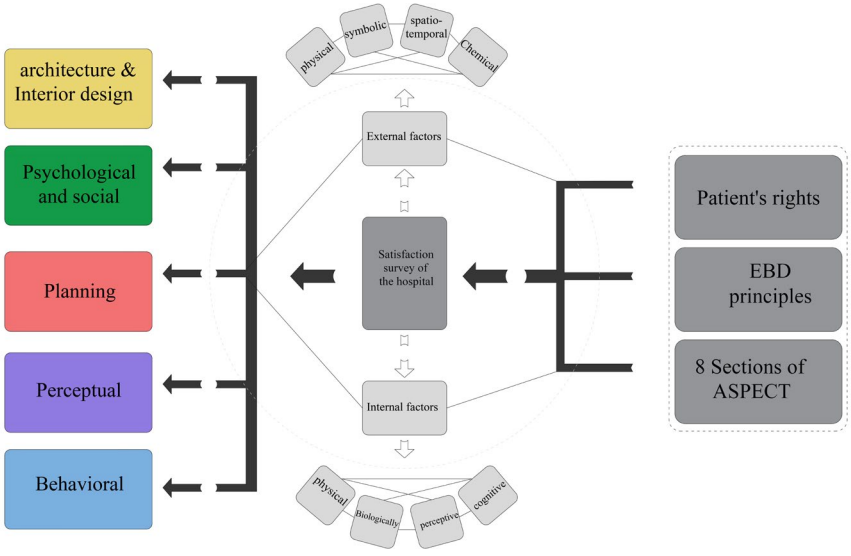


Figure 2. Model 1 of satisfaction.

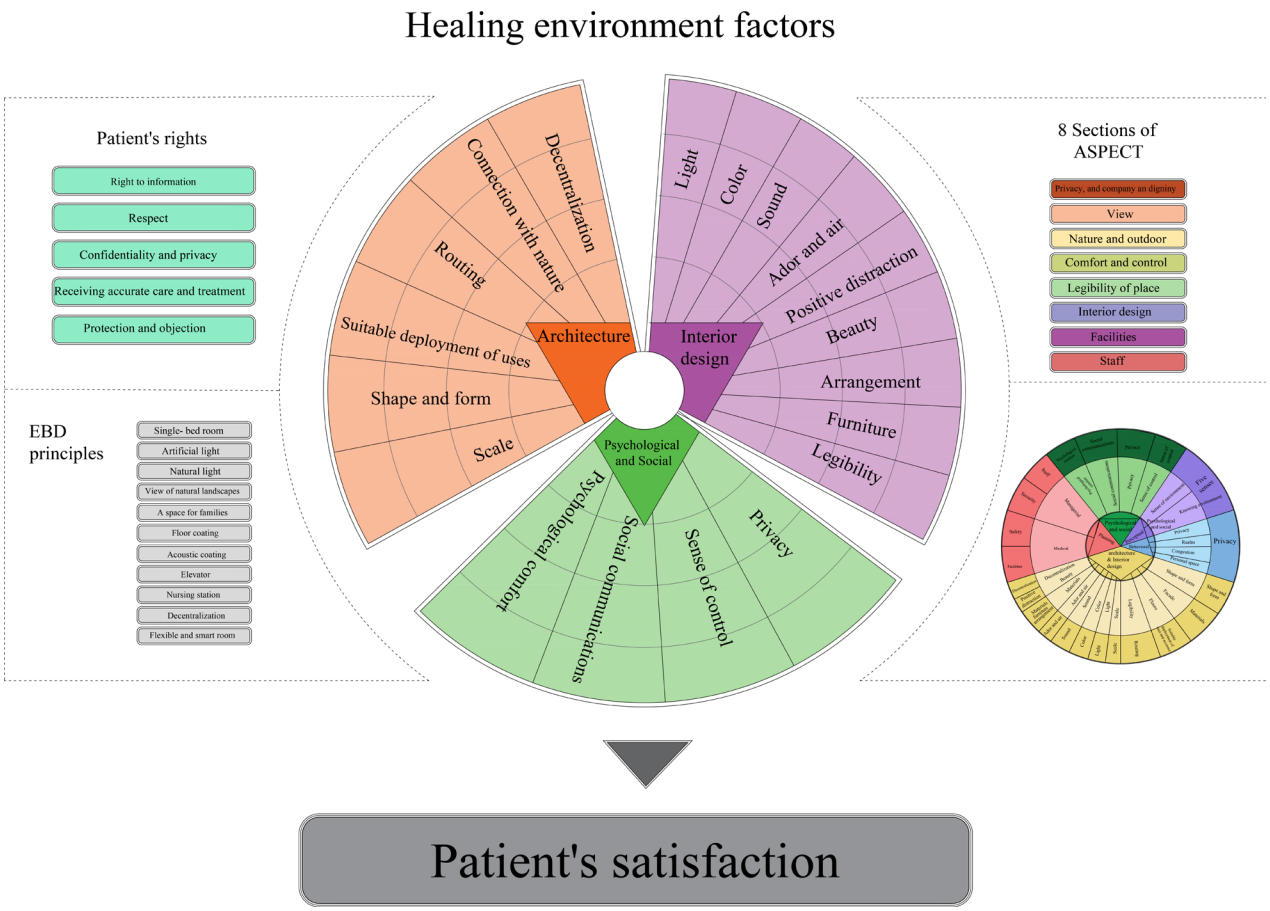


Figure 3. Model 2 of satisfaction.

In the descriptive part, the mean, standard deviation, minimum and maximum responses of the research participants in each of the research variables, including architectural features, interior design features, psychological and social features, as well as eight ASPECT criteria, are reported. In the section related to inferential analysis, research hypotheses have been investigated using correlation coefficient and multivariate regression model using structural equations.

Table 3. Statistical indicators of the level of satisfaction of patients hospitalized in Kasra Hospital by the factors of the healing environment.

Category	Factors of the Healing Environment	Average	Standard Deviation
Architectural features	Shape and form	4.715	0.944
	Suitable deployment of uses	3.328	1.202
	Routing	2.908	1.354
	Connection with nature	3.508	0.821
	Decentralization	2.077	0.862
	Total score of architectural features	**3.309**	**0.510**
Interior design features	light	4.415	0.868
	Color	2.338	1.019
	Sound	2.80	1.148
	Temperature, air and adore	2.423	0.977
	Positive Distraction	3.20	1.134
	Beauty	2.261	1.278
	Arrangement	3.215	1.256
	Textiles, materials and furniture	3.001	0.929
	Legibility	3.862	1.014
	Home-like space	3.210	0.761
	Total score of interior design features	**3.073**	**0.562**
Mental and social features	sense of control	3.261	0.940
	Privacy	2.823	1.049
	Social communication	3.085	1.084
	Psychological comfort	2.761	0.923
	Facilities and safety	3.031	0.980
	Staff	3.670	0.802
	Total score of Mental and social features	**3.817**	**0.574**
The score of components of the healing environment of Kasra hospital		**3.166**	**0.459**

The average indicators and standard deviation of the healing environment components of Kasra Hospital are shown in Table 3. It can be seen that the total average, the average of architectural features, the average interior design features, and the average of mental and social features are reported as 3.166, 3.309, 3.073, and 3.817, respectively, and the total average score of the number It is almost favorable, and in general, the patients' opinion about the condition of the hospital is less than satisfactory. Also, the dimensions of architectural features, interior design features, and mental and social features are higher than the theoretical average, and it shows relative satisfaction with the mentioned factors. With a closer look at each component, we see that the average level of satisfaction of patients in the factors of shape and form (4.715) and light (4.415) is relatively high and higher than the score of 4 out of 6, which shows they have higher than average level of satisfaction with these components. After that, the average level of satisfaction of the patients in the dimensions of Suitable deployment of uses (3.328), connection

with nature (3.508), positive Distraction (3.20), arrangement (3.215), Textiles, materials and furniture (3/001), routing (3/862), home-like atmosphere (3/210), sense of control (3/261), social communication (3/085), facilities and safety (3/031) and staff (3/670). It was on a Likert scale of 6, which is more than the theoretical average, which means that it leads to their relative satisfaction in these areas. Although these numbers do not give the desired satisfaction, it indicates that the design of Kasra hospital has been relatively successful in these indicators. It can also be seen that the average level of satisfaction of patients in other areas (routing, decentralization, color, sound, temperature, air and adore, beauty, privacy and psychological comfort) is lower than the average, which shows the level of satisfaction. It is necessary to explain that the standard deviation of the answers given in the categories and their factors have favorable numbers due to small fluctuations and indicate the concentration of the data on the average and are a seal of approval on the results.

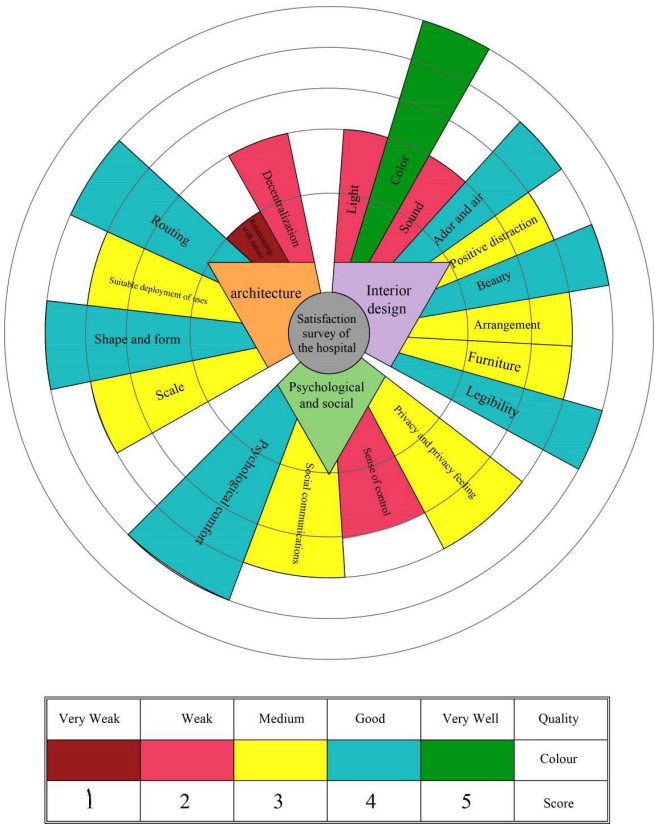


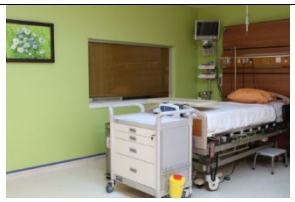
Figure 4. Outcome of 8 elements of ASPECT and healing environment factors and patient rights in Kasra Hospital.

Table 4. Mean satisfaction of hospitalized patients by the healing environment factors.

Category	Healing environment factors	Item/mean	Mean scores given out of 6 by the items of the questionnaire based on the healing environment factors				Average	Mean classification of factors
Mental and social features	Sense of control	Item	Sound/noise control	Light control	Temperature control	Ventilation control	2.50	3.817
		Mean	2.03	2.4	2.6	2.67		
	Intimacy and preservation of privacy	Item	Privacy	Private conversations	Loneliness	Personal items	3.54	
		Mean	4.02	3.98	2.55	3.63		
	Social communications	Item	Collective space	Place for the patients' companion	Religious deeds	Daylight room	3.92	
		Mean	4.93	3.19	4.78	3.80		
	Subjective well-being	Item	Household sense	Comfort	Access to physician and nurse	Respect by physical and nurse	3.23	
		Mean	3.16	2.15	5.50	5.14		
Interior design features	Light	Item	Window	Natural light	Diversity of light sources	Artificial light	3.24	3.073
		Mean	3.64	2.78	2.64	3.93		
	Color	Item	Comfort	Attraction	Legibility	Aesthetics	4.30	
		Mean	4.54	4.61	3.52	4.53		
	Noise	Item	Sound control	Music	Noise	Pitching	1.63	
		Mean	2.04	1.07	2.06	1.37		
	Ventilation and fresh air	Item	Ventilation control	Fragrance	Appropriate ventilation	Window	3.14	
		Mean	3.91	2.16	2.35	4.16		
	Positive distraction	Item	Artistic works	Entertainment	Attractive scenery	View of landscape	3.47	
		Mean	3.34	2.38	4.00	4.17		
	Aesthetics	Item	Diversity	Order	Attraction	Cleanliness	3.69	
		Mean	2.02	3.02	4.65	5.08		
	Textiles, materials and furniture	Item	Joinery	Furniture	Suitable flooring	Suitable curtain	4.38	
		Mean	4.07	4.23	5.09	4.13		
Architectural features	Forms	Item	Index input	Index output	Invitation form	Appropriate spatial distinction	3.88	3.309
		Mean	3.91	3.85	3.78	3.92		

	Path-finding	Item	Pathfinding	Hierarchy	Coloring	Index acceptance	4.30	
		Mean	4.30	4.60	4.88	3.42		
	Communication with nature	Item	View of landscape	View of green space	Comforting landscape	Access to green space	1.77	
		Mean	2.16	1.93	1.33	1.66		
	Decentralization	Item	One-bedroom	Private space	Multi-use room	Distinct facilities	4.20	
		Mean	4.70	4.28	3.63	4.20		

Table 5. Factors of ASPECT in Kasra Hospital of Tehran.

Privacy and Company	**View**	**Nature and outdoor**	**Comfort and Control**
			
Providing waiting halls with flexible chairs Waiting space with flowing daylight A space for the presence of families	Outdoor view for patients, staff, and using daylight with an approximate suitable method	Using green space inside the building Access to outdoor green space is limited.	A kind of design that considers individuals' privacy has a higher effect in terms of disease recovery. Protecting the privacy of patients by using curtains
Legibility	**Interior design**	**Facilities**	**Staff**
			
			
Prominent entrance Proper indoor routing	Pleasant interior design Using diverse colors	Available facilities Proper medical equipment	Rapid access to nurses that are outside, so they can have access to patients rapidly

In Iran, the patient rights charter was enacted in 2002 and submitted to the subordinate centers by the Health Deputy of the Ministry of Health, Treatment and Medical Education. This charter has been designed within five general contexts and 37 paragraphs. The five contexts have been formulated in 9, 7, 4, 14, and 3 paragraphs (Mosadegh Rad, Asna Ashari, 2003).

1. **Right to information, 2. Respect, 3. Confidentiality and privacy, 4. Receiving accurate care and treatment, 5. Protection and objection**

Hypothesis Test

In the current research, the variables of the healing components, which include architectural features, interior design features, and psychological and social features, are known as independent variables, and the design of the treatment center is known as dependent. Before testing the hypotheses, the presuppositions of structural equations, including normality (Kolmogorov–Smirnov test), non-collinearity of independent variables (variance inflation factor test (VIF)) and independence of observations (Durbin-Watson test) were examined. It is assumed that all the mentioned assumptions have been confirmed. According to Figure 4, it can be seen that the architectural features with a rate of 0.486 have the greatest impact on the design of the treatment center, and the psychological and social features with a rate of 0.333 have the second priority, and at the end, the interior design features with a rate of 19 0/ has had the least role. The coefficient of determination for the hospital is calculated as 0.344, which means that the contribution of the variables of the components of the patient's healing environment, i.e. the three factors of architectural features, interior design features, and psychological and social features, in the satisfaction of patients admitted to the hospital is 4.4 It is 34% and the share of other unidentified factors is equal to 65.6%, which should be identified and their impact coefficients should be measured.

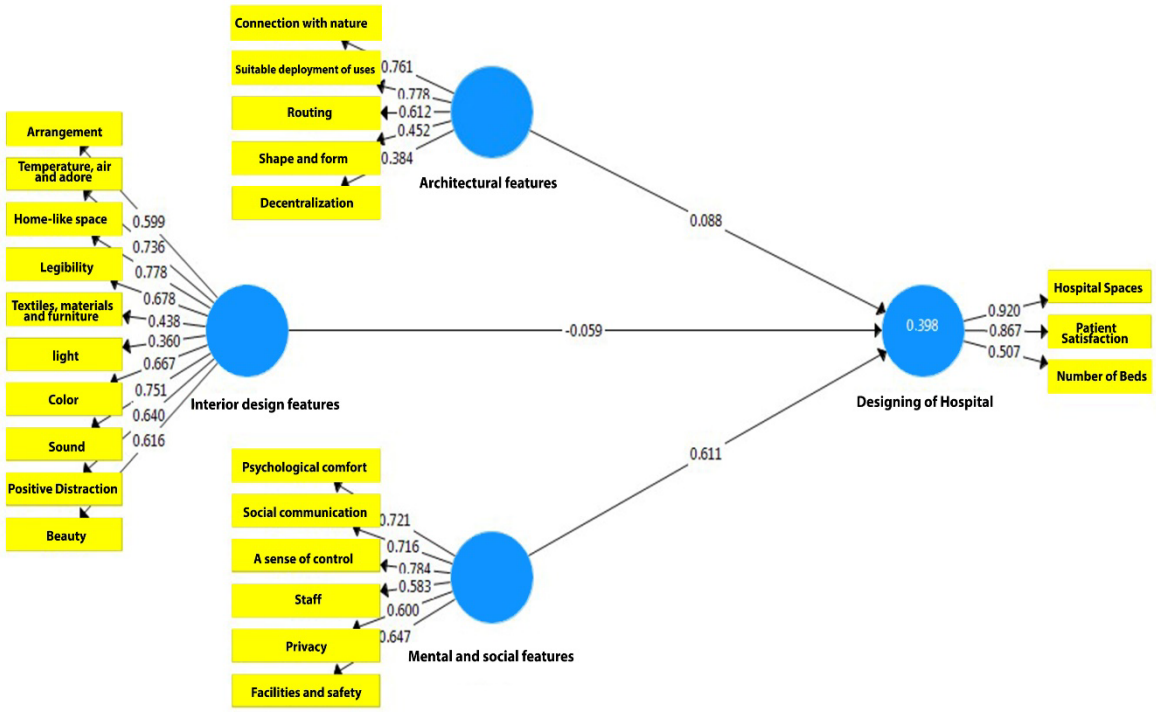


Figure 5. Standardized path coefficients of the conceptual model in Kasra Hospital.

Conclusion and provide solution

The main advice of EBD in comparative evaluation can be mentioned for the design of medical buildings based on the results obtained from the Table and Figures shown above.

Table 6. Design solutions and recommendations.

Factor	Suggestions and design solutions
Privacy and Company	Social support is increased when a suitable and comfortable place is considered for the family in the patient's room
View	Patients must have access to and a view of relaxing natural landscapes. The spaces where patients spend most of their time should have windows.
Nature and outdoor	It is recommended to create a garden with an emphasis on green space presence in the environment and using interior design elements such as comfortable furniture with the proper layout to increase communication.
Comfort and control	One of the significant factors in a healing environment is its similarity with the house's space to break the imagination of patients that they are in hospital spaces allowing them to feel comfortable. Some amenities must be created for illumination control, room temperature, TV control, music, ability to use personal items specific scales for children, and privacy for patients.
Legibility	Visible and understandable signs should be used, and a common language must be applied to design signs and the number of rooms.

Interior design	Light	It is recommended to use indirect and gentle lights in all, hospital spaces to avoid sudden light changes in the spaces. The ceiling is the place that patients see in communicational spaces, corridors, and elevators when patients are on a bed or stretcher, so these spaces must be designed in a way that wall or ceiling lamps do not shine directly into the patient's eyes.
	Color	The color of wards must be chosen from bright colors that provide comfort and peace, so dark colors should not be used in wards. The colors should be selected in all hospitalization wards in a way that the medical group's perception is not disturbed and patients have psychological comfort at the same time.
	Sound	If the fan is used, they must be installed inside the walls or on the ceiling to reduce the sound. The floor and ceiling coverings with a high sound reduction rate can help to decrease noise.
	Positive distraction	Music therapy is suggested for patients with hypertension or those who suffer from migraine headaches. Positive distractors can be a fireplace, a game table, or even access to the outside landscape through a patio or large window.
	Beauty	Accurate planning is required for sufficient storage of portable equipment and extra beds. Strange tools or medical gas outlets must be used rarely.
Facilities		The rooms must be designed uniformly. The uniform rooms provide similar and repetitive arrangements; it means that patient beds, technology, and nurses' places are the same in all rooms. Private rooms should be prepared for all patients. Private rooms can reduce the pollution and stress of patients. The size of hospitalization rooms should be increased.
Staff		A station should be considered for nurses next to the patient room with a window towards the nurse station. Decentralized nurse stations must be designed.

Conclusion

The evidence-based design studies promise a better healthcare sector and better medical buildings. Faster development is required in this field. It is necessary to have cooperation and coordination with evidence-based research centers to complete more accurate methodologies and share information. A collaborative research plan can provide the field for coordination and enhance the research funds.

EBD has become popular in the architecture of medical centers over the years trying to improve various factors. This approach insists on using robust evidence and authentic information resulting from deterministic methods and studies to influence the design process and its results. Hence, EBD is used to create an environment that can treat and support the presence of families, be effective and efficient for staff's performance, and recover the ability of staff that are under stress. In the last phase of analysis, an evidence-based medical design must lead to

confirmed improvements in clinical results, economic performance, job yield, and patient satisfaction.

Since the design and construction of medical centers cannot be postponed until the valid evidence and required knowledge (through studies) are created; therefore, designers and executors of the project must create a balance between available knowledge and evidence obtained from studies to make flexible decisions that are adaptable with future studies and evidence.

Many studies must be done and academic references should be generated to achieve efficient medical centers regarding the country's goals at the macro level describing medical centers based on international standards. Application of the EBD approach in planning, designing, and constructing medical centers can lead to the best results. The presence of a multidisciplinary team and the EBD process ensures achieving these goals.

Author Contributions

All authors contributed equally to the conceptualization of the article and writing of the original and subsequent drafts.

Data Availability Statement

Not applicable

Acknowledgements

The authors would like to thank all participants of the present study.

Ethical considerations

The study was approved by the Ethics Committee of the Islamic Azad University, SR.C. The authors avoided data fabrication, falsification, plagiarism, and misconduct.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors declare no conflict of interest.

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IJAPAS

International Journal of Applied Arts Studies

Print ISSN: 2588-4506 Online ISSN: 2588-4670

Homepage: www.ijapas.ir

Islamic Azad University
Yazd Branch

Analyzing the Effect of the Interconnected Role of Educational Space on Promoting Self-Efficacy in Children Aged 3 to 6 Years (Case Study: Isfahan Fooladshahr Preschools)

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Article Info

Article type:
Research Article

Article history:
Received October 09, 2024
Received in revised form June 12, 2025
Accepted July 05, 2025
Published online August 15, 2025

Keywords:
Integrity,
Educational spaces,
Self-efficacy,
Children,
Physical environment

ABSTRACT

A child needs a space to stimulate understanding, recognition, and self-efficacy. Educational spaces play a significant role in the development and behavior of children. If these spaces are formed with the aim of promoting self-efficacy and based on the social, emotional and behavioral needs of the child, the child's interaction with the built spaces will be compatible and understandable. Self-efficacy is directly affected by the physical environment in the integration of children's educational spaces. This research has investigated the role of children's educational environment on the self-efficacy of children aged 3 to 6 years. The theoretical propositions of this study have been investigated in the field and survey in 5 samples of preschools in Foladshahr, Isfahan. The research method of this study is combined (qualitative and quantitative) and descriptive-analytical. The map of the educational spaces under study was drawn using Autocad software, and Depth Map software was used to analyze the degree of interdependence of the spaces. The level of children's self-efficacy and the correlation coefficient between the variables were measured using data from a researcher-made questionnaire in the Pressline system through Spss software. The results of the study indicate that educational spaces have spatial interdependence differences and significant effects on children's self-efficacy in the indicators under study.

Cite this article: Geramifard, M., Yeganeh, M., & Tabaeian, S. M. (2025). Analyzing the Effect of the Interconnected Role of Educational Spaces on Promoting Self-Efficacy in Children Aged 3 to 6 Years (Case Study: Isfahan Fooladshahr Preschools). ***International Journal of Applied Arts Studies***, *10*(2), 27-48.

Introduction

Educational spaces play a significant role in raising children. A child's understanding of the place and the surrounding environment is achieved by his dynamic interaction with the environment and during numerous activities and environmental behaviors that he expresses

(Murphy and Murtagh, 2010: 5). Over time, the child's interactions with the environment and the correlation of environmental experiences can bring a sense of competence and skill. The growth of children, experiences, and opportunities to see new places help them to support the development of competence (Lim and Barton, 2010: 329). The quality of the place needs to know the behavioral patterns of the users. Therefore, in order to improve the quality of the effective place on behavioral patterns and establish the interaction between place-behavior, behavioral-spatial studies are necessary.

A person's performance is affected by various factors such as motivation and excitement, environmental conditions, fatigue, and illness (Saif, 2001: 33). Self-efficacy determines whether or not a person initiates an activity, as well as his effort to do the work and his persistence and perseverance in facing obstacles and problems while doing the activity (Lent and Brown, 2013). Compared to any other motivational structure, self-efficacy has been introduced as the most consistent predictor of behavioral outcomes (Pajares, 1997; Yousefi, 2011). Addressing the quality of children's interactions with the world around them is necessary because the child's knowledge in the case of the environment is both a function of cognitive abilities and depends on the level of his experience in the environment (Hart and Moore, 1973).

Educational spaces are virtual spaces where children experience a deep connection with place and group interactions. Therefore, it is necessary to examine the quality of educational places and use physical and spatial qualities based on self-efficacy criteria to attract and strengthen children's behavior. Most children spend a long time in the educational space. The educational spaces should provide the platform for growth, learning, motivation, and self-efficacy in children according to age, culture, social, etc. However, the structure of some children's educational spaces is based on the age spectrum, preferences, and environmental patterns and self-efficacy has not been considered and neglected. Accordingly, the lack of these items will cause negative behaviors in children.

The physical structure of educational spaces should have motivational elements to improve the motivation to be in the space. Children communicate with the environment through direct experience and perceive it (Arghiani, Yazdanfar, and Feizi, 2019; Kaplan, 2002; Saif, 2001). The educational environment can create many capabilities in a child, and one of these capabilities is motivation. Therefore, the child needs a space to create self-efficacy to achieve the processes that give strength and direction to his behavior and improve his sense of worthiness and competence. Nevertheless, the effort of a single child alone is not enough to understand and coordinate the space and create self-efficacy, and it will create limitations for the child's presence in the space and place. The child's lack of recognition, understanding, and satisfaction with the space and lack of self-efficacy will disturb the interaction with the space and cause abnormality and suppression of belief and feelings of disappointment and unworthiness in the child. Nevertheless, creating an

atmosphere that matches the child's behavioral and perceptual needs and responding to his needs creates motivation and self-efficacy and achieves a positive behavioral pattern.

This study aims to investigate the spatial and physical factors of spaces that effectively improve children's self-efficacy. In other words, this research seeks to answer the central question of what physical and spatial characteristics of educational spaces can strengthen self-efficacy in children. One of the essential qualities concerning physical and spatial factors is the coherence of spaces. In other words, the premise of this article is that integrating more spaces in educational spaces can lead to improving self-efficacy in children. This study is based on the theory of space syntax. Connection, depth, accessibility, and the ability to choose are among the criteria of spatial structure discussed in this article as an interconnection index. Based on this, using software analysis, the degree of interconnection of spaces and thorough surveying, the degree of self-efficacy has been measured, and this relationship has been investigated with statistical analysis.

Five examples of kindergarten educational spaces based on the components of the space structure affecting self-efficacy in children aged 3 to 6 years have been investigated. Questions are raised in this research: How is the cohesion of the educational space measured? The cohesion of space What effect does education have on the self-efficacy of 3-6-year-old children? The article's central hypothesis is that the space connection directly affects children's self-efficacy in educational spaces.

Research Background

Several types of research have been done in the direction of educational spaces in Iran or the role of combining spaces with other functions, which can be referred to in Table 1.

Table 1. The background of the compilation research (Source: Authors, 2024).

Author	Year	Subject	Methodology	Objective
Turkman, Jalalian, & Dezhdar	2019	The role of architecture and physical factors of the educational environment on facilitating children's learning.	Qualitative - logical reasoning	The purpose of this article is to explain how the design of educational spaces is suitable for children's lives and at the same time effective in the field of education.
Tabatabaiyan	2015	An analysis on the influence of built environments on children's creativity (examination of environmental characteristics affecting children's creativity in children's centers in Tehran).	Analytical-qualitative and case	In order to find those characteristics of the built environment that affect the child's creativity.
Malinin & Parnell	2012	Reconceptualizing School Design: Learning Environments for	Reviewed article	Aim to develop

		Children and Youth		understanding of the relationship between a school's physical environment, the processes undertaken to create that environment, and students' learning and self-development.
Monsur	2013	Transitional Space and Preschool Children's Play& Learning Behavior in Childcare Environment	Case study	Aim of this research is to influence design awareness and design policy for childcare environment
Shawket	2016	Improving sustainability concept in developing countries Educational Methods Instruct Outdoor Design Principles: Contributing to a Better Environment	Analytical	Spaces' design principles should be for each educational system individually in order to reach maximum benefits of the educational process
Vero, & Puka	2017	The Importance of Motivation in an Educational Environment	The study was based on several theories like, socio - educational	The study will be based on a framework familiar with some of the main definitions of the term motivation and some socio - educational and psychological theories, theory of Maslow, Herzbergs, McClelland, etc., to take a point of view from some of the perspectives and cognitive educational skills that realizes the motivation of students in the academic environment
Shaari & Ahmad	2016	Physical Learning Environment: Impact on Children School Readiness in Malaysian Preschools	literature review	this study aims to investigate and propose a clear relationship between the physical environment and school readiness in Malaysia
Sarraf, Alborzi, & Amini	2023	Effect of Physical Elements in Educational Spaces on Children's Creativity Promotion Using Graphic Analysis of Painting	Survey quantitative and qualitative	Investigating the impact of architectural elements and physical factors on the development and promotion of children's creativity and prioritizing the desired

				components.
Gerami Moghadam	2023	Analysis Effect of the Visual Quality of Body´s Educational Space on Improving Self-Efficacy of Children 4 to 6 Years Old (Case Study: Isfahan Preschools)	Analytical quantitative and qualitative	Understanding the dimensions of visual quality, visibility, and visibility play a significant role in shaping children's behavior.

By examining the background of the studies conducted in this field, researchers have conducted comprehensive and separate studies concerning educational and creative spaces, learning environments, and child psychology. However, in a study that plays a joint role, it is not possible to measure the educational environment on children's self-efficacy. Therefore, for the first time, this research is trying to achieve criteria in the design of kindergarten educational spaces to improve self-efficacy and motivation in children aged 3 to 6 years by addressing the relationship between the quality of the integration of educational spaces.

Research Method

The research method in this study is mixed in nature (quantitative and qualitative) and in terms of its process, it is descriptive-analytical using a survey. The method of collecting information is a documentary study and field collection and the use of maps and valid documents as well as a questionnaire. The statistical population in this research is children aged 3 to 6 years as users of educational spaces, parents and teachers as observers and recorders of the questionnaires, and 5 experts to analyze the questionnaire items. The statistical population of Isfahan preschools and the sample size of 5 educational spaces for children in Isfahan (Fouladshahr city) were selected purposefully and clustered. The present research has been analyzed and examined in two parts: spatial correlation analysis and children's self-efficacy. Simulation of preschool maps using computer drawings and Depth Map software. First, the plan of the samples was drawn in Autocad software and transferred to Depth Map software. Then the correlation parameters were analyzed and evaluated and the results were extracted in the form of graphical and quantitative data. The investigated connection factors are: connection, integration, line length, depth and number of nodes, which were studied separately in each of the preschools based on the space map.

To measure children's self-efficacy, a researcher-made questionnaire (Chari, 2007; Nazarpouri, Gadiri, and Shiravand, 2020) was used, and the questions were revised according to environmental conditions by experts. For this purpose, 4 self-efficacy factors "cognitive, social, behavioral and emotional skills" in the form of a questionnaire, in 20 items and with 4 answers (very easy, easy, difficult and very difficult) were designed in the press line system and available to the statistical community. The child's parents and teachers are asked by the child). After collecting information from questionnaires and entering into SPSS software, Cronbach's alpha coefficient has been measured.

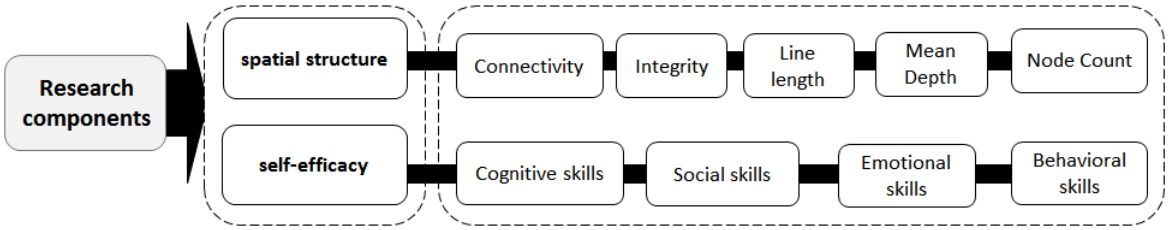


Figure 1. Components to be evaluated (Source: Authors, 2022).

Figure 1, shows the components evaluated in this study.

After research and studies on the research variables, the relationship between attachment and self-efficacy of children in preschools has been evaluated.

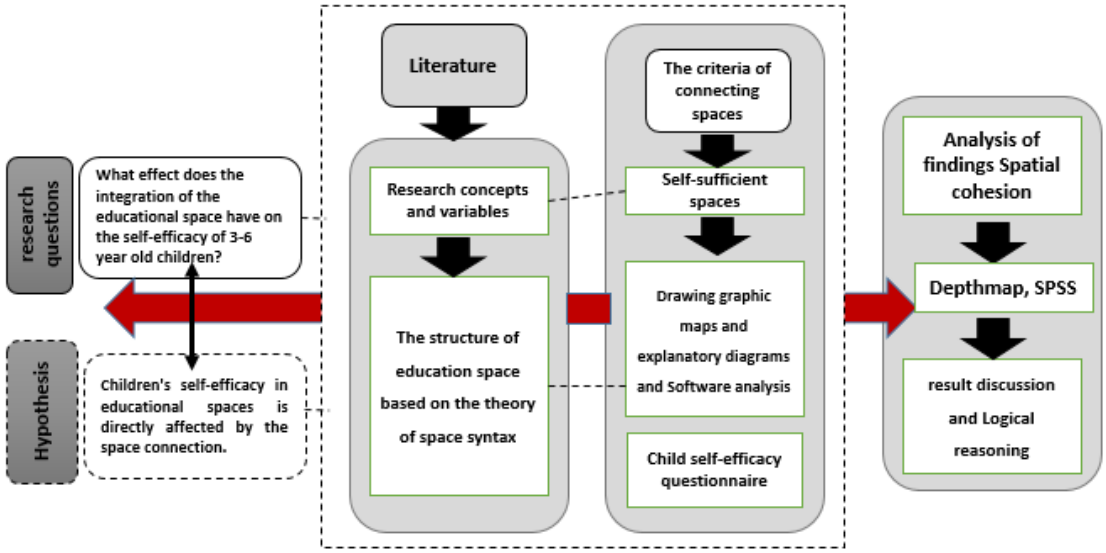


Figure 2. Process diagram of the research method Source: Authors (2022).

Figure 2, shows the process diagram of the research method in this research.

Theoretical Foundations

During the stages of his life, human beings are trying to control the environmental factors and achieve their goals. One of the abilities is self-possession and motivation. In the meantime, the need for a cohesive educational space for children based on self-efficacy is emphasized. In this regard, it is necessary to understand the concepts and the relationship between the variables in order to be able to interact with the environment.

Child and Self-efficacy

Children are comprehensible, objective, and measurable beings, and all behaviors, perceptions, knowledge, or organized concepts are general or universal (Davis, 2009). According to Vygotsky, what children can do with the help of others is more representative of their actual ability than what they can do alone (Brown, 2001: 31). Self-efficacy is one of the motivational constructs that can be adapted to environmental factors. Self-efficacy is a constructive ability by which human cognitive, social, emotional, and behavioral skills are effectively organized to achieve different goals Figure 3, (Pastorelli et al., 2001). The construct of perceived self-efficacy reflects an optimistic self-belief that facilitates goal-setting, striving, perseverance in the face of obstacles, self-discovery after facing failures, better health, more success, emotional adjustment, and better social integration. It is communication (Bandura and Locke, 2003). Self-efficacy occurs when a person feels worthy and competent because he believes in himself and expects himself to be able to do something effectively. Children who lack a sense of self-efficacy feel hopeless and unworthy (Hartley Brunner, 2011).

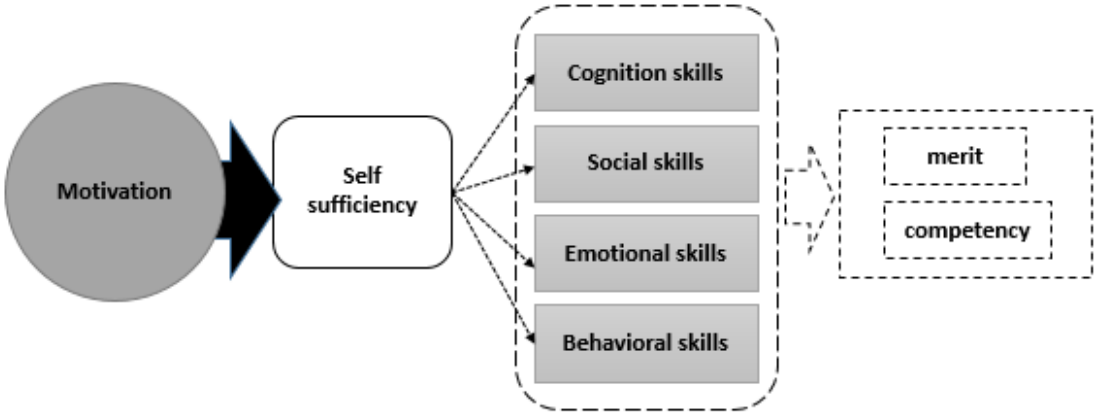


Figure 3. Conceptual model of self-efficacy.

The interaction between the learner and his social environment is the main determinant of his cognitive development. A child's cognitive development is generally dependent on the people who live in his world (Bentham, 2010). According to Bandura, environmental events affect behavior, the environment affects behavior, personal factors affect behavior, and vice versa. In Bandura's view, mutual and three-way influence of behavior, environment and cognitive factors is emphasized. In his opinion, man is an active and influential being on the environment, but at the same time, he is influenced by the environment in a lawful way. In this way, the person and the environment have a mutual effect on each other (Hassanzadeh, and Mehdinejad Gorji, 2019: 391). The child cannot express and solve the problems alone, so the child can be helped to solve them. A child's problems can be found through his behavior. By using the stages of development, the child's behavioral domain will be obtained. Children who cannot adapt themselves to the

conditions of the surrounding environment will often suffer emotional and behavioral problems in the later periods of their lives. To create the child's self-efficacy in the space, the existing space must respond to the child's skills so that the child can achieve competence and success.

Educational spaces for children

Public spaces are complex patterns of functions and contain diverse concepts and meanings, and recognizing and understanding how these relationships can be effective in designing the architectural body with quality (Khozaei, et al., 2010). Herman Hertzberger considered the school a space for children from different cultures to live, and in the design of schools, he sought to improve social relations between them (Tabaian, 2013: 394). Children's environments can be designed to support a wide range of movement possibilities and body balance control. Surfaces, texture patterns, and motifs of spaces can be provided for the exploratory movements of children curious about nature (Tabaian, 2014: 75). A successful design for children's facilities is "a design that gives the child opportunities to explore, grow and learn." Preschool educational spaces support children's growth by providing external and internal areas (Sahin and Türkün Dostoğlu, 2012). People who design for children should know how children explore and are familiar with the environment in which they grow (Lueder, and Rice, 2014: 57). It is necessary for the child to be physically, emotionally, and mentally developed enough to enter the school. The educational environment is different from the home environment. The child may have emotional reactions or behavioral incompatibility upon entering this environment. In the children's educational space, the two-way relationship between the child and the space is intended to lead to a better understanding of the child and a feeling of satisfaction from that space.

Spatial integrity

The combination of spaces forms a spatial structure that consists of relationships and internal actions of spaces. Spatial structure causes special perceptual qualities that play a fundamental role in experiencing and understanding architectural work (Dorri, and Talischi, 2017: 41). The organization of the space should encourage children to follow their interests, answer their questions, show what is on their minds, build healthy relationships, and love learning (Nikolova, 2012). The space syntax technique, the science of space configuration, was founded by Bill Hillier in collaboration with Julian Henson (Hillier and Hanson, 1989). The method of space arrangement is a developed approach to analyzing the spatial structure of artificial environments, the purpose of which is to describe spatial models and display these models in the form of graphic forms and, as a result, to facilitate scientific interpretations of the desired spaces. (Manum, 2009: 3; Mustafa and Hassan, 2013: 445). One of the tools for analyzing space structure is justification diagrams, the basis of which is derived from the theory of graphs. The structure of each environment is drawn in the form of a graph (Brown, 2001), taken from (Heydari, 2016).

The syntax technique indicators of space structure analysis include connection, depth, coherence, and accessibility. The coherence of each space in spatial configuration means the degree of continuity or separation of that space compared to other existing spaces. Space has much interconnection that has more integration with other spaces. To move from any space with a high amount of co-connection to all other spaces in the system, fewer changes are formed in the person's orientation (Peponis, Zimring, and Choi, 1990: 765; Penn, 2003: 45). The greater the number of connections with a space from its neighboring spaces, the more connected that space is (Heydari, 2016: 24). Cohesion is the most basic concept of space arrangement. The connection of each line (space) is the average number of lines (spaces) of its interface from which all other spaces can be reached Figure 4, (Abbaszadegan, 2002: 69).

The greater the connectivity, the greater the accessibility, the presence of people, the optimal space circulation and the ability to use the space (Hillier, 2007: 202). In the spatial configuration, the more the spatial depth increases, the more private the space will be. A large depth is not suitable for public uses and causes a decrease in access to space and a decrease in access to space and a decrease in permeability (Mustafa and Hassan, 2013; Heydari, 2016).

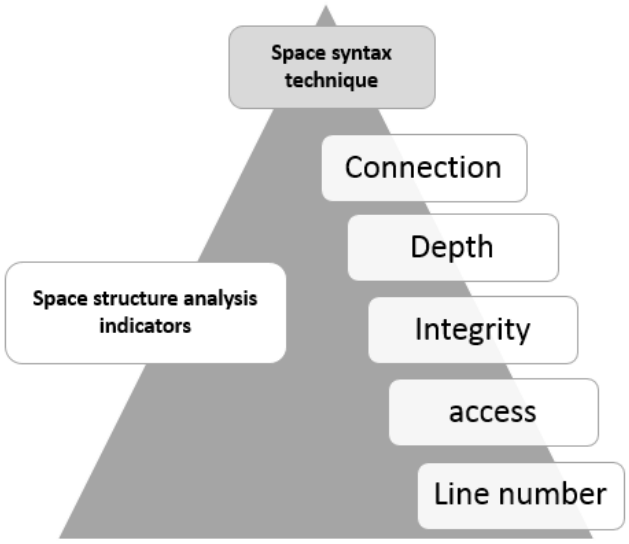


Figure 4. Space structure analysis indicators.

This research used the space coherence index, including space integration, to determine spatial relationships and the degree of children's self-efficacy orientation.

Improving self-efficacy through space integration

Interconnection is the main concept of space composition, which was developed based on the method of space arrangement (Abbaszadegan, Mukhtarzadeh, and Bidram, 2013: 50). It can be explained that spatial arrangement is not directly responsible for environmental behavior, but

finding the mental structure of spatial arrangement based on spatial cognition is responsible for environmental behavior. For this purpose, there is a two-way relationship between spatial cognition and spatial arrangement. Besides being a driving force in human behavioral activities in the artificial environment, spatial arrangement is the only means to influence the spatial knowledge obtained by human movement in the artificial space (Heydari and Taghipour, 2017). Self-efficacy is the assurance that a person successfully implements a specific behavior and expects the obtained results (Bandura and Schunk, 1981). they are setting goals and making commitments (Strobel, Tumasjan, and Sporrle, 2011). there is a relationship between the person and the environment, a relationship that leads to the occurrence of individual behaviors. The environment and people are a function of the living space, so to understand, we must get to know the environment and personality of the person (Khozaei et al., 2010: 149) (taken from Abdi, 2019).

Theoretical basis model

Based on the theoretical foundations and background of the research, the theoretical model of this research is shown in Figure 4. Based on this, children's self-efficacy in educational spaces varies according to the factors of educational spaces. Self-efficacy skills have been investigated by examining children's educational spaces.

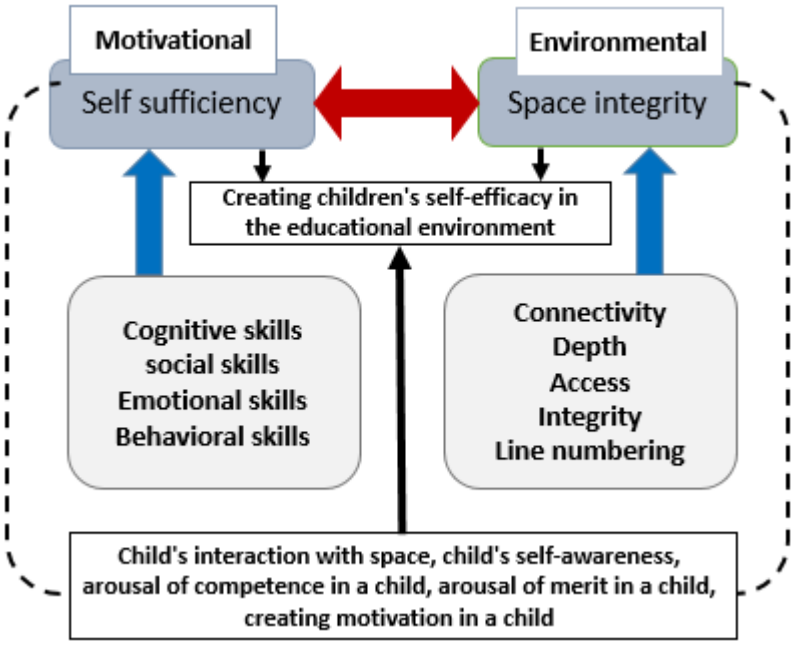


Figure 5. The theoretical model of the research (Source: Authors, 2022).

The assessment of this model, examining and analyzing the concepts and operationalizing them in the research framework is given.

Results and Discussion

Introduction of studied samples

The educational environment is responsible for creating opportunities for growth, character formation, discovery and learning. Environmental designers should respond to the needs by creating special educational spaces for users. Some preschools in the country are designed based on various plans and some are working in residential houses. In order to investigate the effect of the integration of educational spaces on improving the self-efficacy of children aged 3 to 6 years, 5 samples of preschools in Fooladshahr, Isfahan have been studied. To find and understand the spatial structure, Figure 6, Stare preschool (Mirmiran Engineer's design), Figure 7, Shaperk Mehr preschool (change of use from commercial to educational with interior space changes), Figure 8, Deserving Child preschool (residential space), Figure 9, Bagh Khatereh preschool (residential space), Figure 10, Mehr and Mah preschool (residential space) have been selected.

Figure 6. Setare preschool, neighborhood A2.

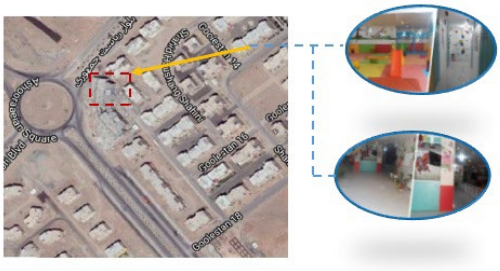


Figure 7. Shapark Mehr preschool, neighborhood E6.

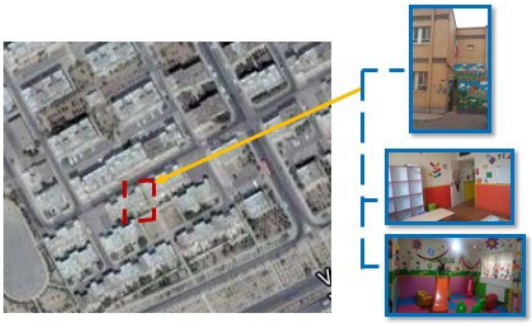


Figure 8. Deserving child preschool, neighborhood B1.

Figure 9. Bagh Khatereh preschool, neighborhood B6.

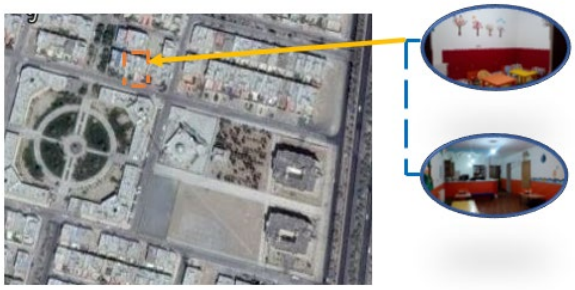


Figure 10. Mehr and Mah preschool in neighborhood C5.

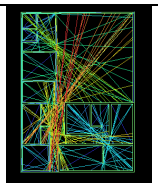
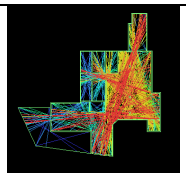
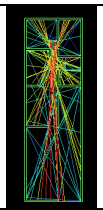
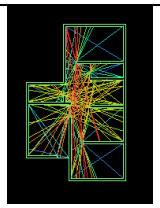
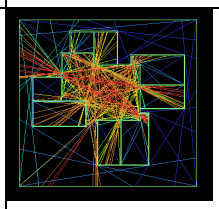
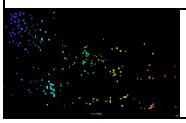
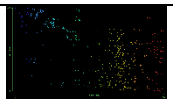
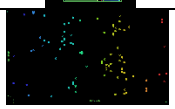
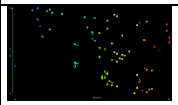
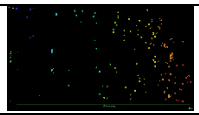
Research findings

The findings of the research have been analyzed based on the spatial structure and examination of interconnection indices in connection, integration, line length, depth and number of nodes. In the following, the findings are presented separately.

a. Spatial structure analysis

For the quantitative and syntactic analysis of the studied spaces based on preschool maps, depth map specialized software has been used. Spatial communication analysis based on graphic and visual representation. According to Table 2, the analysis of the space structure of the studied preschools is presented separately.

Table 2. Analysis of the spatial structure of the studied preschools (Source: Authors, 2022).

Analysis of the maps of the studied preschools					Parameters	Analysis of preschool spaces
Kodadk shayesteh	Shaparak mehr	Mehr Mah	Baghe khatereh	Setareh		
					Connectivity	
						

Based on the Axial movement test and the ability to understand the space, the plan of each preschool has been checked. The explanatory graphs of each preschool have shown the criteria of connection in connection, integration, depth, line length and node, which express the difference in the structure of connection of spaces.

b. Analysis of the degree of connection between spaces

In order to achieve better and more accurate results for this research, the degree of connection between spaces and the interconnection of space has been investigated. Table 3, shows the evaluation of spatial structure indicators in the studied preschools quantitatively (based on the results of Table 2). In this table, the highest correlation with bold red color and blue color shows the least correlation.

Table 3. Evaluation of the indicators of the structure of preschool spaces (Source: Authors, 2022).

Kodakshayesteh	Shapark Mehr	Mehr Mah	Bagh Khatereh	Setare	Indicators	
94	318	75	64	115	Connectivity	Space structures
6.78	16.48	25.39	22.5	18.27	Integration	
19.13	35.45	22.19	17.52	34.25	Line Length	
1.78	1.38	1.16	1.17	1.26	Mean Depth	
235	458	90	78	155	Node Count	

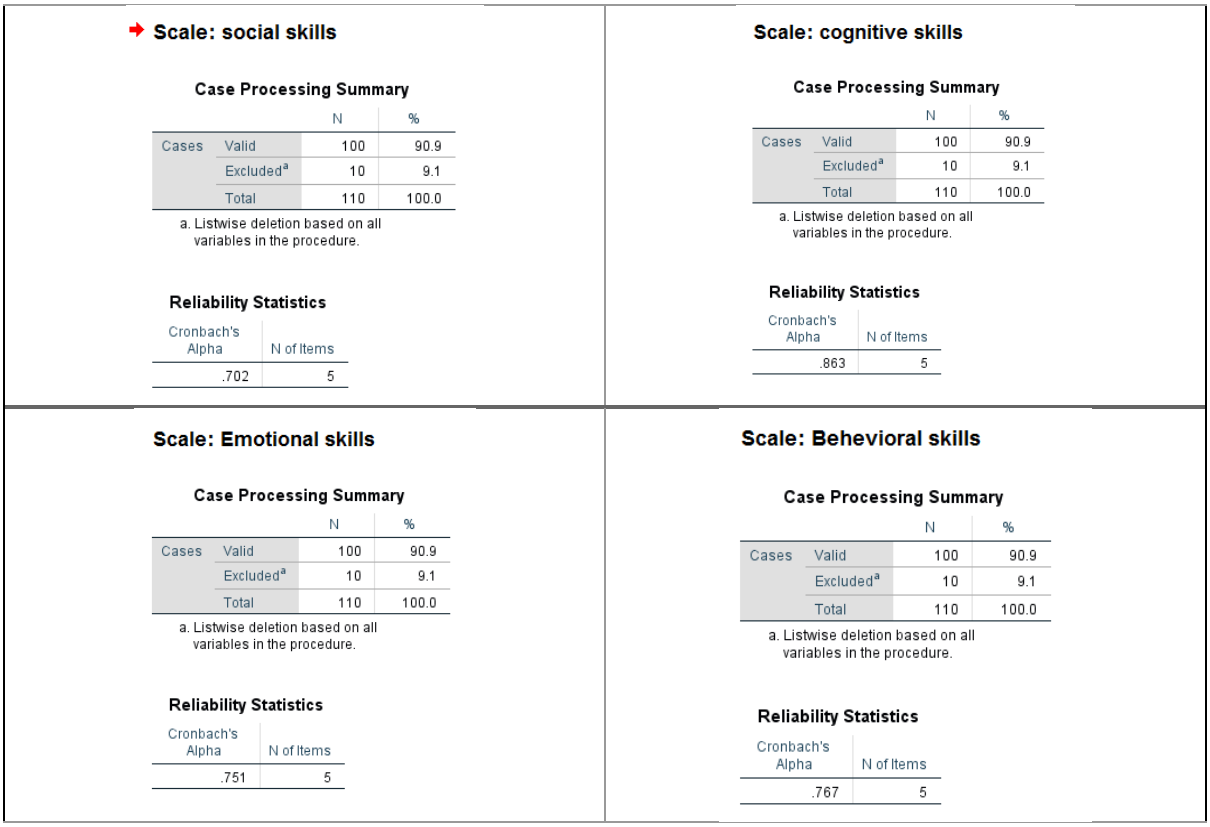
Based on the movement test and spatial understanding in Shapark Mehr Preschool, it has the highest level of connectivity of 318 among the preschools, the level of connectivity is 16.48, which has a suitable space in terms of connectivity, and it has a high depth of 1.38, which It indicates a decrease in access to space and a decrease in permeability. Due to the presence of a large hall and easier access to classes, Stare Preschool has a high spatial connection, 115 connectivity and 18.27 connectivity, and a lower depth of 1.26, which indicates proper spatial integration and connectivity. Due to the location of the classes on two different fronts and the access of some classes directly to the yard and the only connection to the yard, the preschool of the worthy child is more deep by 1.78, has more nodes and fewer connections by 94. In Bagh Khatereh Preschool, due to the two-story building, two separate sections, the communication space of the two floors is connected to the divided corridor by a staircase, has the lowest connection factor of 64 and the highest connection ratio of 22.50. Mehr and Mah Preschool is spatially connected to all classes through a communication route of corridor, which has the highest connection rate of 25.39 and the lowest connection rate is 75.

c. Analysis of self-efficacy scale items

In order to check the validity of the research, statistical indicators related to questions and coefficients are presented. In total, the questionnaire was completed by 100 respondents (based on the statistical population). The questions and how to answer them were explained by the authors for the questioners (parents and teachers). The results of the questionnaires in the press line system, which were completed by the parents and the teacher from the child's questions, were collected. Next, to check the reliability of children's self-efficacy, Cronbach's test coefficient was used in 4 self-efficacy skills such as cognitive skills, social skills, emotional skills and behavioral skills to measure internal correlation.

After entering the information of the items in SPSS software, the analysis was done and the results of Cronbach coefficient of self-efficacy were obtained shown in Table 4.

Table 4. Example of the evaluated skills and Cronbach's coefficient in SPSS software.



Scale: social skills

Case Processing Summary

		N	%
Cases	Valid	100	90.9
	Excluded[a]	10	9.1
	Total	110	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.702	5

Scale: cognitive skills

Case Processing Summary

		N	%
Cases	Valid	100	90.9
	Excluded[a]	10	9.1
	Total	110	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.863	5

Scale: Emotional skills

Case Processing Summary

		N	%
Cases	Valid	100	90.9
	Excluded[a]	10	9.1
	Total	110	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.751	5

Scale: Behevioral skills

Case Processing Summary

		N	%
Cases	Valid	100	90.9
	Excluded[a]	10	9.1
	Total	110	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.767	5

The results of the 5 preschool children studied in SPSS software are given in Table 5, in the form of Cronbach coefficient reliability values.

Table 5. Reliability values of Cronbach's coefficient (Source: Authors, 2022).

Cronbach´s results in children´s self-efficacy						
Index	**Reliability Statistics**	**Setare**	**Bagh Khatereh**	**Mehr Mah**	**Shapark Mehr**	**Kodak shayesteh**
Cognitive skills	N of Items	5	5	5	5	5
	Cronbach´s Alpha	0.762	0.672	0.667	0.784	0.672
Social skills	N of Items	5	5	5	5	5
	Cronbach´s Alpha	0.754	0.595	0.516	0.761	0.702
Emotional skills	N of Items	5	5	5	5	5
	Cronbach´s Alpha	0.667	0.536	0.61	0.7	0.614

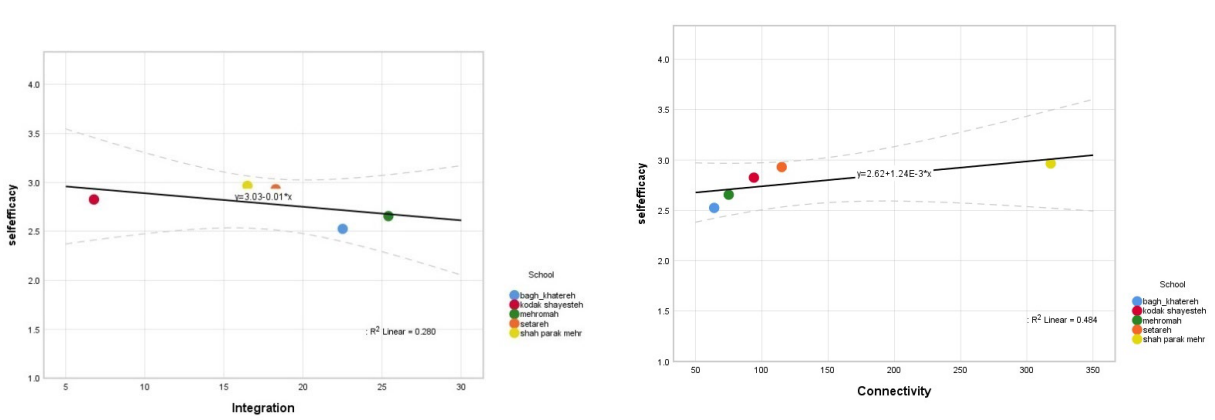
Behavioral skills	N of Items	5	5	5	5	5
	Cronbach´s Alpha	0.767	0.444	0.541	0.615	0.602
Cronbach´s Alpha Average		0.738	0.562	0.538	0.716	0.648

The reliability of the Cronbach's coefficient of children's self-efficacy with indicators of cognitive, social, emotional and behavioral skills with 5 items in Stare, Bagh Khatereh, Mehr and Mah, Shaparak Mehr and Kodak Shayesteh preschools shows that the average Cronbach's alpha coefficient in Setareh primary schools with a score of 0.738 (r= 0.738) and in Shaparak Mehr preschool with a score of 0.716 (r= 0.716) and this indicates that there is a significant positive relationship between self-efficacy in Setareh and Shaparak Mehr preschools. Cronbach's alpha coefficient is lower than 0.7 in Bagh Khatereh, Mehr and Mah and Kadak Shayesteh preschools. which shows the lack of significant correlation of children's self-efficacy in existing spaces. The mentioned findings show the convergent validity of children's self-efficacy scale in two preschools of Setareh and Shaparak Mehr.

d. The relationship between attachment and self-efficacy of children in preschool

In order to achieve the results in this study, after understanding and examining the spatial structure of each of the preschool spaces and evaluating children's self-efficacy, the correlation between spaces and children's self-efficacy was measured, which is shown in Table 6.

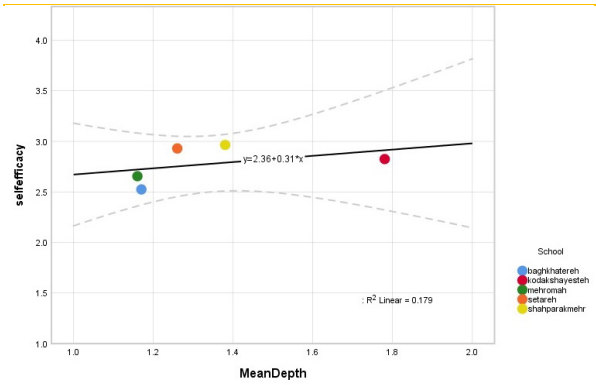
Table 6. Evaluation of diagrams of the effect of spatial integration on children's self-efficacy (Source: Authors, 2022).



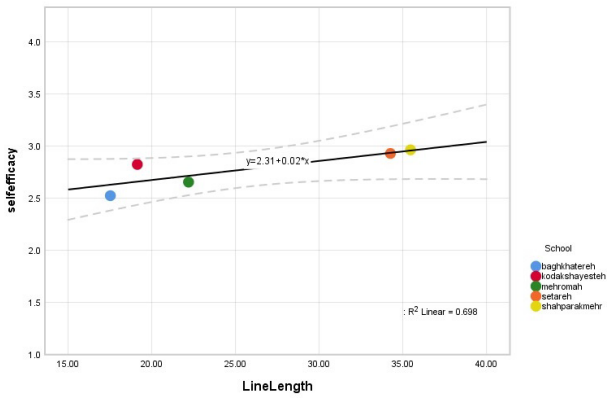
The effect of integration on self-efficacy

The effect of connection on self-efficacy

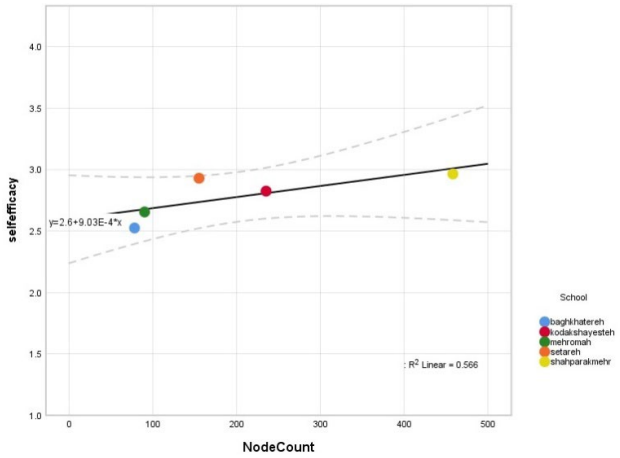
Diagram of the effect of space on self-efficacy



The effect of mean depth on self-efficacy



The effect of line length on self-efficacy



The effect of node count on self-efficacy

In the Table, the points around the line show the uniform distribution of the data. The way Shapark Mehr and Setareh preschools are placed on the top of the line shows the more significant influence of space on self-efficacy. Since there is a direct relationship between the connection and the connection, according to the above Figure, the correlation is positive. As connectivity increases, children's self-efficacy increases.

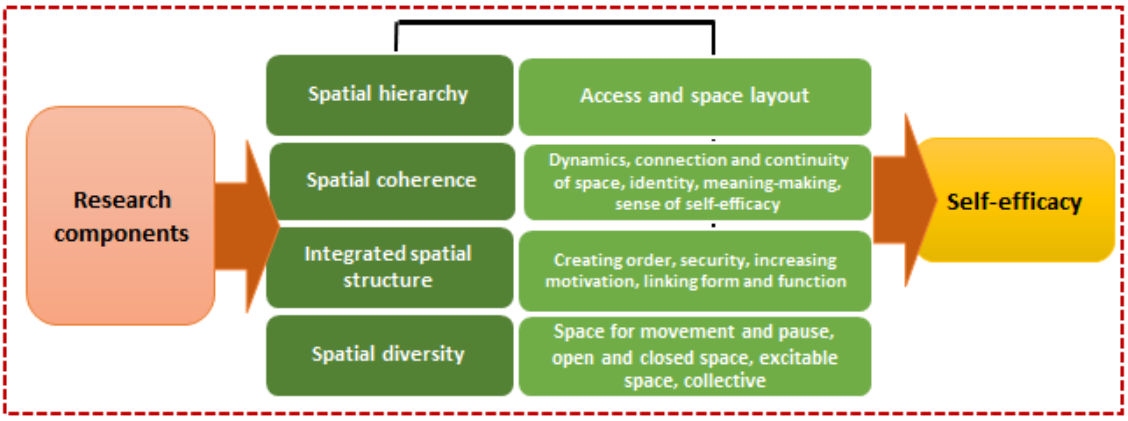


Figure 11. Relationship between spatial structure and self-efficacy (Source: Authors, 2024).

The results of studies conducted on the relationship between research components are presented in Figure 11, which shows that studying, understanding, and applying spatial structure and behavior in child-specific designs leads to quality environments that will lead to children's growth and satisfaction.

Conclusion

Children's educational spaces are known as one of the key factors in the learning, growth and motivation process of children. The appropriate architectural design of these spaces plays a significant role not only in academic achievement, but also in the emotional, social, cognitive and behavioral development of children. In this regard, the architecture of educational spaces using natural light, open spaces and creative designs based on location and motivational components can provide a safe and inspiring environment.

The investigations carried out in the current research revealed the identification and understanding of the role of the educational environment. The research literature shows that cognitive, social, emotional and behavioral skills are effective in improving the child's self-efficacy. In Table 2, the indicators of preschool space structure analysis are evaluated using depth map software and shown in graph form. In Table 3, the evaluation of spatial structure indicators quantitatively shows that each of the spaces has a different connection based on the layout and accessibility of the spaces. The findings of the research indicate that in the samples that have more spatial connections and less depth, there is also more connection.

Psychometric findings for children's self-efficacy in cognitive, social, emotional, and behavioral skills are given in Table 5. The reliability of Cronbach's alpha coefficients obtained indicates a significant positive correlation between self-efficacy and spatial coherence. Since coherence is directly related to connectivity, according to Table 6, the correlation is positive. With increasing connectivity, self-efficacy in children increases. According to the research

conducted, a correlation between the coherence variable and connectivity has been achieved among Setare and Shaparak Mehr preschools, and the level of spatial understanding for children is higher, indicating that the plan has higher accessibility and readability, which indicates a suitable model for preschoolers. The results obtained confirm that in educational spaces where coherence is higher, the level of cognitive, social, behavioral, and emotional skills in children is higher, and this indicates the effect of spatial coherence on children's self-efficacy. Also, the results based on Figure 11, showed that the child's self-knowledge and interaction with space cause self-efficacy and create arousal of competence, competence, satisfaction and security in the child.

Accordingly, the optimal design of preschool spaces based on the components of spatial hierarchy, spatial coherence, integrated spatial structure and spatial diversity creates a sense of security, self-confidence, enthusiasm and satisfaction in children. Such design patterns can lead to the creation of spaces that stimulate children's self-efficacy. By understanding educational spaces, analyzing spatial structure and identifying children's developmental-psychological, environmental and skills needs, spaces specific to children can be achieved.

Author Contributions

All authors contributed equally to the conceptualization of the article and writing of the original and subsequent drafts.

Data Availability Statement

Not applicable

Acknowledgements

The authors would like to thank all participants of the present study.

Ethical considerations

The study was approved by the Ethics Committee of the Islamic Azad University, ShK.C. The authors avoided data fabrication, falsification, plagiarism, and misconduct.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors declare no conflict of interest.

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IJAPAS

International Journal of Applied Arts Studies

Print ISSN: 2588-4506 Online ISSN: 2588-4670

Homepage: www.ijapas.ir

Islamic Azad University
Yazd Branch

Proposing a Comprehensive Theoretical Training Framework (Concepts, Elements and Design Process) for Computational Design (Algorithmic, Parametric and Generative Design Systems)

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Article Info

Article type:
Research Article

Article history:
Received December 04, 2024
Received in revised form June 13, 2025
Accepted July 14, 2025
Published online August 15, 2025

Keywords:
Computational design,
Education,
Algorithmic design,
Parametric design,
Generative design.

ABSTRACT

In recent decades, computer technologies like computational design have made an impact on architectural design. They were first used for automation and form finding, later used for performance-based design and optimization. Computational design lead to the development of algorithmic, parametric, and generative design systems, which are now extensively used in architectural design education. According to previous studies, computational design education mainly focuses on the application of coding and related software, and theoretical knowledge of computational design not proposed and taught in a separate course before its use in the design studio. However, due to the complexities of computational design, an extensive training course is needed to fully understand its capabilities. Therefore, this research proposes a comprehensive theoretical training framework for computational design. To accomplish this objective in the first stage of this research, the current status of its training was examined, and deficiencies in computational design education have been identified through library resources. In the second stage, important concepts for comprehending computational design knowledge were examined, and in the third stage, with the goal of overcoming the deficiencies of the current educational program, a comprehensive theoretical training framework which includes two phases of 1. Learning computational design principles 2. Learning an analysis of computational design principles is proposed. The proposed program includes concepts such as definitions, types, distinctions, components and process of computational design. The findings of this study could serve as a framework for curriculum development in computational design.

Cite this article: Ramyar, M., Bavar, C., & Alimohammadi, P. (2025). Proposing a Comprehensive Theoretical Training Framework (Concept, Elements and Design Process) for Computational Design (Algorithmic, Parametric and Generative Design Systems). ***International Journal of Applied Arts Studies***, *10*(2), 49-96.

Publisher: Islamic Azad University, Yazd Branch.

Introduction

Computational design (CD) has gained popularity in architectural design and education in recent decades (Caetano, Santos, and Leitão, 2020; Ostrowska-Wawryniuk, Strzała, and Słyk, 2022). However, there are two problems with training CD: 1. Learning to program (Austin and Qattan, 2016). 2. extensive CD knowledge (Caetano et al., 2020). To solve the first problem, it was proposed to offer programming courses separately (Austin and Qattan, 2016). The second issue is extensive CD knowledge (Caetano et al., 2020), which some students struggle to apply during the design process (Agkathidis, 2015). However, while studying and assessing existing CD research, it became apparent separate comprehensive course CD knowledge course had not been proposed prior to its implementation in the design studio. For example, students in research (Abdelmohsen, 2013) should acquire knowledge of CD. However, training is required. Some research such as (Fischer, 2002) have exclusively focused on programming. Additionally in some research, only some aspect of CD knowledge is considered. For example (Bianconi and Filippucci, 2018; Lakhanpuria and Naik, 2023), focused on generative and parametric design, although it is obvious that students need to be familiar with algorithmic design before applying these methods. Algorithmic design is the fundamental system underlying other CD systems (parametric and generative) (El-Khaldi, 2007). Lack of CD understanding resulted in limited use of this technology because CD applications in architectural design are various, including automation, form finding (Caetano et al., 2020), performance-based design, and optimization (Alfaris, 2009). To solve this problem, comprehensive theoretical training framework is being proposed in this research that include topics such as: 1. The concept of CD and digital design (DD) and their distinction 2. CD systems (Algorithmic, Generative, Parametric) 3. Differentiation of CD systems 4. Elements and concepts that shape CD systems 5. The concept of system 6. similarity of system concept and CD 7. Prescriptive models and CD Process. The first step is to understand CD concepts and differentiate between DD and CD (Caetano et al., 2020). The Next step is to learn about CD systems and how they differ (El-Khaldi, 2007). Systems consist of units and institutions that work together to achieve a common goal (Schmidt and Taylor, 1970). Systems include concepts such as hierarchy, relationships and rules (Alfaris, 2009). CD systems also takes these factors into account (El-Khaldi, 2007). Additionally according to MIT research, the performance-based CD design process consists of decomposition, formulation, synthesis, analysis, evaluation and optimization (Alfaris, 2009). By learning CD knowledge, its application in architectural design becomes more targeted and conscious. In fact, there are prerequisites in the field of CD that should be provided (Fasoulaki, 2008), to achieve better results in this field. Therefore, in the next section, CD training status and important CD concepts in the theoretical literature is examined.

Theoretical Literature

CD Training Status

Over the past two decades, CD has been used in architecture to solve a variety of design problems (Caetano et al., 2020). Therefore, the curriculum should be adapted to the current situation (Shtepani and Yunitsyna, 2023). Using CD requires extensive theoretical knowledge (Caetano et al., 2020) and programming skills (Shtepani and Yunitsyna, 2023) that many students lack. To solve first problem, (Austin and Qattan, 2016) proposes separate programming courses. Analyzing previous research shows that there is no separate comprehensive theoretical training framework before its use in design process (Vrouwe et al., 2020; Agirbas, 2022)). The training program is based on the research plans of professors (Oxman, 2008). However Students should have detailed theoretical knowledge, such as algorithmic thinking, before applying it. (Abdelmohsen, 2013)) aimed to integrate generative design and digital construction into architectural design education. The students have personally dealt with generative design. But CD knowledge should be taught fully, and professors play an important role (Agkathidis, 2015). Additionally Parametric design and CNC production have been applied in educational research (Karzer and Matcha, 2009). (Gürbüz, Çağdaş, and Alaçam, 2010) used fractals to create design solutions in the early stages of design education. Furthermore (Guidera, 2011) conducted research on parametric generative design education. Other studies taught generative design approaches such as shape grammar through collaborative design (Knight, 2012). Also architectural spaces were reconfigured using generative design and digital construction by students(Abdelmohsen, 2013). Another research in education created a generative model using an ecological approach (Yavuz and Çelik, 2014). In addition, generative design and physical testing have led to a new design process in the design studio (Huang and Xu, 2015). Agkathidis, (2015) examined the impact of generative design on architectural design education and (Bianconi and Filippucci, 2018) examined education in generative design and how design thinking can be transformed through the use of these systems. During landscape design education, a database for generative design and landscape design concepts were introduced (Vaz and Celani). Other studies have included mathematical and algorithmic in early design education (Ostrowska-Wawryniuk, Strzała, and Słyk, 2022). In another research (Abdelmohsen et al., 2017) discussed combination of generative design and intuition can be beneficial in design education. Also recent research used problem-solving based learning based on parametric design thinking in an architectural studio in India (Lakhanpuria and Naik, 2023). Another article evaluated 3D printing and parametric modeling tools by architecture students (Shtepani and Yunitsyna, 2023). Additionally, (Nazidizaji and Safari, 2013) developed algorithmic approaches and reverse engineering for architectural analysis. A significant trend involves integrating algorithmic and parametric thinking (Peteinarelis and Yiannoudes, 2018; Vazquez, 2024). Also, pedagogical

innovations include proposing new teaching methods, such as using incomplete instructions (Vazquez, 2024), fostering interactive learning environments and developing collaboration skills (Vrouwe et al., 2020; Agirbas, 2022).

Furthermore, a review of internal references revealed that they also did not present a comprehensive educational program covering CD concepts and processes. Instead, they primarily focus on digital design education description, computer-aided design (CAD), and the general application of computer technology in education. For example, Poursistany et al. (2016) analyzed the impact of digital education on architectural creativity. Additionally (Asefi and Imani, 2017) investigates the impact of digital software on enhancing creativity in design education. Mahmoudi and Naghizadeh, (2010) addresses the transformation of architectural education due to the introduction of Information Technology (IT) as a design tool for idea representation, speed, flexibility, and 3D visualization, which manual tools lack. Additionally (Ahmadi Tabatabaie and Moosav, 2024) focuses on identifying the appropriate time and method for teaching software to enhance students' creativity. Their findings strongly recommend that software training should commence after students acquire a strong foundation in design and hand drawing. Furthermore (Eynifar and Hosseini, 2014) suggests that digital technologies in architectural design education be viewed as "media" rather than merely tools, as they serve as mediators and shape ideas. Therefore, it is apparent that several studies have incorporated CD systems in their curriculum but separate comprehensive CD knowledge training program was not proposed. The integration of technology into architectural design education precedes the development of its theoretical framework (Schumacher and Krish, 2010). CD training lacks complete training program (Fischer & Herr, 2001) and is not fully covered in the architectural design curriculum (Gürer, Alaçam, & Çağdaş, 2012). Understanding algorithmic thinking is crucial in CD education (Ozkar, 2017). Architectural education should provide future architects with algorithmic thinking skills and thinking (Ostrowska-Wawryniuk, Strzała, and Słyk, 2022). Architectural education must respond to these changes (Soliman, Taha, and El Sayad, 2019) and students should learn fundamental CD concepts. The next section will cover the fundamental CD concepts that students need study in a distinct course in order to meet these changing demands on architecture education.

Computational design and Digital design

Digital design (DD) and computational design (CD) have been driven by the advances in computer technology over the last decades. While DD requires computer tools, CD can be performed with or without a computer (Caetano et al., 2020). Architects used computing and algorithms to break down complicated design problems and solve them more effectively (M Rocker, 2006). Recent advances have resulted in CD replacing CAD (computer-aided design) in architecture (Kalay, 2004). This methodology drastically changes the standard design method by introducing innovative methodologies(Gurcan Bahadir and Tong, 2025). CD requires extensive

design knowledge and enables automation, form finding, optimization and performance based design (Caetano et al., 2020). CD concepts has developed algorithmic, parametric and generative design methods in architecture (Michelle and Gemilang, 2022). These methods have gained popularity in optimization, simulation (Oxman, 2017). Their applicability went beyond design automation and form finding (Mitchell & Terzidis, 2004). CD methods follow a system structure (El-Khaldi, 2007). A system is a collection of units working toward a coherent goal (Schmidt and Taylor, 1970; Alfaris, 2009). System includes CD-related ideas such as hierarchy (El-Khaldi, 2007), relationship (Gu, Yu, and Behbahani, 2021) and rule (Doe, 2018). As technology advances, CD is becoming an increasingly important component in architectural design (Fatai, 2024) and education (Indraprastha, 2018). CD systems are more important than digital technologies for promoting CD thinking in architectural education (Adem and Çağdaş, 2020).

a. Algorithmic design system

Algorithmic design (AD) systems serve as a basis for the development of other CD systems (El-Khaldi, 2007). Online Cambridge dictionary defined the word algorithmic as "connected with or using algorithms." AD become more and more popular because of its versatility and ability to establish work environments free from constraints (Castelo-Branco, 2020). Terzidis proposed AD (Terzidis, 2004), a process that uses algorithms(Sammer, Leitão, and Caetano, 2019). AD Thinking provides a step-by-step guide to achieve design goals and it supports designers in analyzing the context and understanding connections (El-Khaldi, 2007). AD is used in 3D building printing (Guerguis et al., 2017), residential project design (Chen, 2020) and building facades (Caetano, Garcia, Pereira, and Leitão, 2020) and envelope design Figure 1, (El-Khaldi, 2007). Algorithms can find the nth member of an infinite set (Leeds, 1977). It has the potential to produce a novel method of idea generation that is beyond human perception (Terzidis, 2006). Algorithms can be executed in parallel, sequentially (Figure 2,3) or randomly (El-Khaldi, 2007). AD uses algorithms to create design models (Michelle and Gemilang, 2022), the relationship between the algorithm and the design is evident in algorithmic designs such as Morpheus Hotel Figure 4, (Caetano et al., 2020). Algorithms manipulate numbers, alphabets, geometric elements and fixed/variable units (Caetano and Leitão, 2021). Functions connect algorithms to units using equations including operators and architectural operators include activities like movement and rotation (El-Khaldi, 2007). Furthermore (Moussavi, 2009) explores the influence of function on form. In algorithmic design, inheritance refers to a directional relationship in which the child inherits the characteristics of its parent (El-Khaldi, 2007). A rule-based algorithm can be described as follows: If the condition... is true, start the function (De Souza and Ferreira, 2002). Decomposition (dividing a task into subtasks) is a key concept in algorithms. (Fried et al., 2018).

b. Parametric design system

Parametric design (PD) is one of the most commonly used CD methods that allows the creation of a parametric model by specifying dimensions and geometry (Wahbeh, 2017). Online Cambridge dictionary, defined the word parametric as "relating to the parameters of something." Morty introduced parametric design in 1971 as the study of dimensional relationships through the use of parameters (Moretti, 1971). Its powers were further enhanced by the advent of parametric animation in the late 1990s to manipulate forms dynamically by adjusting dimensions, constraints, and connections (Mark, 2008). Greg Lane's work based on transformations is well-known examples. Catia creates models in Figure 5, is regulated by two main parameters: thickness and height (El-Khaldi, 2007). PD is defined by its ability to create multiple solutions through rule-based algorithms, allowing for dynamic adjustments (Gu, Yu, and Behbahani, 2021; Jabi et al., 2017; Eastman, 2011). It enhances creativity by enabling designers to visualize and manipulate complex relationships within their designs (Campbell and Shea, 2014). PD has been used in green building design (Zhang, 2020) and energy efficient design (Touloupaki and Theodosiou, 2017). PD has been described in different ways (Caetano et al., 2020) as an optimization technique that identifies solutions within constraints (Eggert, 2005) and as a design style (Schumacher, 2008). Any system capable of connecting pieces is parametric whereas object properties are established through connections and inheritance (El-Khaldi, 2007). It is a subset of both algorithmic and code-based design (Elghandour et al., 2016). PD can accommodate any unit and relies on relationships. Designers can use inheritance to create families of objects, with changes in the first generation affecting the second generation (El-Khaldi, 2007). When parameters are used in algorithmic and generative design, they can be parametric (Caetano et al., 2020). Parametric design can shift the focus from form to function. For example in Figure 6, PD have been used to discover shape and achieve goals such as user visual comfort, energy optimization and solar protection (Tabadkani et al., 2019). This method can help choose the best solutions from a variety of design options (Khamis et al., 2022).

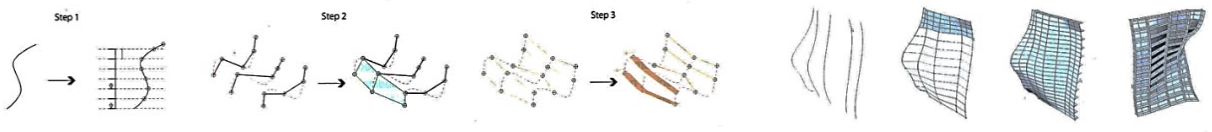

Figure 1. An example of an algorithmic envelope design (El-Khaldi, 2007).

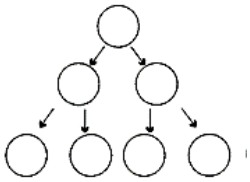

Figure 2. Parallel execution of algorithm (El-Khaldi, 2007).

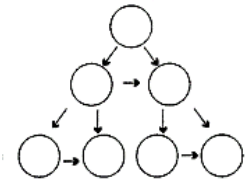

Figure 3. Sequential execution of algorithm (El-Khaldi, 2007).

Figure 4. Algorithmic design of Morpheus hotel (Source: Archdaily).

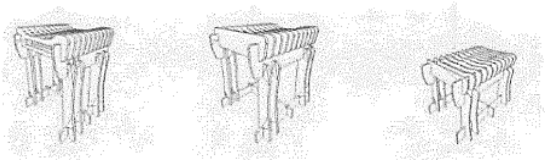

Figure 5. An example of a parametric design (El-Khaldi, 2007).

Figure 6. An example of a parametric facade design (Tabadkani et al., 2019).

c. Generative design system

Generative design (GD) systems have long been used and Durand applied it to architecture in 1803, developing new ways to create plans by assembling structural elements (Fasoulaki, 2008). Online Cambridge Dictionary defined generative as "able to produce or create something." These systems use parallel, sequential and random algorithms (El-Khaldi, 2007). GD is an algorithmic or rule-based technique that creates a variety of possible design solutions(Ashour and Gogo, 2024). This approach executes programmed instructions until the necessary conditions are met, and simple algorithms produce sophisticated results (Humppi, 2015). Cellular automata, L-system and shape grammar are three examples of generative design systems (El-Khaldi, 2007) ; (Fasoulaki, 2008; Abdelmohsen, 2013; Toussi, 2020). Fractals have also been considered as a GD system (El-Khaldi, 2007; Fasoulaki, 2008). There is a relationship between algorithm and design output in AD, but not in GD, sophisticated creations based on simple algorithms (Caetano et al., 2020). L-systems model plant growth (Prusinkiewicz et al., 2018), cellular automata model reproduction (El-Khaldi, 2007), fractals model self-similarity (Lorenz, 2011), and shape grammars mimic the human ability to visually observe and calculate (Stiny, 2022).

d. Generative design system (cellular automata)

Cellular automata (CA) is a GD technique that simulates reproduction(Caetano et al., 2020). John von Neumann's abstract model served as the original inspiration for cellular automata (El-Khaldi, 2007). CA facilitate the generation of spatial layouts by considering user-defined parameters such as geometry and adjacency requirements (Ng, Chen, and Sathikh, 2024). It can model ecological dynamics, allowing for the integration of environmental factors into architectural design (Liu and Herr, 2023). The network of interconnected cells adjusts their state according to its neighbors and local regulations (Patt, 2015). Its applications in architecture can range from facades and interior elements (Herr and Ford, 2015) to the design of urban districts (de Oliveira and Celani, 2019). CA consist of replacement rules, cells(can contain geometric descriptions, colors, numbers, and other data) and initial states and inheritance is not possible with cellular automata because information is not passed on across generations (El-Khaldi, 2007). Chris Langton's diagram illustrates the behavioral transition of CA from fixed rules (generate cells in a fixed section) to random behavior(generates them in random mode) Figure 7, (Flake, 2000). Cellular automata can generate intricate patterns in architectural design (Herr & Ford, 2015). Wolfram, (2002) has studied one-dimensional cellular automata. He found the eight fundamental combinations of primitive cellular automata. Two states (black or white) yield eight (23) combinations Figure 8, and according to the initial combinations, there are 256 potential states (28). The Figure 9, shows CA with rules, an initial state and replaced states. John Fraser used them to form shapes (Januszkiewicz and Paszkowska-Kaczmarek, 2023). The Figure 10, shows application of cellular automata in envelope design (El-Khaldi, 2007). They are crucial to the development of CD thinking in design studios (Adem and Çağdaş, 2020). The integration of CA in academic settings promotes innovative design thinking, preparing future architects to leverage these tools in real-world applications (de Oliveira and Celani, 2019).

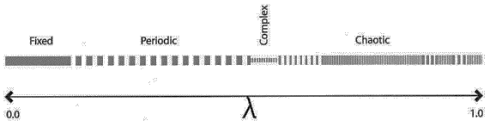

Figure 7. Behavior of CA from fixed to random proposed by Chris Langton (Flake, 2000)

Figure 8. Eight primary combinations of CA (Wolfram, 2002)

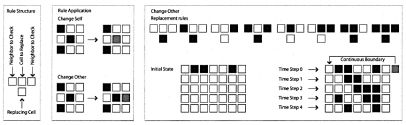

Figure 9. Combinations of CA (Wolfram, 2002)

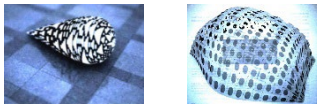

Figure 10. CA in envelope design (El-Khaldi, 2007)

e. Generative Design System (L-System)

Aristide Lindenmayer developed the L-System generate shapes using strings, alphabets, rules, and repetitions (Lindenmayer, 1968). They provide a formalism for simulating plant growth (Prusinkiewicz et al., 2018). They can represent complex branching structures and organ differentiation, enhancing the realism of plant simulations (Loi, and Cournede, 2008). Timed, parametric L-systems enhance their ability to model dynamic phenomena like morphogenesis and mechanical models (McCormack, 2004). Each generation replaces previous data, enabling the generation of new structures without retaining prior configurations (Šťava et al., 2010) and algorithms are executed in parallel. The alphabet growth representation creates a tree-like grid Figure 11, (Prusinkiewicz and Lindenmayer, 2012). Letters are the smallest units of the system. Figure 12, shows the application of L-system in envelope design (El-Khaldi, 2007). They consist of a grammar that includes an axiom, which is expanded into complex strings through defined rules Table 1, (Ashlock, Gent, and Bryden, 2005). They can visualize complex design patterns, such as those found in urban planning (Yu and Min, 2022).

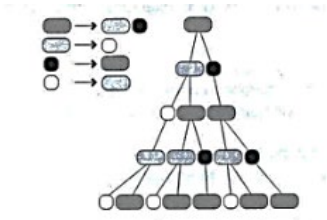

Figure 11. Tree network, L system (Prusinkiewicz and Lindenmayer, 2012).

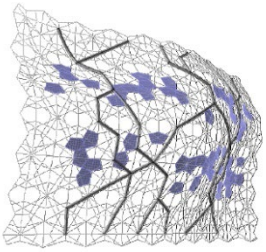

Figure 12. Application of L system in envelope design (Alfaris, 2009).

Table 1. The rules, the initial string and subsequent generations (El-Khaldi, 2007).

Rule	R ⟹ L L ⟹ RR
Initial string	R R L R
Generation 1	L L RR L
Generation 2	RR RR LL RR
Generation 3	LL LL RR RR LL

f. Generative design system (Fractal)

The creation of natural shapes by architects relies heavily on geometric notions (Pérez García and Gómez Martínez, 2010). Euclidean geometry is limited to smooth curves and surfaces, which do not reflect the irregularities present in natural objects (Banerjee, Easwaramoorthy, and Gowrisankar, 2021). Fractal geometry is suitable for developing nature-inspired architectural designs (Mandelbrot, 1982). Fractals are complex geometric forms, pushing the boundaries of traditional architectural design (Ediz and Çağdaş, 2007) with self-similarity, meaning that its constituent parts are similar to one another. Self-similarity allows for the replication of patterns at different scales, which can be observed in historical architectures like Gothic cathedrals and Indian temples (Lorenz, 2011). To create a fractal, you must specify an initializer and rules for replacing copies of the initializer with smaller versions (El-Khaldi, 2007). Fractal geometry has been used in a variety of fields, including the natural sciences (Peitgen et al., 2004; Contini, 2007), engineering (Leung, Wu, and Zhong, 2004) and in medicine (Bankman, 2008). Fractal geometry is used in architecture to visually view buildings (Bovill and Bovill, 1996; Ostwald, 2001; Rian et al., 2007) and cities (Batty and Longley, 1994). Fractals can create new aesthetics (Patuano and Tara, 2020). Greg Lynn used fractals to create the Cardiff Bay Opera House (Addison, 1997). They lack a smallest unit because they are based on recursive models because they iteratively decompose components and replace them with new algorithms (El-Khaldi, 2007). Fractal geometry has been used to develop and study properties of innovative planar truss configurations (Rian and Sassone, 2014) and created new free and complex shell structures (Stotz, Gouaty, and Weinand, 2009; Vyzantiadou, Avdelas, and Zafiropoulos, 2007). The Sierpinski triangle (Ettestad and Carbonara, 2018) and the Koch curve (Purnomo et al., 2019) are two well-known instances of fractal geometry (Figure 13,14,15). Albrecht Dürer 's pentagonal tile pattern was an early example of fractal design Figure 16. In fractal systems such as the L system, inheritance is not possible because data is constantly replaced (El-Khaldi, 2007). A fractal system creates objects with similar components that appear at different sizes Figure 17. They have been used to create a porous roof Figure 18, filtered sunlight and allowed air circulation Sakai et al., (2012) and to design a non-smooth covering surface Figure 19, that can transmit sound (Cox and d'Antonio, 2016). They have been used in computer models of tree column topologies (Rian, Callegary, and Spinelli, 2015). However fractals and other mathematical concepts do not teach us how to create; Nevertheless, they can help improve the design process (Rian and Asayama, 2016). Digital tools facilitate the application of fractal geometry in design (Ediz and Çağdaş, 2007) and is increasingly used in architecture to create unique and structurally optimal designs, inspired by natural forms and mathematical principles (Mayatskaya et al., 2022).

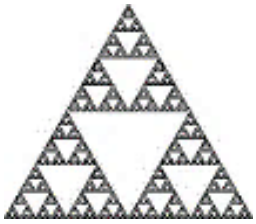

Figure 13. Serpinski's triangle Source: (El-Khaldi, 2007).

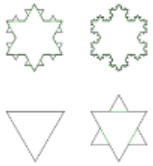

Figure 14. Koch curve Source: (El-Khaldi, 2007).

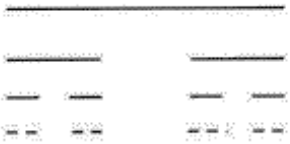

Figure 15. Contour set Source: (El-Khaldi, 2007).

Figure 16. Fractal pattern, Albrecht Dürer Source: (El-Khaldi, 2007).

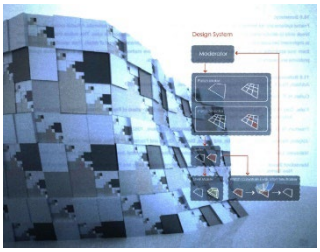

Figure 17. Fractal envelope Source: (El-Khaldi, 2007).

Figure 18. Fractal pattern roof (Rian and Asayama, 2016).

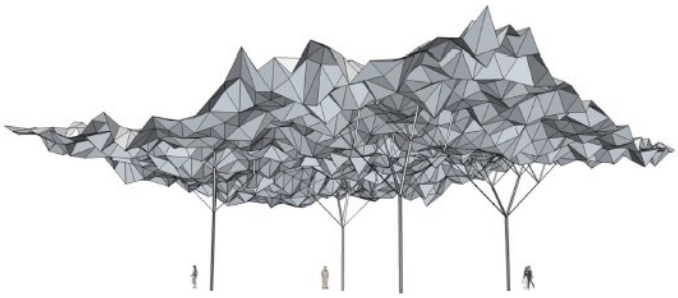

Figure 19. Non-smooth covering fractal surface (Sakai et al., 2012).

g. Generative design (Shape Grammer)

Shape Grammar (SG) is a generative design system (Caetano et al., 2020). Stiney and Gips were pioneers in this discipline (Stiny and Gips, 1971). It integrate visual observation with computational processes, enabling designers to engage in a form of "visual calculating" that enhances creativity (Stiny, 2022) and they are series of recursive transformations performed on an original shape to produce new shapes (Toussi, Etesam, and Mahdavinejad, 2021). SG develops an endless number of designs with just a few rules and it can decompose complex structures into basic components and create complex shapes from simple shapes (Stiny and Gips, 1971). Figure 20, demonstrates a SG rule (El-Khaldi, 2007). By combining SG with parametric

design, designers can simulate energy performance, (Granadeiro, Duarte, and Palensky, 2011). SG enable inheritance because replacement rules can be applied to certain parts of components while leaving others without transformation (El-Khaldi, 2007). Stiny categorizes units as point, line, plane and solid Table 2, (Stiny, 2006). Stiny and Mitchell used a parametric SG to create Palladio's villa designs (Tepavčević and Stojaković, 2012). Furthermore SG was used to analyze Frank Lloyd Wright's houses and the vernacular Japanese teahouses, traditional Taiwanese houses, Mongolian garden (Chiou and Krishnamurti, 1995; Stiny and Mitchell, 1980; Knight, 1981). SG could describe the historical development of styles in the creation of new design (Knight, 1981). SG is used to optimize daylight in the building envelope (Ashrafi and Duarte, 2017). Truss structures were created using performance-based optimization and SG (Haakonsen, Rønnquist, and Labonnote, 2023). It was also used to generate compositions Figure 21, (Eilouti, 2019). The Gothic minaret was designed using SG Figure 22, (Knight, 2000) and Frank Gehry used SG algorithms to justify envelope manufacturability Figure 23, (Shelden, 2002). City Engine, a software program that uses SG to autonomously create models based on a set of rules is creating virtual cities using 2D road networks (Müller et al., 2006). The Figure 24, shows how the program was used to create photos of Pompeii (Tepavčević and Stojaković, 2012). In architecture schools they are often used in design lessons (Haakonsen, Rønnquist, and Labonnote, 2023). CD systems gives users a tool to achieve goals (Haakonsen, Rønnquist, and Labonnote, 2023). The concept of a system is important in CD (Alfaris, 2009). This concept is examined in the next part.

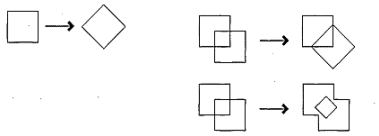

Figure 20. An example of a shape grammar (Stiny, 2006)

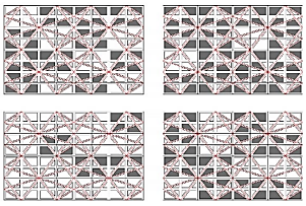

Figure 21. A shape grammar composition (Knight, 2000)

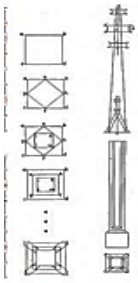

Figure 22. Minaret design (Knight, 2000)

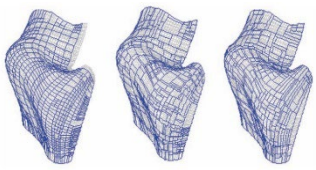

Figure 23. Shape Grammar envelope (Shelden, 2002)

Figure 24. Modeling the Pompeii city using shape Grammar software (Tepavčević & Stojaković, 2012)

Table 2. Shapes grammar units (Stiny, 2006).

Basic element	Dimension	Boundary	Content
Point	0	None	None
Line	1	Two points	Length
Plane	2	Three or more	Area
Solid	3	Four or more	Volume

System concept and computational design

The system concept influenced the architectural design and CD system. System is a collection of units and institutions that work together to achieve a common goal (Schmidt and Taylor, 1970). They have systematic structure (El-Khaldi, 2007). In these systems, components are hierarchically structured and interact to achieve goals such as envelope design and energy optimization (Granadeiro et al., 2013). As an example, the bottom-up approach of CA allows for self-organization, where local interactions lead to global patterns (Liu, Corcoran, and Feng, 2020) or in algorithmic design systems, multiple components described by rules, work together to achieve design goals (El-Khaldi, 2007). CD systems were used to create an integrated architectural design and Subsystems have an interaction with each other (Alfaris, 2009; Fasoulaki, 2008). In this status there is a balance between shape exploration and performance, for example it can be used to design high-rise building based on structural, lighting, zoning and aesthetic criteria (Fasoulaki, 2008).

A. The concept of the system and its components

The concept of system has penetrated to architectural design and CD systems (Alfaris, 2009). The Cambridge dictionary defines a system as “a set of connected things or devices that operate together.” Systems thinking encourages a holistic view, allowing architects to consider interactions within complex environments, leading to more effective design outcomes (Furtado, 2012). Systems are characterized by their goals such as service-oriented (airport, stadium), product-oriented (car factory) and process-oriented (oil refinery) (DAG and Ethic, 2000). Systems consist of numerous components that can adopt various configurations (Wong et al., 2023). Architectural research is concerned with systems in design to design the building envelope and predict energy consumption (Granadeiro et al., 2013). Systems analysis can help us better understand goals, constraints, risks, costs, opportunities and resources (Alfaris, 2009). System characteristics include integration, correlation, input/output, hierarchy, interaction, change and adaptability (Littlejohn and Foss, 2010). System tasks are completed in response to inputs (Papalambros and Wilde, 2000). The system's ability to form patterns is not solely dependent on local interactions but also on the broader context of the system's environment (Middya and Luss, 1994). Diagram 1, shows the boundary of the office building system as influenced by its

surroundings and environmental components (site conditions, soil quality, weather and urban environment) and it affects energy consumption, structural stability and working conditions (Alfaris, 2009).

The behavior of a system varies over time and System status is a set of variables that represent a specific characteristic of the system (DAG and Ethic, 2000). For example, variables such as aircraft waiting times and available parking spaces can be used to monitor the airport system (Alfaris, 2009). Effective variable selection should ensure that the chosen variables are relevant and significant (Mulaik, 2009). For example, if an airport wants to improve the passenger experience, parking lot modeling may be necessary. However, parking spaces may not improve safety (DAG and Ethic, 2000). Every system has an architecture that determines its behavior (Whitney et al., 2004). Hierarchy is a key concept in systems and Diagram 2, shows a hierarchical organization of system (Alfaris, 2009). Complex systems are typically organized into layers, where each level represents different scales and interactions among components (Wu, 2013). Hierarchy enables inheritance, which means that traits are passed from parents to children (El-Khaldi, 2007). Each system can be a subsystem of a larger system (Alfaris, 2009). The system concept distinguishes between two types of architectural artifacts: modular (Kazemi, 2019) and integrated (Miraglia, 2014). In the modular architecture Diagram 3, function and physical elements are inextricably linked (Eppinger and Ulrich, 1995) and each component can be developed separately. In integrated architecture Diagram 4, the connection between function and physical elements is complicated (Ulrich, 1995). It is difficult to determine the mutual impact of components on performance (Ulrich and Eppinger, 2016). Integrated systems prioritize a cohesive design that enhances operational efficiency (Miraglia, 2014). While some theories advocate modular architecture, real-world examples show that designs with integrated functions can achieve greater success and goals (Ulrich and Seering, 1990; Whitney, 1996). As Figure 25, shows, the modular design of a nail clipper does not always outperform an integrated nail clipper Figure 26, (Ulrich, 1995). In addition, Figure (27,28), illustrates two types of building envelopes (modular and integrated envelope).

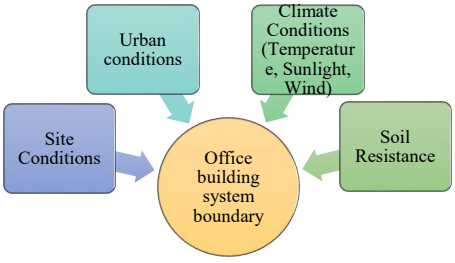

Diagram 1. The boundary of the office building system (Source: authors).

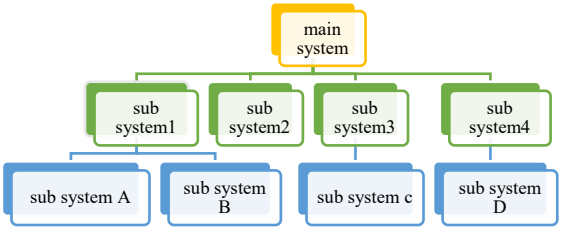

Diagram 2. Hierarchy in system (Alfaris, 2009).

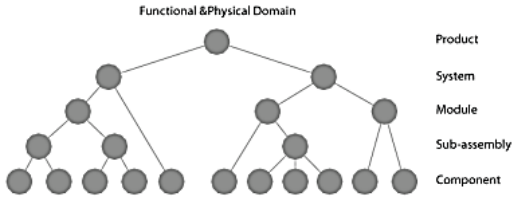

Diagram 3. Hierarchy and connection of physical elements in modular architecture (Alfaris, 2009).

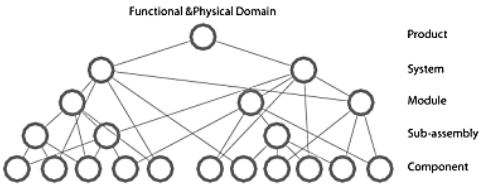

Diagram 4. Hierarchy and connection of physical elements in integrated architecture (Alfaris, 2009).

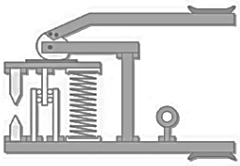

Figure 25. A Modular nail clipper (Ulrich, 1995).

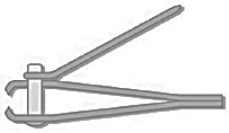

Figure 26. An integrated nail clipper (Ulrich, 1995).

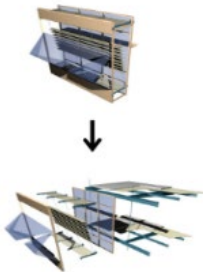

Figure 27. Modular façade design (Alfaris, 2009).

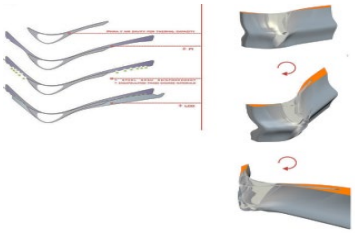

Figure 28. Integrated façade design (Alfaris, 2009).

Computational design process

In the late 1950s and 1960s, design models were created to reflect creative problem solving in design through phases such as synthesis, analysis, and evaluation (Alfaris, 2009). The design process involves a sequence of analytical, synthetic, and evaluative steps, allowing for iterative problem-solving and solution refinement (Vande Zande, 2006). Prescriptive models provide guidelines for implementation to achieve specific goals in design processes (Fernstrom, 1988) have algorithmic or systematic structure (Alfaris, 2009) and descriptive models capturing the actual process and patterns, identifying innovation opportunities (Zhang et al., 2012). Teaching prescriptive modeling alongside descriptive techniques enhances students' ability to implement design intent effectively (Gogolla and Selic, 2020). CD systems have algorithmic or systematic structure (Alfaris, 2009). Prescriptive models include the Archer (Archer, 1984), Eggert (Eggert, 2005), Asimov (Asimow, 1962), Marcus (Markus, 1969), and Mawer (Maver, 1970) models. Various prescriptive design models provide organized methods for the design process. These models outline the stages of a project from inception to completion, ensuring systematic progress

and quality control (Maher, 1990). Archer 1984, identified six design tasks Diagram 5, including programming, data collection, analysis, synthesis, development, and communication. The Eggert 2005 model Diagram 6, is divided into four phases: formulating problem, generating alternatives, analyzing alternatives, and evaluating alternatives (Eggert, 2005). As another prescriptive model, Asimo's model Diagram 7, is vertically structured and extends from needs description to production, including feedback loops to monitor and resolve difficulties. Asimo's horizontal model consists of repeated decision cycles: analysis, synthesis, evaluation and communication (Asimow, 1962). Marcus and Mawer's design model Diagram 8, provides a decision-making sequence that includes analysis, synthesis, evaluation, and decisions at various design levels (outline proposal to detail design) (Markus, 1969; Maver, 1970). MIT researchers proposed a Prescriptive performance-based CD process consisting of six phases including decomposition, formulation, synthesis, analysis, evaluation and optimization Diagram 9. Decomposition as a first step, breaking the problem into components. Formulation (the second phase) identifies component relationships (Alfaris, 2009). Alexander initiated the study of these ideas (Chermayeff and Alexander, 1963). Synthesis assembles recognized components according to desired principles and uses CD systems and offers a variety of design solutions (Alfaris, 2009).Computational design synthesis is a research area focused on approaches to automating synthesis activities in design (Campbell and Shea, 2014).

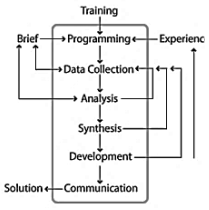

Diagram 5. Archer's design model (source: Archer, 1984).

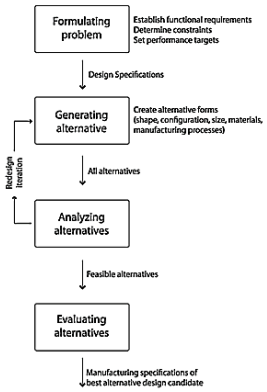

Diagram 6. Eggert design model (source: Eggert, 2005).

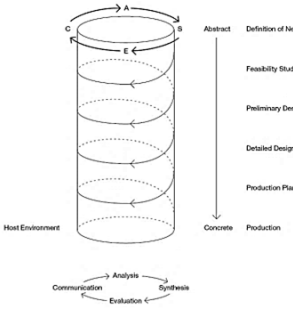

Diagram 7. Asimov design model (source: Asimow, 1962).

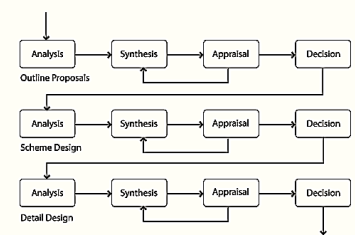

Diagram 8. Tom Marcus and Tom Mawer's design model (source: Markus, 1969; Maver, 1970).

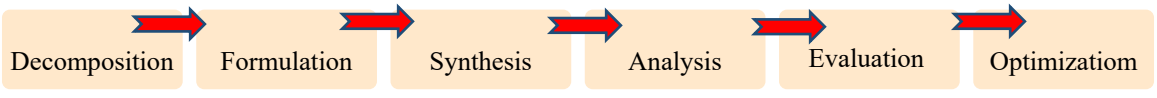

Diagram 9. Performance based computational design process (Alfaris, 2009).

Decomposition

In computational contexts, tasks can be broken down into sequential sub-tasks, which can simplify the design process (Fried et al., 2018). Decomposition is essential since learning individual components leads to a greater comprehension of the whole system (Alfaris, 2009). Alexander, (1964) broke down design problems based on customer needs as a network Diagram 10. Vertices represent functional requirements, while edges illustrate their connections and the degree of interaction. Shorter edges mean more interactions (Alfaris, 2009). This grouping allows interactions to be mapped (Alexander, 1964b). Models such as decomposition help in structuring design knowledge, facilitating better problem-solving and innovation in design (Maher, 1990). Two hierarchical methods can be used in decomposition (1. tree hierarchy Diagram 11, and 2. network hierarchy Diagram 12. Decomposing 3D models into architectural elements enhances comprehension of their structure, allowing for better analysis and representation (Kobyshev et al., 2016) Figure 29, shows decomposition of school floor plan into sub-problems (environmental, structural and circulation sub problems) and Figure 30, shows how the outer envelope is decomposed into its components (Alfaris, 2009).

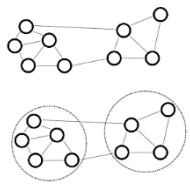

Diagram 10. Decomposition of a problem (Alexander, 1964a).

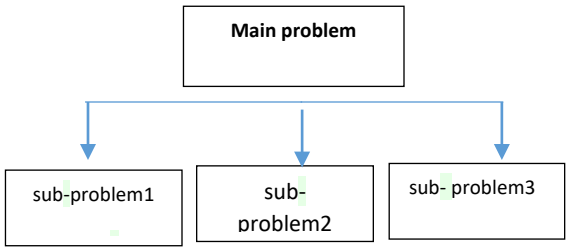

Diagram 11. Decomposition (tree hierarchy) (Alfaris, 2009).

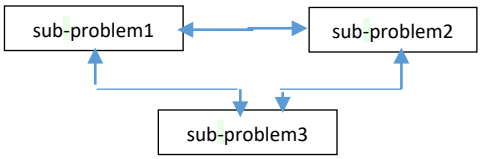

Diagram 12. Decomposition (network hierarchy) (Alfaris, 2009).

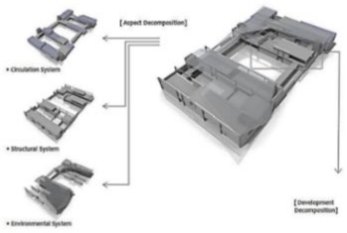

Figure 29. Decomposition of the school plan (Alfaris, 2009).

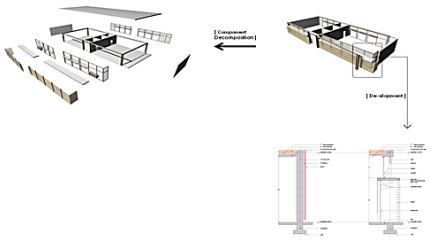

Figure 30. Decomposition of the (source: Alfaris, 2009).

Formulation

The next step (formulation) in the CD model is to understand the relationships between the various components Diagram 13 (Alfaris, 2009). CD utilizes mathematical languages to define relationships between components, enabling sophisticated design processes that are otherwise unattainable (Koyama, 2021). Components in CAD systems are often sized and positioned based on their relationships with other components, ensuring that designs are coherent and functional, which necessitates a clear understanding of these relationships (Amadon, Rajkumar, and Kumar, 2021). Chermayeff and Alexander (1963) pioneered structural formulation techniques and they outlined the links between these problems Diagram 14. Alexander focused on patterns in his work Pattern Language (Alexander, 1977). Design Structure Matrices (DSM) is used in systems engineering to represent component interactions (Samson and Peterson, 2010). Diagram 15, shows an activity-based DSM for the creation of a soda bottle (McCord 1993). Reading across rows identifies the other activities on which a given action depends for information. Black squares represent the transmission of information or activity interdependence (Grady, 1994). The interactions that occur in DSM differ from one project to the next and provide a taxonomy for system element interactions based on four categories: spatial, energy, information, and material (as illustrated in Table 3). They also provide a quantification scheme for these interactions, where the square marks are replaced by numbers or colors Diagram 16, (Pimmler and Eppinger, 1994).

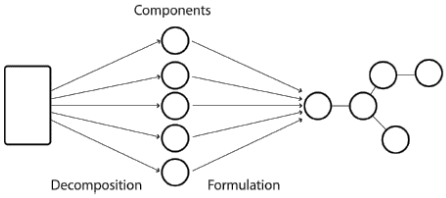

Diagram 13. Decomposition and formulation (source (Alfaris, 2009).

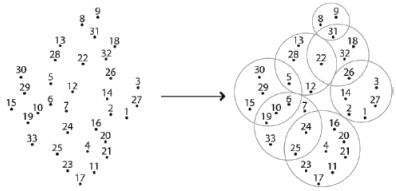

Diagram 14. Issues share many connections are grouped together (Chermayeff and Alexander, 1963).

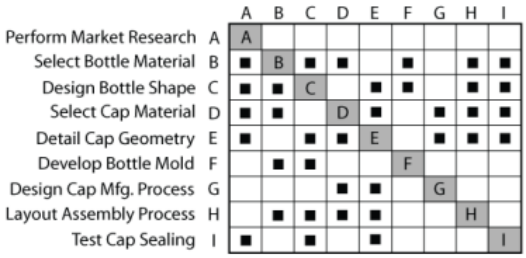

Diagram 15. An activity-based DSM for a soda bottle (McCord 1993).

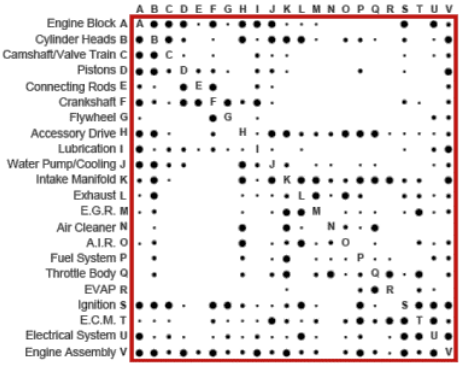

Diagram 16. DSM (Pimmler & Eppinger, 1994).

Table 3. Taxonomy for system element interactions (Pimmler and Eppinger, 1994).

Spatial	Associations of physical space and alignment; needs for adjacency of orientation between two elements.
Energy	Needs for energy transfer/exchange between two elements (e.g. power supply).
Information	Needs for data or signal exchange between two elements.
Material	Needs for material exchange between two elements.

Synthesis

Online Cambridge dictionary, defined synthesis as" the act of combining different ideas or things to make a whole that is new and different from the items considered separately." Synthesis involves the use of abductive reasoning, which generate innovative concepts (Fei, 2019). It involves decisions about arrangement, connections, forms (Papalambros and Wilde, 2000) and the creation of physical and informational structures (Suh, 1990). (Eder, 2009) discusses the cyclical nature of design engineering, where analysis and synthesis are interlinked processes that inform the development of technical systems. Computational design synthesis has also championed the use of generative design grammars as a means to simultaneously provide structure and design freedom during synthesis (Campbell and Shea, 2014). Synthesis models should have a generative mechanism, typically performed using parametric or algorithmic descriptions (Alfaris, 2009). A design algorithm expresses a strategic approach to tractable problems or a stochastic search for intractable problems (Terzidis, 2006). The connection between form and performance should be included in the representation formalism. This provides restrictions on permitted designs and ensures that the rules discard designs that do not comply with constraints (Alfaris and Merello, 2008). Synthesis models require a geometric representation (Alfaris, 2009). Advances in function-based and analogy-based synthesis have expanded the range of potential solutions (Chakrabarti et al., 2011). As sown in the Diagram 17, the synthesis model uses the original design parameters to generate a variety of design solutions through internal operations. For example, in a curve or surface equation, parameters can be changed to represent a family of curves or surfaces Figure 31, (Alfaris, 2009). In the conceptual design phase, synthesis is key to explore and define design concepts. It allows architects to invent transitions that lead to the description of artifacts (Kotsopoulos, 2005; Hartmann et al., 2018). By generating a wide range of design alternatives, synthesis supports the innovation process and enhances creativity in architectural design. It allows for the exploration of new forms and solutions, contributing to the evolution of architectural practices (Helms and Shea, 2012). Relationships (enable communication between the components), constraints (conditions that must

be met) and rules (to verify the logic) determine the behavior of the synthesis model. Methods such as L-systems, CA and SG can be considered for capturing design relationships (Alfaris, 2009).

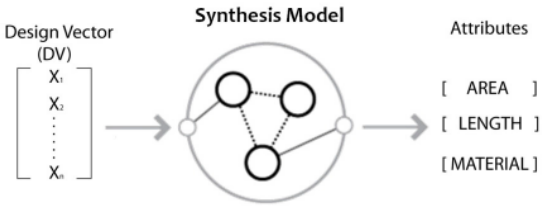

Diagram 17. Expected input and output of the synthesis model (Alfaris, 2009).

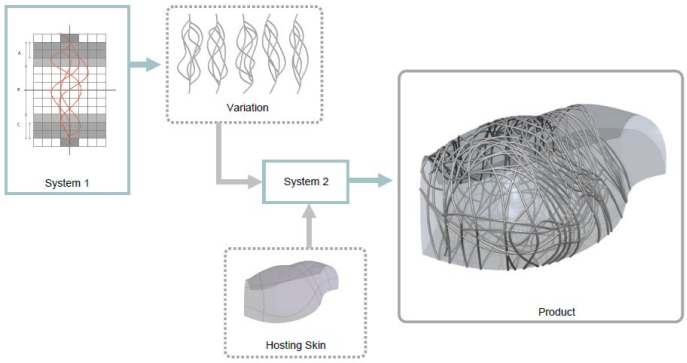

Figure 31. Parametric equations in geometry define curves (Alfaris, 2009).

Analysis, Evaluation and Optimization

The analysis model determines the behavior associated with each design and the evaluation model attempts to take into account the multi-objective criteria of the design problem. Optimization models are then used to determine the best designs (Alfaris, 2009). Online Cambridge dictionary, defined analysis as "the act of studying or examining something in detail, in order to discover or understand more about it." Alexander, (1964) describes analysis as determining how effectively a solution achieves its stated goals. Design challenges sometimes involve numerous disciplines, each with its own analytical model. For example Figure 32, (Averill, 2006), Figure 33, shows analysis models for examining the quality of light in different spaces and the air flow around the building (Alfaris, 2009). Analysis models have different input requirements and output accuracies Diagram 18, (Alfaris and Merello, 2008). Outputs can include energy efficiency, structural integrity, and environmental impact, which are derived from the analytical model's computations (Mitchell and Molloy, 2020). Analytical models are formal representations that support reasoning and understanding in design processes (Jackson, 2009). In architectural education, analytical models assist students in grasping design principles by organizing elements hierarchically (Azmy, 2010). These models are represented in abstract

mathematical form by variables, parameters, equations and algorithms (Jacoby and Kowalik, 1980). Evaluation models make it easier to select good design by creating and comparing alternatives Diagram 19, (Alfaris, 2009). Online Cambridge dictionary defined evaluation as "the process of judging or calculating the quality, importance, amount or value of something." Real-world problems sometimes involve multiple, possibly conflicting goals. This results in a collection of equivalent solutions rather than a single optimal solution (Abraham and Jain, 2005). Evaluation models aid decision making in multi-objective design challenges. If decision-making is delayed, the evaluation model becomes part of the optimization process (Alfaris, 2009). Online Cambridge dictionary defined Optimization as "the process of making something as good or effective as possible." The chosen solution is determined by additional restrictions or objective functions that integrate the search goals (Gries, 2004). Guass invented algorithm, which gave rise to the term optimization. It serves as the basis for the science of optimization (Gray, 2018). Optimization requires identifying performance criteria to maximize or minimize, such as cost or efficiency, while adhering to constraints like physical laws and manufacturing limitations (Lam and Chen, 2019). Optimization is the process of refining or fine-tuning a design or system based on one or more performance criteria (Papalambros, 2000). The optimization process is continuous, as architects must adapt designs based on evolving requirements and feedback throughout the project lifecycle (Davis, 1997). An optimization model generates a new design vector, which is then used as input to the synthesis model Diagram 20, (Alfaris, 2009). Multiple objectives in design can be inherently conflicting, such as minimizing control effort (Sardahi, 2016). This shows that there are numerous optimal solutions and not just one model. Multi-objective optimization integrates functional constraints, such as accessibility, into layout designs, ensuring that components are both operational and maintainable (Song et al., 2023).

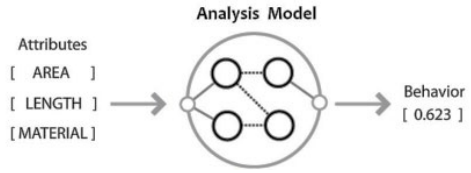

Diagram 18. Expected input and output of the analysis model (Alfaris, 2009)

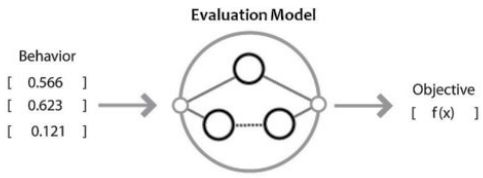

Diagram 19. Expected input and output of the evaluation model (Alfaris, 2009)

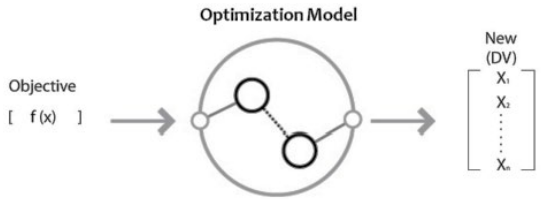

Diagram 20. Expected input and output of the optimization model (Alfaris, 2009)

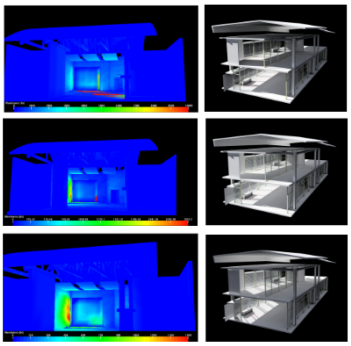

Figure 32. Analysis model for daylight to assess the quality of light in different spaces (Averill, 2006)

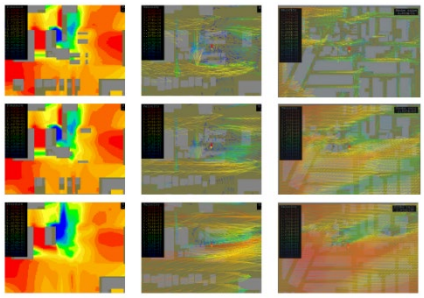

Figure 33. Analysis model to study of air flow around the building (Alfaris, 2009).

Methodology

The purpose of this research is to propose a comprehensive theoretical CD training framework. The selected method is based on the Design Research Method (DRM) by (Blessing and Chakrabarti, 2009), and research method conducted by (Vazquez, 2024) that merely provided a restricted program in parametric design training. However comprehensive CD training program had not been presented in that research. The DRM method is a framework in four stages: 1. Research Clarification 2. Descriptive Study I 3. Prescriptive Study and 4. Descriptive Study II. This paper proposed 3 research stages and the prescriptive study is followed by a second descriptive study that aims to implement and test the proposed approach will be done in further studies.

Research clarification and descriptive study which consists of a literature survey, followed by a prescriptive study, in which an instructional method is proposed. The descriptive study, is conducted through literature review on CD training and CD knowledge studies. The survey is conducted by searching in several databases with the following terms: (“teaching method” OR “pedagogical approach” OR “teaching strategy”) AND (“digital design” OR “computational design” OR “parametric design” OR “generative design” OR “algorithmic design”). After identifying the main articles in the area, an analysis was conducted. The outcome of the

descriptive study revealed that there is no specific comprehensive CD theoretical training framework prior to its usage in the design studio, and each study focused on some aspects of CD and concentrated on the use of software and coding (Austin and Qattan, 2016; Ostrowska-Wawryniuk, Strzała, and Słyk, 2022; Shtepani and Yunitsyna, 2023). However, learning CD necessitates theoretical knowledge (Caetano et al., 2020) that extends beyond software and programming. Additionally library resources analyzed and important topics in this field identified (DD and CD concepts, CD systems, system concept, CD system elements and CD design process (Caetano et al., 2020; Michelle and Gemilang, 2022; El-Khaldi, 2007; Alfaris, 2009; Fasoulaki, 2008). Finally in third stage (prescriptive study), with the goal of overcoming the deficiencies of the current educational program, this research will propose a comprehensive knowledge-based training framework. The training framework consists of two phases: 1. Learning CD principles 2. Learning an analysis of CD principles. In the first phase, topics such as DD and CD definition, types of CD systems (Algorithmic, Parametric and Generative design), system concept, prescriptive models and CD process were examined. Understanding CD concepts is necessary but not sufficient. Therefore, in the second phase, CD systems and their components were analyzed to identify differences. Additionally, integration of prescriptive models and CD process were examined. Finally training framework is proposed. Research methodology is presented in Diagram 21.

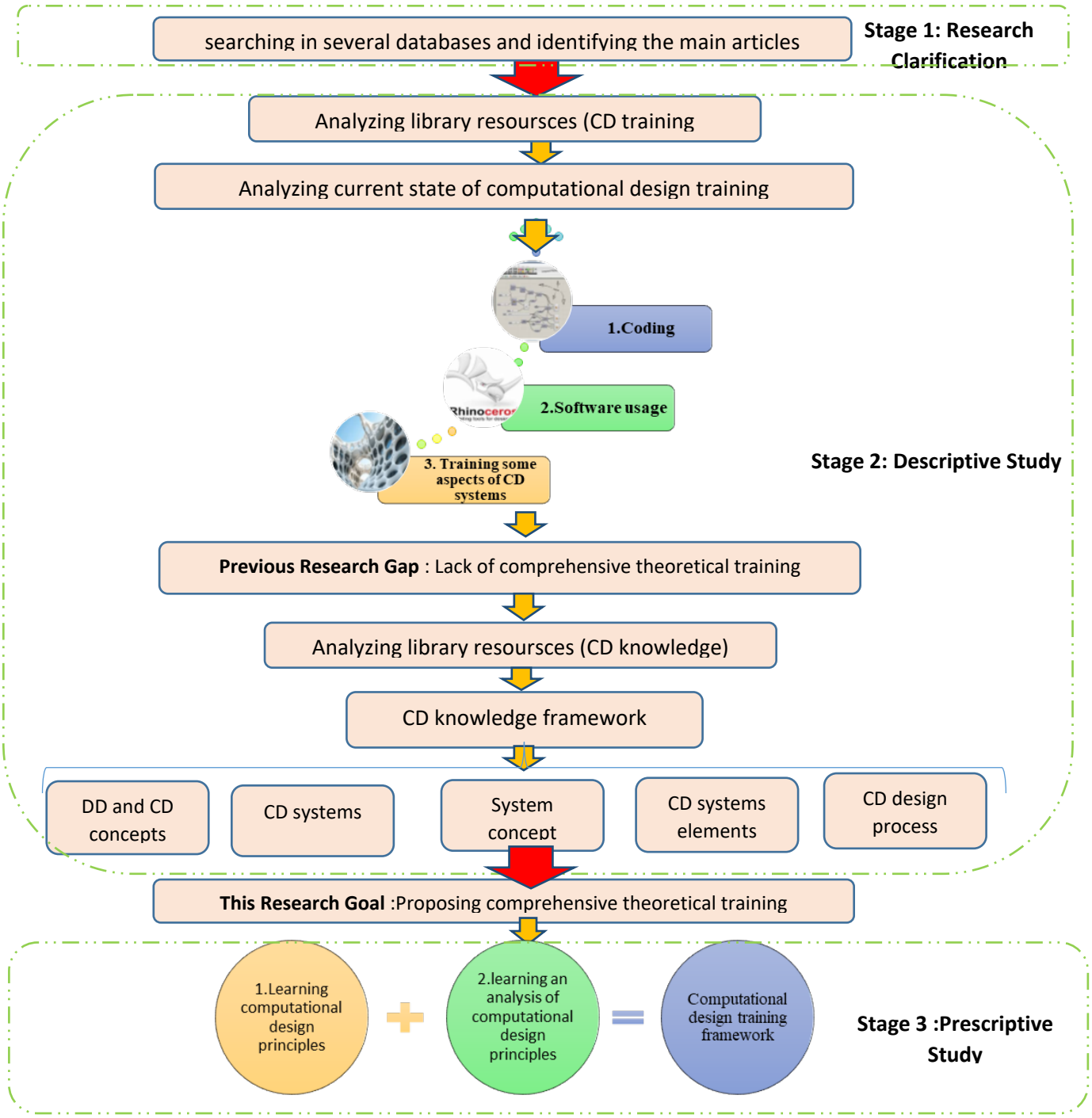

Diagram 21. Research methodology (analyzing current state and proposing CD training framework) (Source: Authors).

Results and Discussion

Research clarification and Descriptive study

Analysis of the current state of CD education and CD concepts

According to the previous research (Vazquez, 2024; Ostrowska-Wawryniuk, Strzała, and Słyk, 2022; Lakhanpuria and Naik, 2023), as mentioned in Table 4, CD was partially taught in the design studio, and the emphasis of these studies were on coding and software usage. A review of internal articles (Mahmoudi and Naghizadeh, 2010; Poursistany et al. 2016; Asefi and Imani, 2017; Ahmadi Tabatabaie and Moosav, 2024), revealed that only the impact of information technology and digital tools on architectural education have been examined and comprehensive CD training program had not been studied. However architecture students should have a thorough understanding of CD theory before applying it (Caetano et al., 2020). Some previous research focused on GD (Bianconi and Filippucci, 2018) and PD (Lakhanpuria and Naik, 2023), however it is obvious that students need to be familiar with AD (as fundamental concept) (El-Khaldi, 2007). A review of Research like (Caetano et al., 2020), (Michelle and Gemilang, 2022)) demonstrates the importance of CD and DD concepts. However, research in the Table 4, shows that CD training research has generally focused on AD, PD, and GD methodologies, and the underlying concept of CD itself has received little attention. CD methodologies have a systematic framework ((El-Khaldi, 2007; Alfaris, 2009; Fasoulaki, 2008). However, this concept has not been considered in previous education research. Additionally there are differences in CD systems, as evidenced by CD-related research such as (Michelle and Gemilang, 2022; El-Khaldi, 2007; Fasoulaki, 2008) and previous CD training studies did not address distinctions. Prescriptive models such as Archer (Archer, 1984) have been proposed and demonstrate the importance of the design process. The architectural theorists, Alexander and Chermayeff studied design stages such as decomposition and formulation (Alexander, 1964a; Chermayeff and Alexander, 1963). Academic research, particularly at MIT, has also proposed a model for the CD process, which includes steps such as decomposition, formulation, analysis, evaluation and optimization (Alfaris, 2009; Alfaris and Merello, 2008). But these concepts have been missed in previous CD training research described in the Table 4. Based on the findings and in order to fill research gap (the lack of a comprehensive CD training program), a comprehensive theoretical training framework on Learning CD principles has been proposed in this research. These concepts have been incorporated and examined in the upcoming section of the curriculum and main CD concepts collected from literature analysis represented in Table 5.

Table 4. Previous (CD) training research (Source: Authors).

	Research	CD type		Research	CD type		Research	CD type		Research	CD type
1	(Fischer, 2002)	GD	7	(Yavuz & Çelik, 2014)	GD	13	(Lakhanpuria & Naik, 2023)	PD	19	(Vazquez, 2024)	PD and AD
2	(Karzer & Matcha, 2009)	PD	8	(Huang & Xu, 2015)	GD	14	(Nazidizaji & Safari, 2013)	AD	20	(Mahmoudi & Naghizadeh, 2010)	Information technology
3	(Gürbüz, Çağdaş, and Alaçam, 2010)	GD	9	(Agkathidis, 2015)	GD	15	(Austin & Qattan, 2016)	AD	21	(Eynifar & Hosseini ,2014)	Digital technology
4	(Guidera, 2011)	GD and PD	10	(Abdelmohsen et al., 2017)	GD	16	(Peteinarelis & Yiannoudes, 2018)	PD and AD	22	(Poursistany et al. 2016)	Digital technology
5	(Knight, 2012)	GD	11	(Bianconi & Filippucci, 2018)	GD	17	(Vrouwe,et al., 2020)	PD	23	(Ahmadi Tabatabaie & Moosav, 2024)	Teaching software
6	(Abdelmohsen, 2013)	GD	12	(VAZ & CELANI)	GD	18	(Agirbas, 2022)	PD			

Table 5. CD concepts in pervious CD research

CD and DD concepts	Cd and DD concepts and their distinctions	(Michelle & Gemilang, 2022), (Caetano et al., 2020)
CD systems	CD systems (AD, PD, GD) concepts and their application	(Michelle & Gemilang, 2022),(Caetano et al., 2020), (El-Khaldi, 2007); (Fasoulaki, 2008)
System concept	System concepts and its application in CD, system components	(Alfaris, 2009), (Alfaris & Merello, 2008)
CD systems elements	Units, smallest units, rules, inheritance, algorithm execution	(Caetano et al., 2020), (El-Khaldi, 2007), (Fasoulaki, 2008)
CD design process	Prescriptive models and CD design process	(Alexander, 1964a), (Chermayeff and Alexander, 1963)

Prescriptive study (Training program)

a. First training phase (Learning computational design principles)

This research training program has two phases (1. Learning CD principles 2. Learning an analysis of CD principles). During the initial training phase Diagram 22, it is critical to grasp the CD principles, such as definitions of CD and DD (Caetano et al., 2020; Michelle and Gemilang, 2022), recognition of all types of CD systems (El-Khaldi, 2007; Michelle and Gemilang, 2022; Fasoulaki, 2008). AD requires knowledge of algorithms, decomposition, and how to propose solution for each part (Terzidis, 2004; Fried et al., 2018). PD requires knowledge of parameters,

variables and algorithms (Gu, Yu, and Behbahani, 2021). GD requires an understanding of algorithms and the recognition of generative systems (Caetano et al., 2020). CD systems have systemic structure (Alfaris, 2009; Alfaris and Merello, 2008) and understanding its concept and components is critical. Recognizing design models, especially prescriptive models and CD design process (Alfaris, 2009; Alfaris and Merello, 2008), is also necessary in the first phase of training.

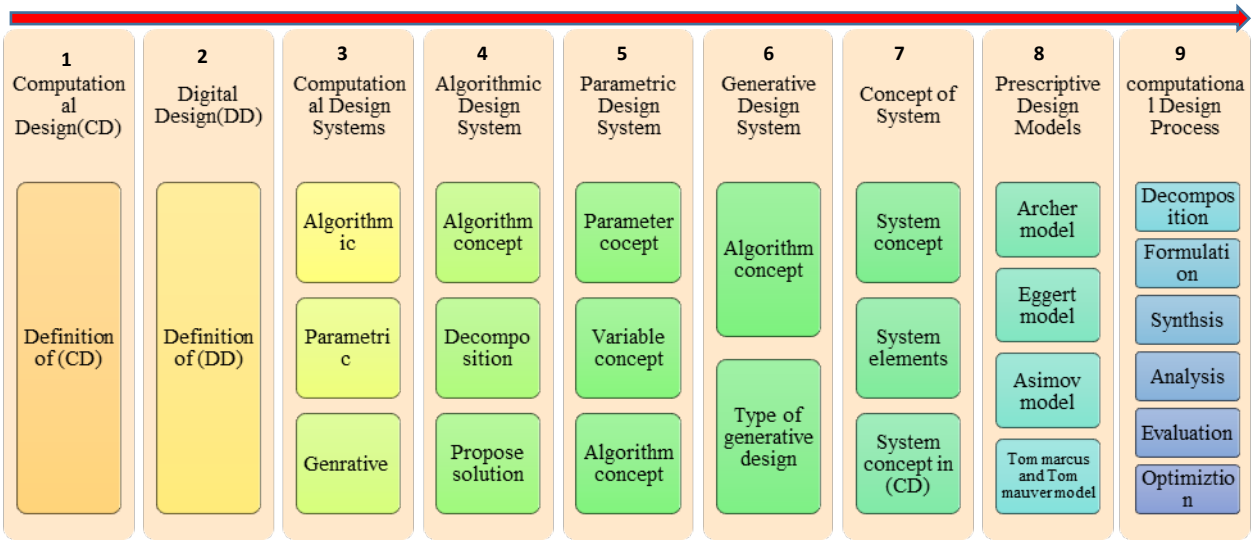

Diagram 22. First training phase (Source: Authors).

b. Second training phase (learning an analysis of computational design principles)

The second phase of CD training Diagram 23, is the analysis of CD systems. Studies such as (Caetano et al., 2020) examined CD and differentiated it from DD. As a result, knowing this distinction is critical as the first step. Furthermore, research like (El-Khaldi, 2007; Michelle and Gemilang, 2022; Fasoulaki, 2008; Caetano et al., 2020) examined CD methodologies and their constituent elements and structures, emphasizing the distinctions between them. As a result, it is critical to familiarize students with these distinctions and their basic components (application, algorithm execution type, unit, rules, smallest unit and inheritance). CD follows a systematic structure (El-Khaldi, 2007; Alfaris, 2009). As a result, knowing the systematic structure of CD and comparing it to the concept of system is important in the following step. The next step is to consider integrating prescriptive design models with CD process (Alfaris, 2009) in order to produce a comprehensive design model. Both of them (prescriptive model and CD process) have a systematic and algorithmic framework and can overcome each other's shortcomings (Alfaris, 2009).

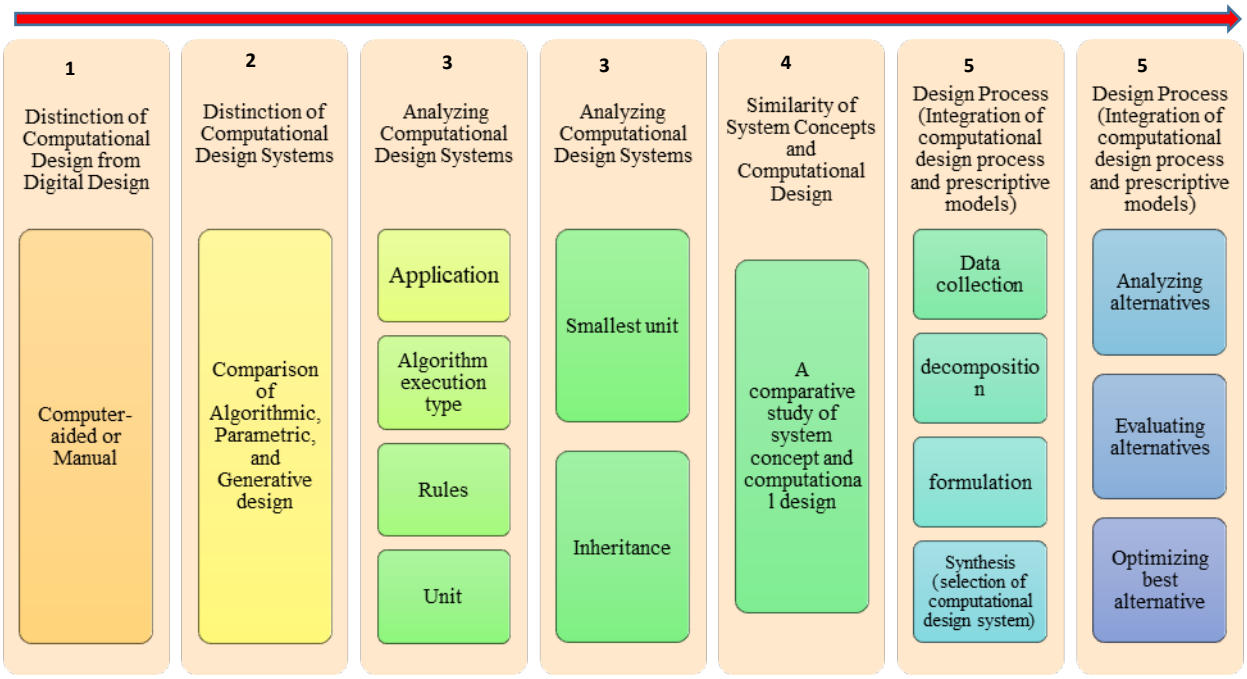

Diagram 23. Second training phase (Source: Authors).

c. Proposing a comprehensive theoretical training framework

By combination of first and second phase, CD training program is proposed Diagram 24. CD training program includes CD principles and their analysis. As Diagram 24, shows, Students should comprehend CD and DD and their distinction 2. CD systems (algorithmic, generative, parametric) and their distinctions 3. Analyzing CD systems (recognizing elements of CD systems such as hierarchy, inheritance, rules) 4. the concept of system and the similarity of system and CD 5. Design process (integration of Prescriptive Models and CD Process).

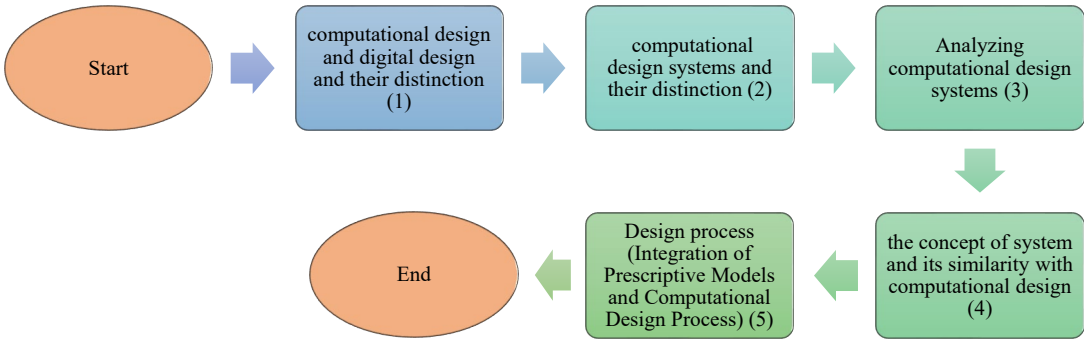

Diagram 24. Proposing a computational design training program (Source: Authors).

Computational Design, Digital Design, Computational Design Systems and their Distinction

DD and CD are widely used and Knowing their differences (Caetano et al., 2020) is helpful in understanding them better and using them in education. Digital design requires computer tools. CD requires calculations to develop designs and can be performed with or without computers Diagram 25, (Caetano et al., 2020). It is important to understand the differences between CD systems which are critical to maximizing their application. Algorithms are applied in algorithmic and generative design systems but in generative design system, the relationship between the algorithm and the output is difficult to discover. Parametric design systems are used when a number of parameters affect the final design and algorithms can be used in parametric design Diagram 26, (Caetano et al., 2020; El-Khaldi, 2007; Michelle and Gemilang, 2022; Fasoulaki, 2008).

Diagram 25. Distinction of (DD) and (CD) (Source: Authors).

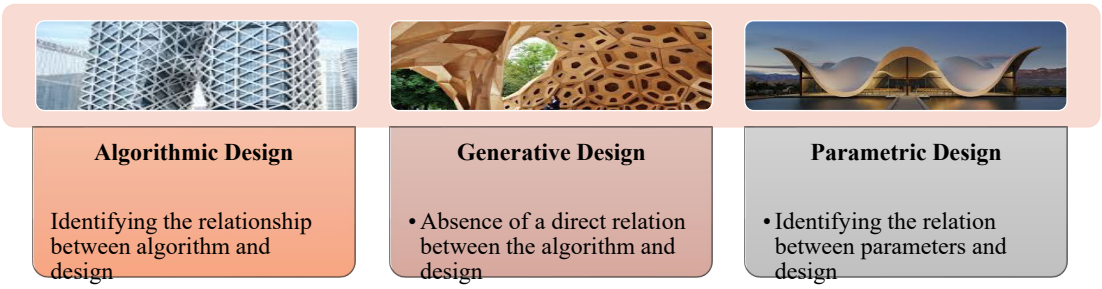

Diagram 26. Distinction between computational design systems (Source: Authors).

Analyzing computational design systems

The concept of decomposition can be used to examine the structure of CD systems. This may focus on the use of CD systems, rules, constituent units, the smallest unit, and inheritance (El-Khaldi, 2007). Various design problems are solved and simulated through algorithmic design (Terzidis, 2006) and parametric design (Schumacher, 2008; Tabadkani et al., 2019). Generative systems use L-systems (Prusinkiewicz and Lindenmayer, 2012), CA (Adem and Çağdaş, 2020), fractals (Mandelbrot, 1982; Patuano and Tara, 2020), and SG (Stiny and Gips, 1971; Tepavčević and Stojaković, 2012; Eilouti, 2019). CD systems are rule-based (Caetano et al., 2020). AD (Caetano and Leitão, 2021) and PD use numerous rules and generative systems use the substitution rules. Units used in CD systems are different. Algorithmic and parametric units are diverse, while L-systems and cellular automata use symbols. Fractals and shape grammar use

symbols, numbers and shapes. AD and PD use various smallest units, but L-systems, CA, and SG use alphabet, cell, and basic architectural elements. Fractals do not have a smallest unit due to substitution. Algorithmic and parametric design include inheritance, but L-systems, CA and fractals do not include inheritance. However, shape grammar can use replacement rules to change elements or parts while keeping the rest, allowing inheritance (El-Khaldi, 2007; Alfaris, 2009; Michelle and Gemilang, 2022; Fasoulaki, 2008; Caetano et al., 2020). The characteristics of each system (AD, PD and GD) such as their implementation, rules, units, smallest unit and inheritance are presented in Diagram 27, 28.

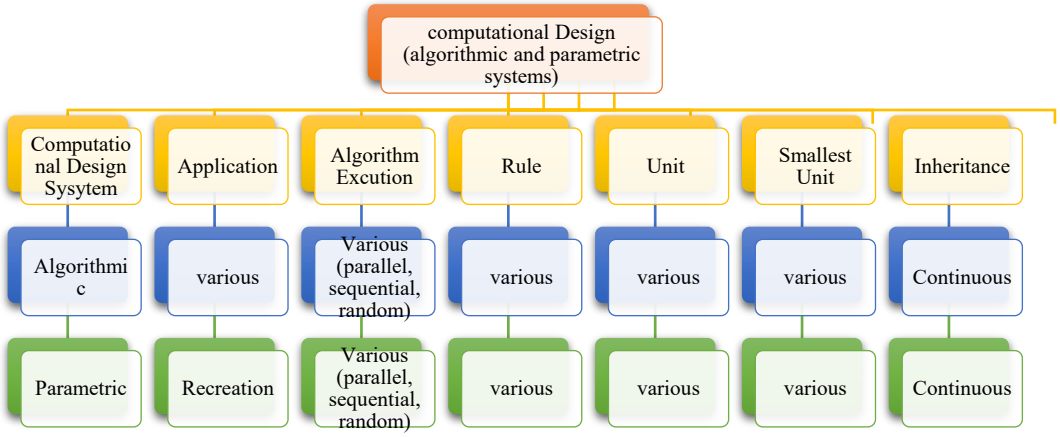

Diagram 27. Computational design systems analysis (algorithmic and parametric design system) (Source: Authors).

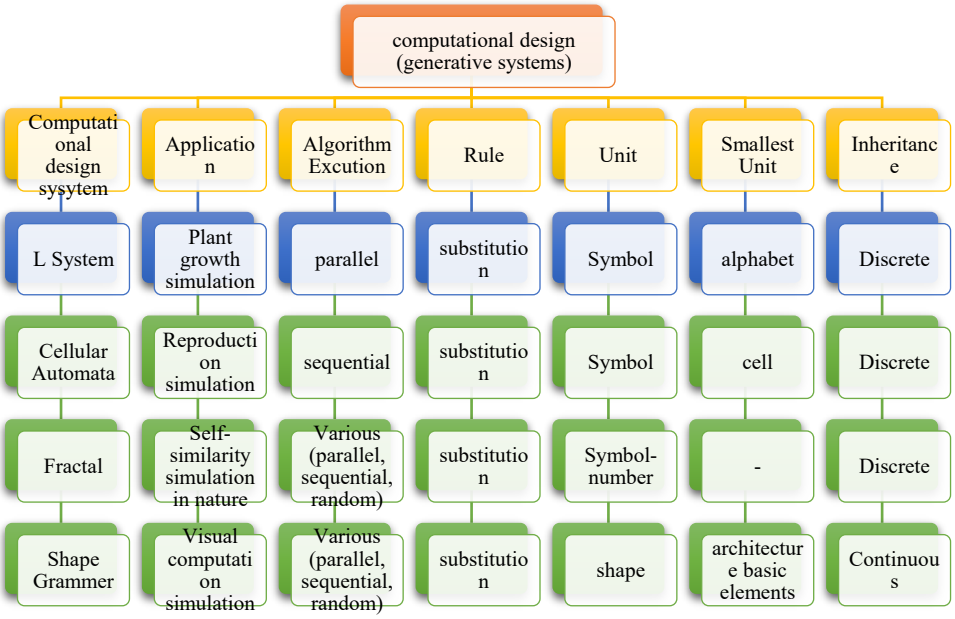

Diagram 28. Computational design system analysis (generative systems) (Source: Authors).

Concept of system and its similarity with computational design

Systems are collections of units and institutions that work together to achieve common goals. This concept could be used in CD systems (El-Khaldi, 2007, Alfaris, 2009). As showed in Table 6, System and CD have comparable principles such as component relations, hierarchy, rules, and system execution (parallel, sequential, and random).

Table 6. Similarity of system and computational design (Source: Authors).

Concept	System	Computational design
Relation between components	✓	✓
Hierarchy	✓	✓
Rules	✓	✓
System execution (parallel, sequential and random)	✓	✓

Design process (Integration of Prescriptive Models and Computational Design Process).

The algorithmic and systematic structure of the CD process includes decomposition, formulation, synthesis, analysis, evaluation and optimization (Alfaris, 2009; Alfaris and Merello, 2008). In addition to the phases mentioned, the prescriptive models also include phases like planning, data collection Table 7. By combining prescriptive models and the CD process, shortcomings of these models can be minimized and a complete design process can be proposed Diagram 29. These steps are not sequential and can be performed and repeated as the designer considers (Alfaris, 2009).

Table 7. Similarity of prescriptive model and computational design process (Source: Authors).

Prescriptive models					Computational design process
	Archer	**Eggert**	**Asimov**	**Tom Marcus and Tom Mawer**	**Computational design process**
Programming	+				
Data collection	+				
Identifying needs		+	+		
Formulating the design problem (specifying goals and constraints)		+			
Feasibility studies	+				
Data analysis (decomposition)	+	+	+	+	+
Synthesis		+	+	+	+
Analysis of design alternatives		+	+	+	+
Evaluation of design alternatives		+	+	+	+
Optimization	+				+

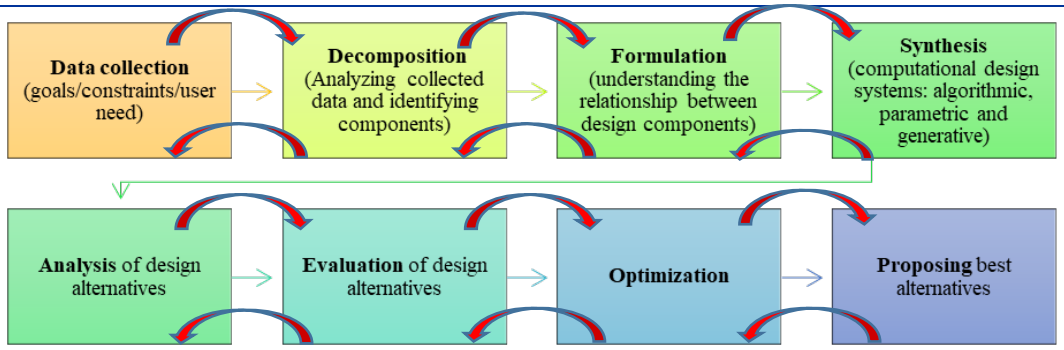

Diagram 29. Design process (combination of prescriptive models and computational design process) (Source: authors).

Decomposition is an important concept in algorithms and CD systems. Decomposition can be used to decompose both the design product and the process. The Diagram 30,31, shows decomposition of the office building components (envelope, structure, space organization, facilities). The next step is to understand how they interact (formulation) (Alfaris, 2009). For example, when designing a sport stadium, the relationship between material, structure, envelope and space organization is crucial Figure 34, and Diagram 32. This makes it clear that the building does not consist of independent individual components, but is a networked system of subsystems in which all components interact with each other and create a mutual effect (Fasoulaki, 2008). The synthesis phase is crucial in CD because it combines components to provide design possibilities. By Using algorithmic, parametric and generative design methods, designers create a variety of alternatives (Alfaris, 2009). In contrast to traditional methods, CD offers a wider range of solutions (Agkathidis, 2015). The diagram shows an example of using a CD system to make design decisions in various areas such as structure, envelope and floor plan design Diagram 33.

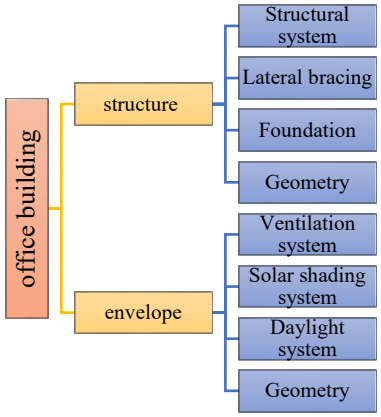

Diagram 30. Analysis of the envelope and structure of an office building (Source: Authors)

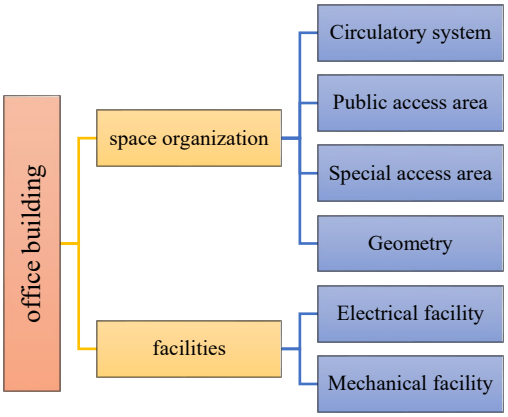

Diagram 31. Analysis of spatial organization and facilities of an office building (Source: Authors)

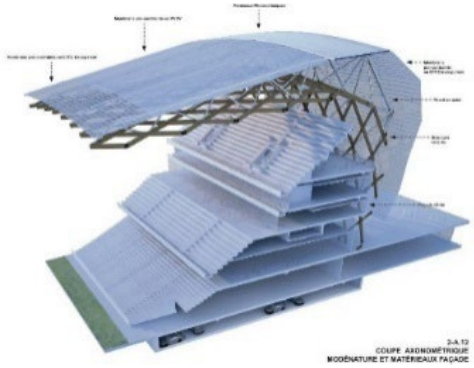

Figure 34. Allians Riviera stadium (Source: Archdaily).

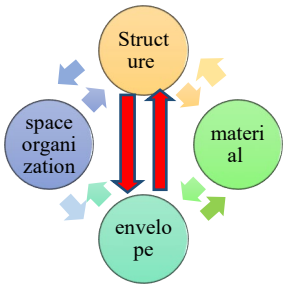

Diagram 32. Relationship between structure, material, envelope and space organization in stadium design (Source: Authors).

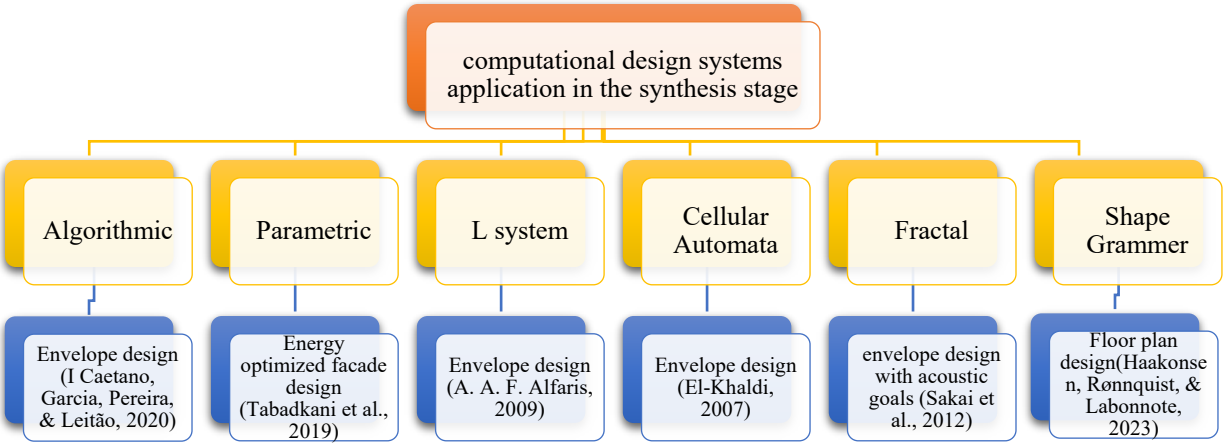

Diagram 33. Application of computational design systems in the synthesis phase (Source: Authors).

Before proceeding, all design decisions must be analyzed and evaluated (Alfaris, 2009; Alfaris and Merello, 2008). Students should be able to analyze and evaluate design criteria such as goals and restrictions. CD can be performed with or without a computer (Caetano et al., 2020). When analyzing a building, accurate revision of plans, elevations, sections, openings, site plans, installation problems, form analysis, function, structure, climate, acoustics, topography, analysis of economic, social and cultural factors, historical records, obstacles and legal restrictions should be taken into account (Ching, 2023). After analyzing and evaluating the design alternatives, the selected alternative may need to be optimized (Alfaris, 2009). Optimization can be used in a variety of goals including energy consumption, column spacing, and space organization. Training in analysis, evaluation and optimization is presented in Table 8.

Table 8. Training in analysis, evaluation and optimization in CD (Source: Authors).

1. Understanding the concept of analysis and evaluation
2. Ability to examine design constraints and objectives in design alternatives
3. Recognizing analysis and evaluation software
4. Understanding the concept of optimization
5. Ability to optimize the selected alternative based on design criteria
6. Recognizing optimization software

Conclusion

Computational design (CD) systems (Algorithmic, Parametric and Generative design systems) have been widely used in architectural education during the last decade. Examining previous research indicates that separate comprehensive framework for its training has not been proposed. Previous research focused on programming, the use of software and some aspect of CD systems in the design process. However, learning CD necessitates theoretical knowledge that extends beyond software and programming. An extra course on theoretical topics can improve its use. Therefore, this research proposes a framework for training theoretical knowledge in this field. In the first and second stage of the research (research clarification and descriptive study), the existing state of its training was reviewed and analyzed, and its deficiencies and shortcomings were identified through the use of library resources. Additionally important concepts for comprehending CD knowledge were identified, and in the third stage (prescriptive study), with the goal of overcoming the deficiencies of the current CD training, a comprehensive framework including two phases of 1. Learning CD principles 2. learning an analysis of CD principles is proposed. This framework consists of topics ranging from basic to advanced, including: 1. computational design and digital design and their distinction 2. CD systems (Algorithmic, Generative and Parametric) and their distinctions 3. Analyzing CD systems (recognizing concepts such as hierarchy, inheritance, rules and units in CD) 4. The concept of system and the similarity of system and CD 5. Design process (integration of Prescriptive Models and CD Process). This framework can gradually familiarize students with principles of CD systems and their analysis. Results of this study can be applied as a framework for CD training.

Author Contributions

All authors contributed equally to the conceptualization of the article and writing of the original and subsequent drafts.

Data Availability Statement

Not applicable

Acknowledgements

The authors would like to thank all participants of the present study.

Ethical considerations

The study was approved by the Ethics Committee of the Islamic Azad University, Sav.C. The authors avoided data fabrication, falsification, plagiarism, and misconduct.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors declare no conflict of interest.

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IJAPAS

International Journal of Applied Arts Studies

Print ISSN: 2588-4506 Online ISSN: 2588-4670

Homepage: www.ijapas.ir

Islamic Azad University
Yazd Branch

Revitalization and Adaptation of Houses in the Historical Neighborhood of Moghadamian in Dezful City with a Sustainable Architecture Approach

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Article Info

Article type:
Research Article

Article history:
Received December 02, 2023
Received in revised form January 01, 2025
Accepted July 14, 2025
Published online August 15, 2025

Keywords:
Revitalization,
Adaptation,
Sustainable architecture,
Moghadamian neighborhood,
Dezful city.

ABSTRACT

Revitalization of historical works and buildings are of special importance as an important part of the history of culture and civilization of any society. Historical houses are facing the development of urbanization today. This development and expansion have been associated with destruction and change in historical contexts. The best way to protect abandoned and decaying buildings is to revive them and give them use, which should be done in such a way that their spiritual, material, and historical values are compatible with the new values that are given to them. In most cases, these buildings have been defined as different from their original identity during intervention for revitalization. Many small spaces of the houses have been left unused. This research is based on a qualitative and quantitative approach in terms of its practical purpose and its governing system. The researcher has used survey methods to collect information and descriptive-analytical methods to achieve the conceptual model. Interviews, questionnaires study of documents, and field surveys were the tools of research data collection. AHP and Delphi techniques have been used to analyze and infer data. The results show that in the restoration of the historical houses of the Moghadamian neighborhood in Dezful City, there is a big gap between the appropriate methods of intervention that are presented in the restoration documents and criteria and the results of the research. Also, according to experts in the field of restoration, the interventions made in historical houses for revitalization have not been at a favorable level.

Cite this article: Ghafari Khalaf Mohammadi, S. M., & Ghobadian, V. (2025). Revitalization and Adaptation of Houses in the Historical Neighborhood of Moghadamian in Dezful City with a Sustainable Architecture Approach. ***International Journal of Applied Arts Studies***, *10*(2), 97-126.

Publisher: Islamic Azad University, Yazd Branch.

Introduction

In the last century, the issue of historical monuments and monuments and how to deal with them in the matter of reviving and giving life to them as historical monuments of a border and region has been of special importance (Ziya Shahabi and Imani, 2018: 37).

Today, the historical context of cities is going through stagnation and backwardness due to the traditional structure, wear, and tear of residential units, difficulty of access, weak infrastructure, and environmental organizations. Taking into account that the historical monument was responsive to the needs of the people of his time; Therefore, its non-compliance with the needs of today's people makes the issue of revitalization and functional compatibility of historical neighborhoods important. The ancient and historical context of the cities is the valuable historical, cultural-social, and physical-spatial heritage of the cities, which is considered an indicator of the urban identity. Therefore, the restoration and reconstruction of this fabric prevent its identity lessness and wear and tear from the inside and can contribute to the appropriate development of the city (Kusheshgaran, 2011: 73)

Textures and historical buildings contain historical-cultural values and show a teaching of the collective wisdom of humans, which includes a mixture of art, experience, a sense of place and the biological world of humans, and a precious heritage for future generations. (Shahbazi et al, 2020). It is considered, therefore, that abandoning the historical context prevents the contemporary man from making wise use of past experiences and being on the path of historical continuity, which is the key to the survival of any culture. (Randall, 2002). The special nature of the old texture rejects any neglect of it in many ways. From the economic point of view, it has potential infrastructural and construction facilities, from the cultural point of view, it is a relic of the previous history, and from the physical point of view, it has unique architectural and urban planning values. (Shahbazi et al., 2020). It seems that revitalization and other methods of protection and restoration as long as the historical monument is still identifiable as a work and the possibility of granting new functions and adaptation of human activities to the body of architecture in the form of a defined use in If it exists, it can prevent the deterioration of the work and help preserve the historical work (Baker, 2009)

When it comes to revitalizing a building or worn-out urban fabric, the main goal is something beyond physical and spatial measures. In this process, an attempt is made to create a creative link between the past, present, and future of the historical building. What should always be considered in this direction is the preservation of the material and spiritual values of the historical work (Redondo, 2008).

Getting to know as much as possible about the architecture of traditional textures and how to make them, in addition to getting to know more solutions in the direction of maintenance and

restoration, can be a beginning for the implementation of modern architectural constructions, and Iranian engineers in the continuation of the identity of the architects that their predecessors They have achieved it, it has helped. The purpose of this article is to compare the revitalization and compatibility of the historical neighborhood of residents in Dezful City with the approach of sustainable architecture and answer the following questions:

1. What kind of interventions have been done in the historical houses of the Moghadamian neighborhood to revive and adapt the houses?

2. Where is the place of the revitalization of historical buildings of Moghadamian neighborhoods in sustainable architecture and how is it addressed?

Theoretical Foundation

Revival

Revitalization or revival in architecture is the use of visual styles, which is conscious feedback from the architectural styles of the past.

Revitalization or revitalization in architecture and design means reviving a pre-existing building so that life can flow in it. This term is mostly used in the architecture and urban planning literature in the branch of building restoration. Regeneration and revitalization have something in common. Regeneration is a process that leads to the creation of a new urban space by preserving the main spatial characteristics (physical and functional). (Caple, 2000). In this action, a new urban space is created that, while maintaining the basic similarities with the old urban space, has substantive and semantic differences with the old space. This word also means "regeneration" and "renewal", which actually means renewal and updating, although this action can have differences in behavior and norms in addition to external similarities, and has an independent personality and identity (Ansari and Anjomani, 2011: 3). Contemporizing a historical work, from a material point of view, means an intervention in the work for the creator's dialogue between stable ancient values and contemporary high values, and not temporary and transitory decisions, contemporizing a historical work from a spiritual point of view, means turning the material and cultural heritage into material and cultural wealth. (Lorestani et al., 2010).

Table 1. Dimensions and common principles of urban revitalization and conservation regeneration, (Source: Author).

Dimensions of reconstruction of base protection		Dimensions of urban revitalization	
Improving the quality of life and social relations, reducing social crime, overcoming stigmatization and social exclusion	Social	Creating social cohesion and the spirit of participation and increasing social capital	Social
Increasing employment opportunities, improving the distribution of wealth, cultivating talents, increasing taxes and local rents, the relationship	Economic	Attracting investors, creating economic job opportunities and	Economic

between civil engineering and local, regional and urban improvement, attracting domestic investments.		modernizing the city economy	
Development and management of the environment along with the introduction of a more comprehensive idea of environmental sustainability	Environmental	Dealing with environmental pollution and improving the quality of life	Environmental
Reorganizing decision-making mechanisms through democratic understanding, increasing the amount of space for cooperation and participation, considering different expectations, emphasizing various regional partnerships, paying attention to interactions between organizations and institutions and their internal relations.	Rulership	Promotion of cultural heritage and urban tourism	Cultural
Contemporizing the historical environment means functional intervention and taking over it for a creative dialogue between ancient sustainable values and contemporary high values.	Practical	Improving access network, public transportation network and urban infrastructure quality	Practical
Solving problems related to physical wear and tear along with new lands and appropriate needs	Physical	Improving the physical-spatial quality of buildings, creating a coherent network of public spaces, creating attractive and readable public spaces	Physical-spatial
Integrated management of existing resources and applied changes	Management	Enhancing physical-spatial quality of buildings, creating a complex network of public spaces, creating attractive and readable public spaces	Management

Based on the contents of the above Table 1, it can be acknowledged that in urban revitalization, the qualitative and quantitative improvement of all the above-mentioned dimensions is treated equally, while the restoration of minibar protection pays more attention to the economic benefit of historical buildings and environments and attracts tourists (Golant, 2015: 1539). In the meantime, neighborhoods and historical areas play an important role in the success of these regeneration projects for the following reasons (Landeta, 2006: 469).

Investing in historical places are attractive lands for the establishment of companies, life, and residence, people are business investments and tourist destinations, and the market value in historical places are higher than anywhere else; a sense of place people enjoy living in historical places and generally have more social cohesion is seen in these places (Yaghoubi et al., 2024).

The sustainable reuse of historic buildings minimizes the exploitation or misuse of resources, and the findings also imply a lower cost of maintaining historic houses (Orbasli, 2000).

The quality of life in neighborhoods and historical areas leads to the improvement of the quality of life and the enrichment of people's understanding of the diversity and changing nature of society Figure 1.

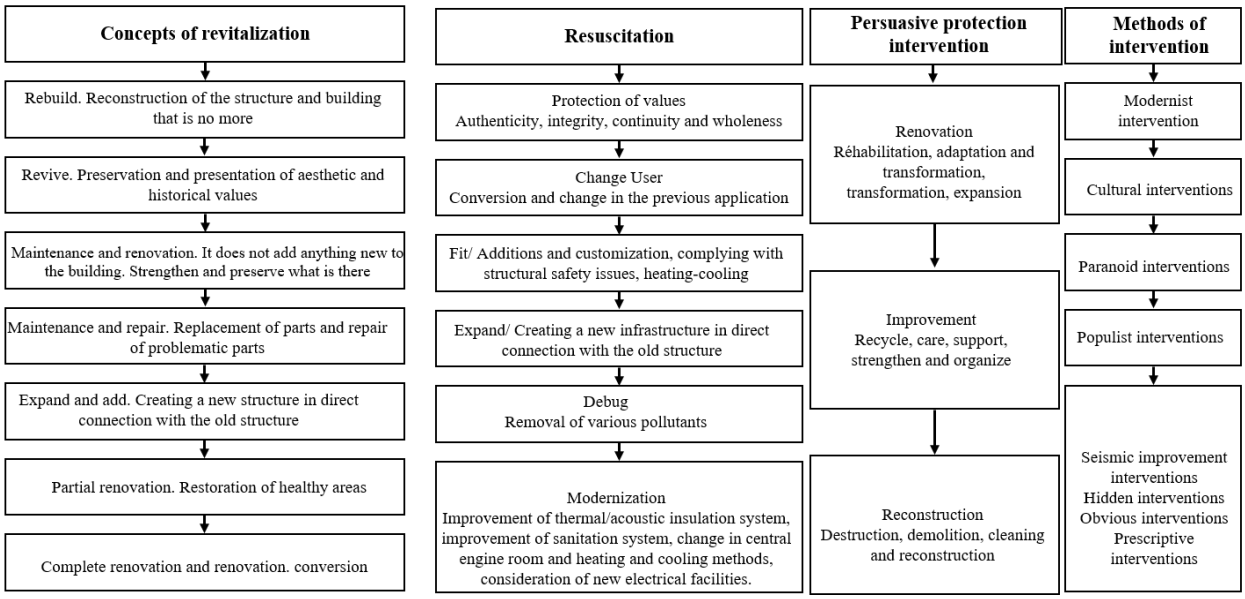

Figure 1. General diagram of resuscitation and intervention methods taken from research literature.

Sustainable Architecture

The concept of sustainability in architecture is not to create buildings that will only last a long time, because a building with a lifespan of several hundred years is not in harmony with the needs of the present time (Pye, 2001: 173). Sustainable architecture is a design method that deals with reducing the consumption of non-renewable resources and optimizing the consumption of renewable resources and states that we can get what we need for survival from the environment (Belniak, 2008: 92).

Sustainable development means providing solutions to the physical, social, and economic patterns of development that can prevent issues such as the destruction of natural resources, the destruction of biological systems, global pollution, climate change, excessive population growth, injustice, and the lowering of the quality of human life (Kusheshgaran, 2011: 157).

Sustainable architecture is a broad term that describes architectural design techniques that are in line with environmental attitudes and formed with the idea of respecting nature (Tavakoli Kazeruni et al., 2023) In fact, this architecture is not a new trend, because in many ancient

civilizations and traditional architectures, including the traditional architecture of Iran, it has existed in a fundamental way, and today, due to the negative consequences of the industrial world, such as increasing air and environmental pollution, the reduction of natural resources, and the energy crisis (Olia et al., 2023). It has become one of the most important concerns of people in the present age (Vinas, 2009).

Compatibility

The history of using this word in the literature of the management field is more than 50 years (Tsaur et al., 2014) in management and psychology, adaptation means the proper integration between the needs and capabilities of a person and the supply and demands of the environment.

Spokane, Meir Catalano, (2000) according to another definition, adaptation is the set of actions and behaviors that a person shows in new situations and conditions in order to provide appropriate responses to existing stimuli (Amani et al., 2012: 16). Edward Hall defined adaptation as the encounter of cultures with each other or a culture with new spaces and believes that when the effort to reorganize the space begins, the person has begun to adapt himself to the environment (Hanan, 2012: 152). Karl Steiner has defined compatibility as the coordination between the characteristics of the physical form of an environment and the characteristics of its activities, and he believes that to evaluate compatibility, both the qualitative relationships - form - activity and their quantitative relationships can be examined (Jusan, 2010). Lynch used compatibility in urban spaces and believes that compatibility has three different types, which are type compatibility, is the coordination between the type of activity of a place and the type of its form. Density compatibility, which is the coordination between the busyness of a place's activity and the spatial and informational density of its shape, and importance compatibility, which is the coordination between the importance of a place and its physical form. In an explicit definition, Moore (2014) defines adaptation as the degree of harmony between human needs and the capabilities of the environment (Moore, 2014). In his research, Shin (2016) also considers adaptation to be the process of optimizing the relationship between humans and the environment, and it is an endless cycle. Regarding residential space, Festinger (1962) believes that residents are trying to achieve the highest level of compatibility between what they have made of the living space in their minds (ideal environment) and the actual living space of the original environment (Festinger et al., 1962) in general. In research that has paid attention to the issue of compatibility, we come across two main approaches

1. Some have focused on the results of human-environment compatibility, such as satisfaction with the environment and improvement of living conditions (Jusan, 2010; Musiol and Boehnke, 2013; Altaş and Özsoy, 1998; Galster and Hesser, 1981; Jansen, 2014).

2. Some strategies of people to create compatibility between themselves and the built environment have been studied. (Brown and Moore, 1970; Pickvance, 1973; Morris and Winter, 1975; Angell, 1984; Parrot, 1985; Ann Lodi and Raedene Combs, 1989; Baum and Hassan, 1999; Crull, Bode, and Morris, 1991; Steggell et al., 2003; Helderman et al., 2004; Ferreira et al., 2004)

For example, Ann and Ryden used the term housing adaptation in their research as equivalent to adaptation strategies. They consider housing adaptation as strategies that are used to better meet the needs in housing, and its goal is to achieve better housing; In other words, housing adaptation can be interpreted as overcoming normative deficiencies in housing (Ann Lodi and Raedene Combs 1989). Morris and Winter have defined adaptation in the context of the relationship between family and housing. They believe that the behaviors and strategies that the family performs throughout its life to always be able to meet its needs from housing are called adaptation (Morris and Winkel, 2009).

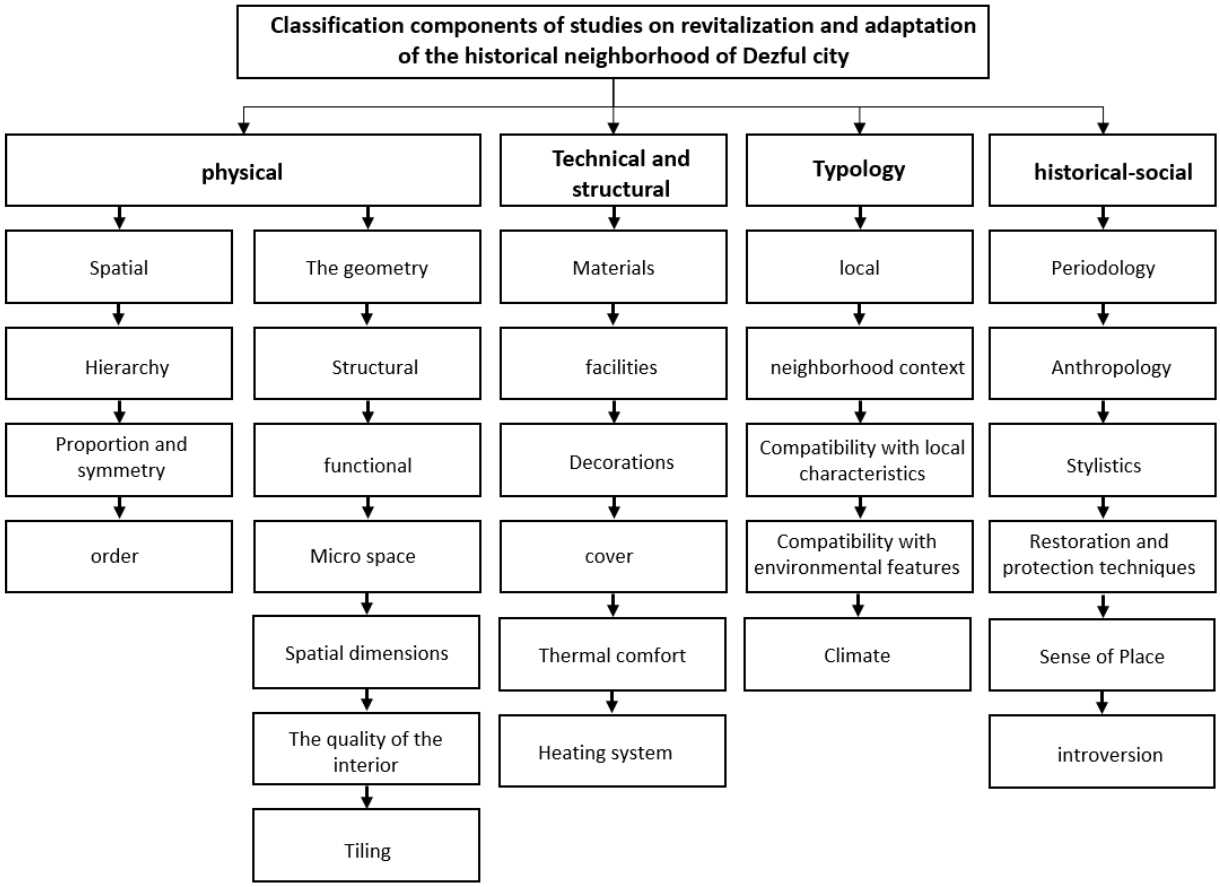

Figure 2. Research components for revitalization and adaptation of historical houses in Moghadamian neighborhood.

In 2019, Kamranifar in her thesis titled "Restoration plan of Azar Dezful house with feasibility approach of restoration", after studying and presenting the findings in the form of literature, tries to analyze the experiences of Reconstructed and revived studies. The purpose of this thesis is to design a social space by considering the effective factors in creating a sense of place and then using the obtained components in the design of the desired space in order to achieve a desirable environment.

In 2016, in his thesis entitled "Revitalization of Tuideh Neighborhood of Noushabad City Based on Sense of place criteria", Mazifian investigated the dimensions of different dimensions of sense of place and its role in the revitalization of the historical Tuideh neighborhood of Noushabad City. The results show that the physical-social cohesion of the Tuideh neighborhood will be realized as an integral part of the historical context and connected with it, relying on the revitalization of the whole city. Formulating the type of relationship between the audience (residents and tourists) with the body of the historical context, identifying the main influencing elements in the identity of the place, and finally establishing a logical connection between the parameters of the sense of place in the process of revitalization and creating a sociable space are among the achievements of this research.

Galwani and Khanmohammadi, 2014, research is about the necessity of revitalizing historical buildings (case example: Shahr Khoi Khan Caravanserai) with the approach of revitalizing Khan Caravanserai through the establishment of suitable uses in the caravanserai. The obtained results show that the creation of cultural and attractive uses for the Khan Caravanserai will activate and revive the worn-out fabric of the city, especially the Caravanserai building.

Ghanbari and Sharif Khaje Pasha, 2013, their article is about the investigation of the identity crisis in the architecture of contemporary buildings in Gilan. The results of this research show that although the construction industry in Gilan has experienced significant growth in various quantitative and qualitative dimensions in recent years and has depicted novel and at the same time unique effects, it has been disconnected from values, history, and culture. It has caused the disappearance of systematic architecture in people's lives, and contemporary architecture is suspended between the past and the future, so its architecture and construction must be in accordance with the identity, originality, and rich traditions of the earth, which includes all these dimensions.

By reviewing the conducted studies, it is clear that in most of the research conducted in revitalization and conservation and restoration interventions, focusing on the case study is the main approach of the research and in the rest of the cases, generalities and frameworks have been discussed. Also, in most cases, the extraction of intervention criteria has been the main concern of researchers; In addition, in most cases, the intervention is in the urban context and no single buildings or historical monuments that need a clear restoration approach. On the other hand, in

some cases, criteria and criteria have been investigated, and the rest of the research is devoted to the investigation of methods and procedures. This issue reveals the necessity of categorizing the methods of intervention and the reasons for the different types of this category. It seems that the types of categories and classifications of intervention definitions are based on the following criteria.

Case Study

Geographical and climatic location of Dezful City

The city of Dezful is part of Khuzestan province in the southwest of Iran and is located at 32 and 25 north latitude and 48 and 28 east longitudes from the Greenwich meridian. This city is located on the east bank of the Dez river and in the southwest of the Zagros Mountain range. This area faces the mountains on one side the Khuzestan plain on the other side and then the Persian Gulf. Therefore, it has a climatic position between the desert and peripheral cities of Fars. The heat of the air in the summer sometimes reaches more than 50 degrees Celsius and the relative distance from the Persian Gulf (about 250 km) reduces the air humidity; Therefore, it has a warm and semi-humid climate.

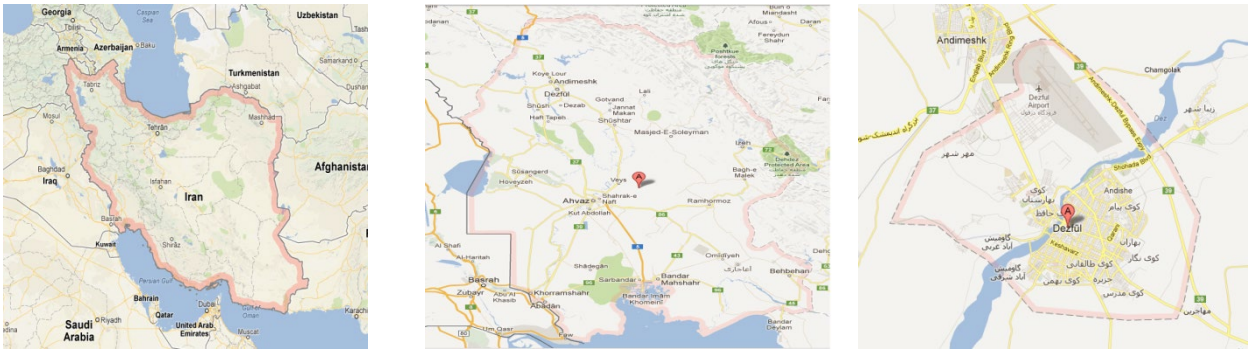

Figure 3. Google Map database, 2019

The climatic conditions of this city require dense architecture with a lot of shade and blinds. In the old context of this city, there are many narrow alleys and sabbats. This city is built on a conglomerate rock formation and has a height above the river Dez, and has always benefited from the clear and cold water flowing from the Bakhtiari mountains Figure 3.

Moghadamian neighborhood

The results of the housing population census show that the highest population density in the old context of Dezful is related to the northern part of Shariati Street, that the population density of peaks in this section is generally between 300 and 600 people per hectare, and it is considered

the densest part of the area, which is the neighborhood Moghadamian is also placed in this section.

Moghadamian neighborhood is limited to the Kattan neighborhood from the north, the Lurian neighborhood from the south, the Sarmidan and Sakian neighborhoods from the east, and the Dez river bank from the west. Moghadamian and Kat Katan neighborhoods were formed next to a part of the Dez river bank called Rana. Centuries ago, the river bed was at a much higher level than the current level and almost in line with the current location of these areas. Due to the extremely hot weather in the summer season, the early residents of this area used the proximity of their residence to the clear water of the Dez River and created their living spaces in the form of hand-cut holes in the coastal wall. Examples of these coats can be seen in Azar's house. It should be mentioned that there are examples of these coats on the western side of the Dez River bank, which is used as a summer resort for people. Moghadamian neighborhood is known by this name because of the presence of an influential person named Haj Gholmareza Moghadamian who had dealings with Khanin. It is necessary to mention that the mentioned neighborhood is located on the land of Mahori Hill and at a higher level than the river bed, and for residents to access the river water, the neighborhood is connected to the river bank by means of stairs, which include the Moghadamian stairs and Bandar Abdullah Neychit pointed out. Ni Chit is one of the traditional artifacts of the Dezful people, which is made by finding and connecting long reeds together. In the old days, people used to sleep under the roofs and sometimes one roof was a resting place for several families, they used reeds as a barrier Figure 4.

All the residents of the Moghadamian neighborhood are natives of Dezful City, Shiite Muslims, and speak with Dezfuli dialect. According to the statistics obtained from the questionnaires, the gender composition of the neighborhood is 312 men and 288 women. Despite the migration of many of the original residents of the neighborhood, the old residents of the neighborhood still have the largest percentage of residence time, which includes more than 80 plots according to the field survey and with the help of questionnaires. In the picture below, neighborhood 8 is the neighborhood under study (Moghadamian neighborhood). According to the aerial photographs of different years of the Moghadamian neighborhood and the surrounding area of Azar house, it can be concluded that from 2009 to 2019, there was no significant destruction and change in the texture, and the greatest change occurred between 1998 and 2009. As can be seen, the road construction of Dezful coastal road, which is one of the main traffic routes in Dezful, has not caused any damage to the Moghaddmian neighborhood except for the loss of direct connection between the neighborhood and the river, and this neighborhood is one of the healthiest old neighborhoods in the old context of Dezful city.

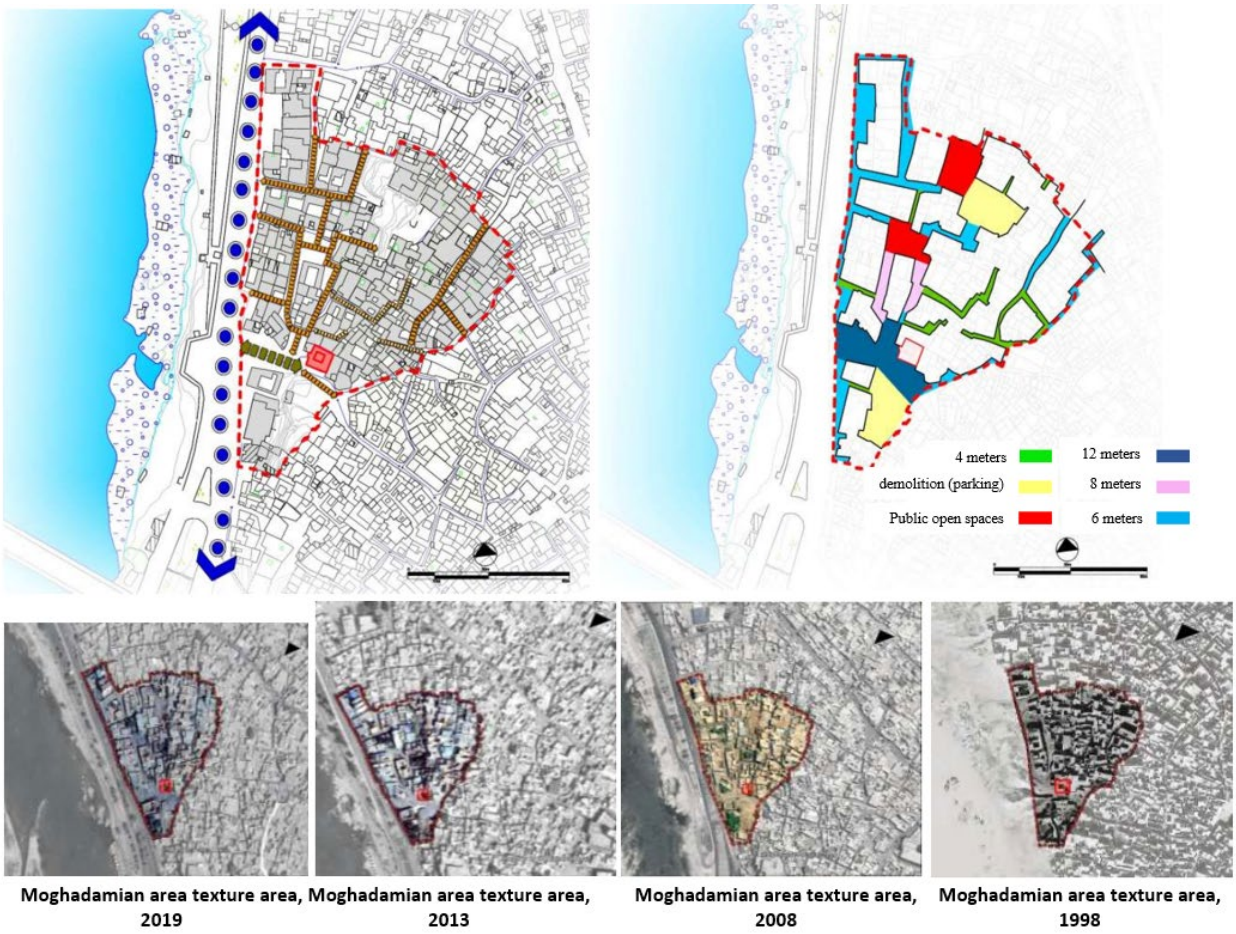

Figure 4. Access to Moghadamian neighborhood

The duration of residence is a suitable indicator to measure the interest and stability of the residents in the neighborhood. Also, this issue can show the willingness of residents to participate in improvement and renovation projects. However, what this index provides is more related to the category of tissue migration. The higher the number of newly settled residents, the greater the migration potential of the area. According to the results of the questionnaire, about 38% of the residents have been living in Baft for more than 20 years. Also, 44% of households have lived in the area for less than 10 years. About 90% of immigrants have entered Bafat in search of housing according to their financial ability Figure 5. People looking for work and families forced to migrate due to job transfer each make up 4% of immigrants.

Figure 5. A view of the historical houses of Moghadamian neighborhood.

Research Method

In terms of method, this research is based on the description and examination of the structures of houses in the Moghadamian neighborhood in Dezful City. On the other hand, data collection has been done through library and field methods such as questionnaires and interviews. From the point of view of genealogy, it is considered a survey and examines the conditions and relationships in the historical houses of the old neighborhood of Moghadamian. In fact, the

research method is mixed (qualitative and quantitative). The strategy of this research is induction, and it is actually a descriptive and in-depth research; Because the houses of the old neighborhood of Moghadamian in Dezful city have been studied deeply and widely. Its purpose is to study and understand all the variables related to the historical houses of the Moghadamian neighborhood in order to achieve the way of revitalization and compatibility with the approach of sustainable architecture. In this research, the researcher designed questionnaires for experts and restorers of traditional buildings. The purpose of using this method is to evaluate the information of these people about the methods used in the construction, restoration, intervention process, and revitalization of these buildings Figure 6. For this reason, the questionnaire was sent to the statistical community of experts in different stages. But due to the specificity of the subject and the inadequacy of the information obtained through the questionnaires, it was necessary to directly interview some people involved in the restoration of historical houses. The questions included the following:

1. What issues and problems do the historical houses of Moghadamian neighborhood in Moghadamian neighborhood face?

2. What components of the intervention can play the greatest role in the process of revitalizing the historical houses of the Moghadamian neighborhood?

3. What challenges and obstacles are there to reaching the appropriate use in the stage of the redevelopment of historical houses in the Moghadamian neighborhood? What are the appropriate strategies and criteria for the revival of historical houses in the Moghadamian neighborhood?

4. What kind of interference has been created in the historical houses of the Moghadamian neighborhood during construction?

5. What institutions or organizations should be involved in the process of revitalization and adaptation of the historical houses of the Moghadamian neighborhood that currently do not have a role in this process or their role is not properly defined?

6. How can we achieve a conceptual model of sustainable intervention in the revitalization and adaptation of historical houses in the Moghadamian neighborhood?

According to what has been said about the Delphi sample, there is a possibility of participants dropping out during the research; In this way, 63 people were selected from the beginning of the research, with the aim of remaining between 30 and 40 participants. The size of the participating population during the different stages of Delphi was as follows:

In the first questionnaire, the questions were asked in an open-ended manner and were given to 12 Delphi members, of which 7 were faculty members and 5 were cultural heritage experts.

In the second stage of Delphi, questionnaire questions were designed with 22 indicators based on the Likert spectrum, and 17 faculty members and 13 cultural heritage experts answered. The questions were analyzed with the Delphi technique

The questions of the third stage questionnaire were designed on the basis of the second stage questionnaire in the form of a Likert scale, and 15 faculty members and 13 cultural heritage experts answered. These questions were analyzed with the Delphi technique.

Based on the information obtained from library studies, questionnaires, and interviews, both qualitative and quantitative methods of analysis have been used simultaneously to review the data and information collected on the way to achieve the research goals. By using the interpretation of old pictures, historical maps of houses, and the use of qualitative content analysis, each of the sub-spaces that make up the historical neighborhood has been extracted and analyzed after separating them; The indexing of the indicators as well as the weighting of the sub-indices taken from the research questionnaire has been done using the multi-indicator decision-making model (AHP) method. The validity of this research is based on content validity. Usually, experts in the studied subject determine the content validity of a test. To increase the credibility of this research, a questionnaire was prepared, derived, and combined from two primary questionnaires. The validity of the research questionnaire has been checked by ten experts and is also based on the opinion of the supervisor. In this questionnaire, the reliability of the whole questionnaire is 0.878, which becomes 0.880 after standardization. Then, with the information obtained from the studies and their compatibility with each other, it is possible to reach the desired results regarding the presentation of a conceptual model for the revitalization and adaptation of the Moghadamian neighborhood with a sustainable architecture approach.

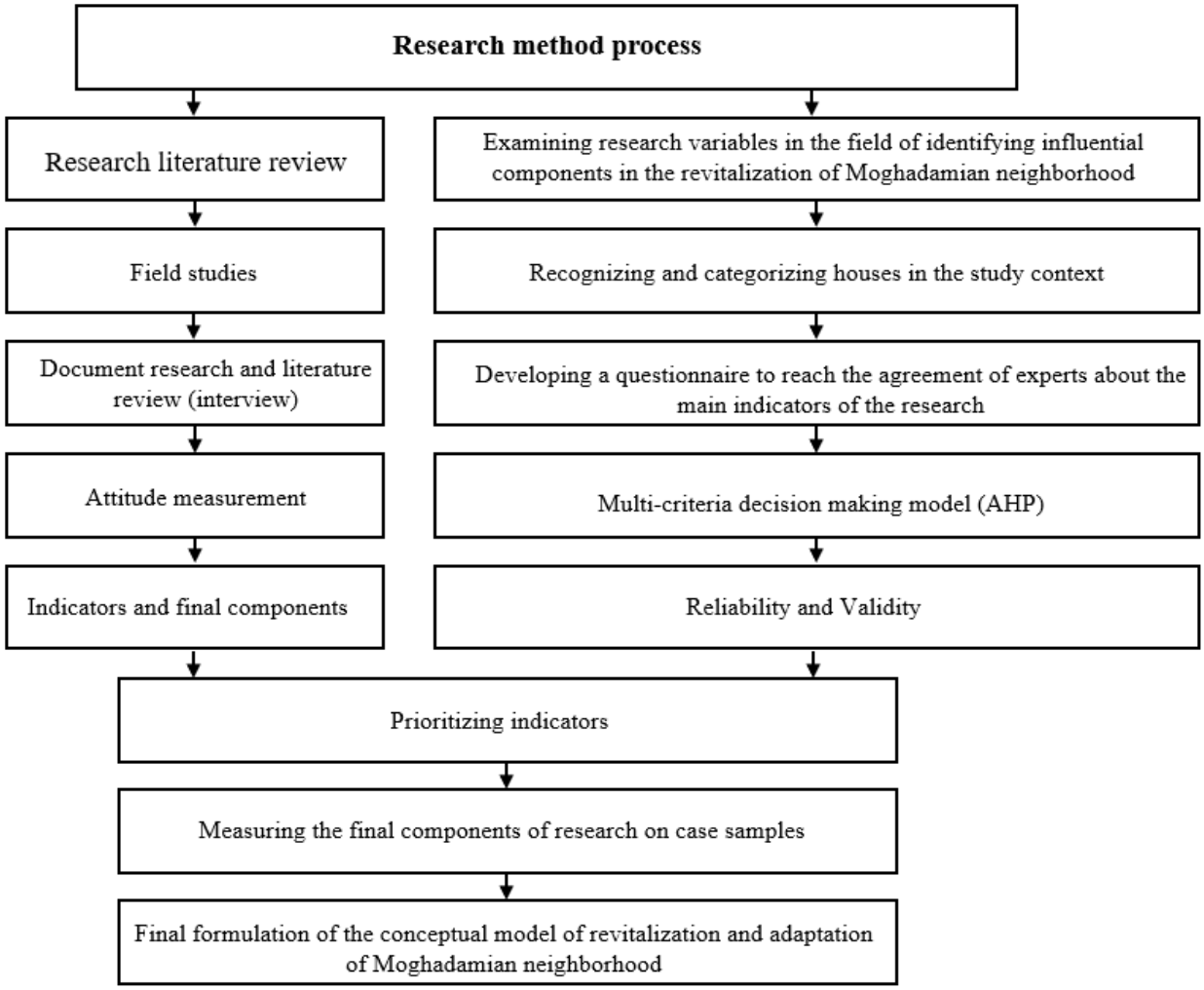

Figure 6. The process of the research method.

Research Findings

In order to evaluate the influential indicators in developing the conceptual model of intervention in the revitalization of historical houses, questionnaires were distributed and completed among cultural heritage experts. After completing and collecting these questionnaires, they were coded and entered into SPSS software. Data analysis was done based on frequency distribution tables, in this chapter attention is paid to the results of research data analysis. In addition to Delphi questionnaires, Analytical Hierarchy Process (AHP) model and CHOICE EXPERT software were used to check other relevant information, and the details and stages of the work were compiled and analyzed in the form of two research phases.

Analysis of the first phase of Delphi

The concepts extracted from the research literature and interviews were carried out in the preliminary stage with 12 experts in the field of restoration and an open questionnaire was provided to the experts. According to the review of the research literature and using the content analysis method, 101 codes were extracted to achieve the research indicators. The extracted codes are as described in the Table 2.

Table 2. Concepts extracted from the research literature and interviews of the preliminary stage about the revitalization and adaptation of Moghadamian neighborhood in Dezful city with sustainable architecture approach.

Basic coding				Conceptualization of primary code	Category
Quality of extensions	Quantity, how to implement	During the intervention, respect, material	Documenting evidence of distortion	Minimal intervention, Reversible, repeatable Maintaining maximum available materials Same original form and scale Skilled people, originality	Quality of intervention
Compliance	Amount of intervention	Physical conditions	Structure	Protection, historical effect, level of intervention	Limits of intervention
Integrity	Development	Body	Quality of the environment	Improvement, renovation, renovation, maintenance, keeping fit, concealed, prescriptive, overt	Methods of intervention
Heritage	Rules	Framework	Instructions	Pay attention to the rules	Legal rules and regulations in historical monuments
Economy	Project	Fund	Profitability	Financial facilities, government departments	Funding and cost resources
Cooperation	People's participation	Restoration	Point of view	Integrated management, increasing the sensitivity of officials to revitalization	Satisfaction and cooperation of owners, trustees and policy makers
Changes	Expanding and adding to the building	Construction	Space	Strengthening the sense of place, creating new spaces, additional components, stylistic reconstruction	Modernization
Consonance	Increase the life of the building	Changes	Granting a user	Degree of concordance of the building, proportionality	Adaptability and programmability
Original patterns	Cultural significance	Building capacity	Respect for texture	Preservation of physical values, form and appearance of the building, strengthening	Compatible user
Restoration	Destruction	Complication	Natural factors	Pathology, damaging factors	Documentary
Assimilation	Heat	Humidity	Light	Sound comfort, visual comfort	The quality of indoor spaces
Liming	Tiling	Miniature	Native materials	Removal, transfer, style, maintenance	Maintain home decorations
Economy	Prosperity	Opportunity	Tourists	Reviving and functionalizing houses, paying attention to cultural values,	Development of the tourism industry

				strengthening infrastructure	
Thermal comfort	Orientation of the building	Facility heating system	Climate of the region	Manufacturing techniques, skilled and expert people	Specialized implementation
Building height	Sustainability	Building load	Coordination with the structure	Geometry, proportionality of spatial dimensions	Physical features of Moghadamian neighborhood houses
Spatial complexity	Ease and accessibility	Between the greenhouse, Bineh, Chal Hoz	Quadrilateral plan, entrance	Micro space, programmability	Spatial situation of the sub-spaces of historical houses in Moghadamian neighborhood
Local employment	Economic activity	Resuscitation	Level of living	Performance injection, building activity, social solidarity	Social and economic development
Getting attention	Informing	Promotion	Education	People's participation, people's institution, cooperation in the project	Interest groups and local people
Adaptation	Debugging	Modernization	Protection	Methods of renovation, change, use	Methodology of revitalization and revitalization of houses
Health considerations	Specialized working group	Management	Push	Staging, intervention strategies	Development of management plan
Building upgrade	Amount of destruction	Repair	Shape of space	Partial renovation, regular renovation, complete renovation	Spatial intervention in houses
Cultural beliefs	Social structures	Culture	Historical identity	Recognizability of time and historical layers, preservation of historical identity, architectural and aesthetic values	Historical-cultural and functional values

Analysis of the second phase of Delphi

After conducting the interviews, a structured questionnaire was prepared in the preliminary stage to achieve the research objective. In the second stage of Delphi, after initial and back-and-forth reviews and changes made to the questionnaire, 22 indicators with items suggested by experts were provided to 30 Delphi members and they provided their quantitative and qualitative opinions. In this period, the purpose of the research was again reminded to the participants and they were asked to give their opinions only about determining the indicators, regardless of how the indicators are measured.

Analysis of the third phase of Delphi

After collecting the data in the third stage of the Delphi method, to find the level of experts' agreement with each index, the sum of the scores and their average were first used. In this course, in general, 22 qualitative indicators, 2 exclusion indicators, and 20 indicators related to priority

indicators have been used to develop a conceptual model of intervention in the revitalization of historical houses in the Moghadamian neighborhood Table 3.

Table 3. Statistical analysis of the Delphi table.

Category	Sub criterion	Average	Middle	Mode	Number of quality comments
Quality of intervention Limits of intervention Methods of intervention	The visibility of historical evidence in the interventions made in historical houses	3.57	3.00	3	2
	Preservation of existing materials and reversibility of interventions and additions in the revival of historical houses	3.14	2.00	2	0
	Maintaining the originality of the building with the same form and scale in historical houses	3.89	2.00	2	2
Legal rules and regulations in historical monuments Funding and cost resources Satisfaction and cooperation of owners, trustees and policy makers	Compliance with the permitted level of intervention in the body of historical houses	3.43	2.00	1	1
	Preservation of historical works according to the type of structure and physical and environmental conditions of historical houses	3.17	2.00	2	0
	Using the capacity of the building with minimal interventions	3.36	2.00	2	0
Modernization Adaptability and programmability Compatible user Documentary The quality of indoor spaces	Using the improvement method, especially in the physical field, to integrate and preserve the integrity of historical houses	3.54	2.00	2	1
	Renovating and preserving existing proportions in historical houses	3.18	3.00	3	2
	Using the reconstruction method to complete and achieve the destroyed parts of historical houses	3.23	3.00	3	0
	Considering the improvement of tremors in overt and hidden and prescriptive interventions in maintaining and maintaining the houses as a whole	2.35	2.00	2	0
	Using non-physical methods such as works of art to make the historical monument more readable for observers	3.25	2.00	1	2
Maintain home decorations Development of the tourism industry Specialized implementation	Considering the methods, framework and principles of appropriate intervention	3.18	2.00	2	1
	The requirement to implement the considered rules and regulations along with compliance with the rules and regulations of the intended use area in the houses	3.18	2.00	2	0
	Eliminating legal gaps and developing executive regulations in the field of revitalizing historical houses	3.64	2.00	1	0

Physical features of Moghadamian neighborhood houses The spatial situation of the sub-spaces of historical houses in Moghadamian neighborhood Social and economic development	Allocation of financial facilities from the government for revitalization projects of historical houses	3.68	2.00	1	2
	Driving and paying attention of the stakeholders to the profitability of investing in the revitalization of historical houses	3.31	2.00	1	0
	Attracting capital in television programs or holding side events to attract public and charitable donations	3.65	2.50	1	1
Interest groups and local people Methodology of revitalization and revitalization of houses Development of management plan	Increasing the sensitivity of the officials to wear and tear and possible and irreparable damage to historical houses	3.00	1.00	1	2
	Integrated urban management in the field of revitalization of historical houses among officials	3.54	2.00	1	0
	Pushing the owners to revive and use successful national and transnational experiences while avoiding any uninformed imitation.	3.36	2.00	1	0
Spatial intervention in houses category Quality of intervention	Creating new spaces in the revitalization process considering the role of strengthening the sense of place and preserving the urban identity of houses	3.43	2.00	2	1
	Reconstruction and creation of new space (expansion and addition) according to the climate of the region and the historical character of the houses	3.32	2.00	3	0
	The requirement to consider any possible future changes in the lifestyle of the residents of the historical context around the historical houses, the feasibility and feasibility of the revitalization plan	3.21	2.00	2	0
	The need to include all amenities and comfort for users	3.00	2.00	2	0
Limits of intervention Methods of intervention Legal rules and regulations in historical monuments	Coordinating the adaptation of the new function and its requirements with the body of historical houses	3.39	3.00	2	1
	The degree of coordination of the new function with the previous use of the building in the revival of traditional houses	3.27	2.00	1	0
	Coordination of new performance according to the needs of society and people	3.71	2.00	2	1
Funding and cost resources Satisfaction and cooperation of owners, trustees and policy makers	Preservation of physical values in revitalization and giving use to historical houses	3.72	2.00	1	2
	Fortification and preservation of authentic patterns in accordance with the form and appearance of historical houses	3.14	2.00	1	0

Modernization	Coordination of new components added to the house with old components	3.89	2.00	1	0
Adaptability and programmability Compatible user Documentary	Providing thermal and environmental stability and comfort for users in historic house spaces	3.13	2.00	1	2
	Matching the interior furniture of the house with the proposed use	3.56	1.00	1	0
	Enhancing the sense of place in the interior spaces of houses	3.18	2.00	1	0
The quality of indoor spaces Maintain home decorations Development of the tourism industry	The importance of knowing the natural and human factors effective in the erosion of houses and preventing the factors that damage the building	3.79	2.00	2	0
	Knowing the historical intervals of the houses to achieve a suitable restoration plan	3.14	2.00	2	0
	Showing the documents and historical periods of the work in the building site in a visual form, telling the stories of the events that happened in different places of the historical houses.	3.54	2.00	1	0
Specialized implementation Physical features of Moghadamian neighborhood houses The spatial situation of the sub-spaces of historical houses in Moghadamian neighborhood	Maintaining and preventing the removal and relocation of decorations related to the building according to the style used in historical houses	3.57	1.00	1	1
	Preserving the sanctity of works of art in historical houses by observing the hierarchy of valuation	3.81	1.00	1	0
	Restoration, redrawing and display of current and previous decorations of houses	3.71	2.00	1	0
Social and economic development Interest groups and local people Methodology of revitalization and revitalization of houses	Revival and functionalization of historical houses as an opportunity for prosperity and development due to the presence of tourists	3.89	1.50	1	2
	The need to strengthen political, economic and social infrastructures in order to attract more national and international tourists in the surrounding areas of historical houses.	3.76	1.50	1	0
	Attention to cultural values along with tourism development	3.23	1.00	1	0
Development of management plan	Using specialized working groups familiar with construction techniques to intervene in houses according to the climate of the region	3.57	1.00	1	0
Spatial intervention in houses category Quality of intervention	Updating the science and knowledge of restoration specialists involved in the restoration of historical houses	3.04	1.00	1	2
	Taking health considerations into account when renovating homes	1.25	2.00	1	1
	Preservation of existing structure and geometry in the body of historical houses	3.86	1.50	1	0

	Application of historical houses according to physical characteristics and spatial proportions	3.40	2.00	1	0
Limits of intervention Methods of intervention Legal rules and regulations in historical monuments	Identifying and redefining the sub-spaces of traditional houses based on revitalization and programmability capabilities	3.89	1.00	1	1
	Investigation and analysis of the architecture used in the small spaces of historical houses	3.96	1.00	1	0
	The influence of small space dimensions in granting the use of houses	3.86	1.00	1	0
Funding and cost resources Satisfaction and cooperation of owners, trustees and policy makers Modernization	Raising the standard of living of the residents with economic activities through the restoration and revitalization of historical houses	3.71	2.00	2	0
	Creation of local employment centers, prosperity of handicrafts through the revival of historical houses; This development should not come at the cost of losing the residents' previous abilities	3.84	1.00	1	0
	Employing local forces for the self-sufficiency of residents by creating job opportunities	3.92	2.00	2	0
Adaptability and programmability Compatible user Documentary	Attracting the opinions of stakeholders, including officials and people of the region, and the possibility of people's participation in revitalizing houses	3.52	2.00	1	0
	Education and public awareness in the field of revitalization of traditional houses	3.71	2.00	1	1
	Attention to the effective position of people's approach in revitalization projects	3.86	2.00	2	0
The quality of indoor spaces Maintain home decorations	Considering practical methods in the reconstruction of historical houses	2.25	2.00	1	2
	Developing operational strategies for revitalizing houses	1.82	2.00	1	0
Development of the tourism industry Specialized implementation	Prioritizing different stages of restoration in the revival of historical houses	3.82	1.50	1	0
	Pushing the custodian organization towards continuous supervision in the restoration process of historical houses	3.86	2.00	2	0
Physical features of Moghadamian neighborhood houses The spatial situation of the sub-spaces of historical houses in Moghadamian neighborhood Social and economic development	Adhering to proportionality in the amount of admission of visitors in the interior of historical houses	2.68	2.00	2	2
	Repairing and preventing destruction and improving the existing condition of historical houses in different stages of restoration	2.88	1.00	1	0
	Coordination in the color of the materials in the interior of the houses	2.50	1.00	1	0

Interest groups and local people	Preserving the architectural and aesthetic values of historical houses in any interventions aimed at revitalization	3.64	2.00	2	1
	Recognizability of the temporal and historical layers of the work in the intervention process aimed at revitalizing the house	3.43	2.00	1	0
	The requirement to preserve the originality and integrity in the process of revitalizing historical houses	3.68	1.50	1	0

The foundations considered for this part of the research are to select the main indicators and the final sub-criteria of AHP, the importance of the main indicators and sub-indices of the research relative to each other in the decision-making process, to develop a conceptual model of intervention in the revitalization of historical houses, is considered as a comparison. In this section, the 20 indicators identified in the third stage of Delphi have been summarized and organized into 11 groups according to the items suggested by the experts for each indicator Table 4. For a pairwise comparison, 18 faculty members and 14 cultural heritage experts have been used. It is important to mention that for better communication of experts, equivalent expressions of each index are mentioned in parentheses and in front of it for pairwise comparison. Definitions of specialized words are needed to enter data into Expert Choice software and perform pairwise comparisons. Using the introduced specialized equations, modeling will be done in the software below. In the table below, an image of the process model is presented.

Table 4. Objectives and indicators of input to Expert Choice software.

Term in Expert Choice	**Main objective**	**Row**
Revival of historical houses in Moghadamian neighborhood	Revitalization and adaptation of houses in the historical neighborhood of Moghadamian in Dezful city with a sustainable architecture approach	1
The term in Expert Choice	Indicator	Row
Criteria 1	Considering the methods, framework and principles of appropriate intervention	1
Criteria 2	Identification and obligation to preserve the authenticity and integrity of the sub-spaces of historical houses in the process of intervention	2
Criteria 3	Attention to the legal laws and executive requirements approved at the national level	3
Criteria 4	Intervention aimed at attracting investors	4
Criteria 5	Intervention with the participation and application of local people's opinions and votes	5
Criteria 6	Staging building restoration operations for optimal management and specialized restoration	6
Criteria 7	Optimization and application of historical houses according to the characteristics of the structure of the work	7
Criteria 8	Preservation of historical values related to the building	8
Criteria 9	Development of the region due to intervention	9
Criteria 10	Intervention aimed at developing the tourism industry	10
Criteria 11	Compatible user according to previous performance	11

Then, consistency in judgments and stability coefficient as well as the final weight of each criterion have been calculated by entering the information of the pairwise comparison table into the Expert Choice software. The factor weight table is given in detail in the third step. The available options are measured according to the double standard. This work has been done in the first stage by using the questionnaire and the opinion of experts. After collecting the questionnaires, the statistical inference of the data was formed and entered into the software, and the results of the final matrix for comparing the indicators and the calculated compatibility rate are shown in Table 5.

Table 5. Pairwise comparison of the main research indicators in the model made in Expert Choice software.

Criteria	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8	Criteria 9	Criteria 10	Criteria 11
Criteria 1	1	-2	2	8	4	5	2	-3	5	5	4
Criteria 2	-2	1	8	8	6	8	5	1	8	8	7
Criteria 3	2	8	1	7	3	2	5	-4	5	7	5
Criteria 4	8	8	7	1	1	1	-3	-7	2	7	-3
Criteria 5	4	6	3	1	1	1	-2	-4	1	2	-3
Criteria 6	5	8	2	1	1	1	2	-4	3	3	-3
Criteria 7	2	5	5	-3	-2	2	1	-4	3	6	2
Criteria 8	-3	1	-4	-7	-4	-4	-4	1	8	9	8
Criteria 9	5	8	5	2	1	3	3	8	1	2	-3
Criteria 10	5	8	7	7	2	3	6	9	2	1	-4
Criteria 11	4	7	5	-3	-3	-3	2	8	-3	-4	1

Compatibility rate = 0.09

According to the pairwise comparison, the research of ranking and weighting of its main indicators is as follows:

The term in Expert Choice software is “Shakhese”.

Examining the results of pairwise comparison of the main indicators of the research

1. Considering the appropriate methods, framework, and principles of intervention
2. Identification and obligation to preserve the authenticity and integrity of the sub-spaces of historical houses in the process of intervention;
3. Attention to legal laws and executive requirements approved at the national level;
4. Intervening with the participation and application of local people's opinions and votes;
5. Intervention with the aim of attracting investors;
6. Staging building restoration operations for optimal management and specialized implementation;
7. Applying historical houses according to their physical characteristics;

8. Preservation of historical values related to the building;
9. Development of the region due to intervention;
10. Intervention aimed at developing the tourism industry;
11. Compatible user according to previous performance.

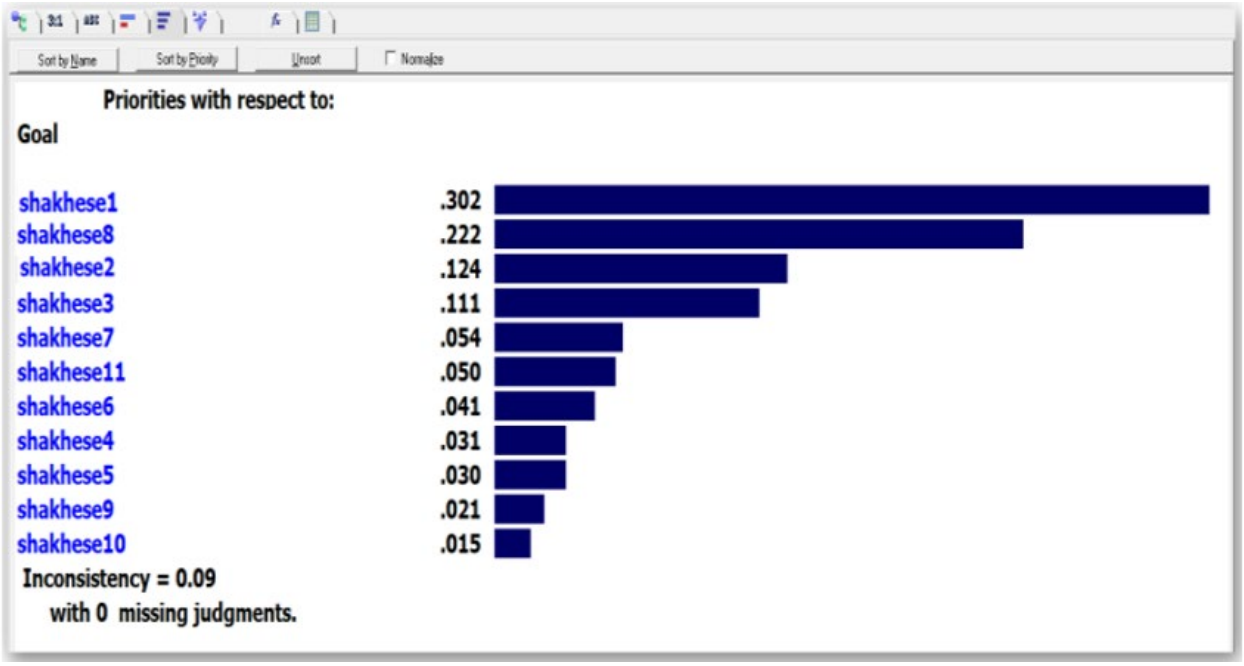

Figure 7. Calculated weights for the main criteria using the hierarchical analysis method.

As it is clear from the results of the hierarchical analysis, index number 2 (paying attention to the importance of recognizing the effect and investigating the spatial condition of the small spaces of historical houses in the intervention phase) has the highest rank with a weight of 0.302, index number 8 (preserving historical values related to the building)) with a weight of 0.222 have the second rank and indicator number 10 (intervention aimed at developing the tourism industry) with a weight of 0.015 is ranked the lowest compared to other indicators. is 0, which is acceptable in terms of numerical standards Figure 7.

Historical houses have always played a role in the formation and consolidation of an important part of social subcultures. Such influence has been accompanied by highs and lows in various periods. Historical houses, due to having a deep connection with the native beliefs and culture of the people, have formed interconnected sets of behaviors and customs. Historical houses are made up of small spaces such as a vestibule, kitchen, hall, and Shahneshin.

This system of formation of small spaces reveals the importance of preserving and stabilizing them in the process of restoration and revitalization of historical houses. Identifying and redefining small spaces through their analysis and documentation as well as coordinating the

restoration plan with the concept and function of small spaces the requirements of the master plan for the restoration of a historical house are from the pathological point of view, not knowing the function of small spaces can lead to the loss of a part of the conceptual and functional organ of the historical house. It is possible to preserve the small space from the process of revitalizing a historical house in several ways:

• Physical preservation without playing a role in the new use in such a way that it reflects its original function.

• The use of small space in the new activity process and showing the primary function through images, tools, etc.

• Maintaining the body without playing a role in the new activity process and strengthening the perception of the basic function for the later users of the building through the display of images of tools and...

• Identifying and requiring the preservation of small spaces as the most important influencing factor identified in the process of revitalizing a historical house requires documentation of all stages and technical recording of actions from the recognition stage to direct intervention in the work.

In houses, the body, as that which expresses and represents the ideas of construction and function in architecture, is an objective entity that includes the volume of the building, structure, materials, and shape characteristics; But the conceptual and semantic part has less objective capability and is perceptual. The spirit and heaviness of the house have meaning in the interior spaces and in the exterior space. At the stage of granting new functions with changes, openings, lights, etc., it becomes difficult to understand and feel the semantic part of old houses. In order to transfer and strengthen this aspect of old houses, it is recommended to leave all the decorations, tools, and signs of the previous building in their place in the new function. Although the awkward connections are in the form of the new function, these few signs are necessary to remember what the predecessors have created. In the meantime, decorations play a special role. Tiling, plastering, brickwork, and limestone are the result of the combination of brick, plaster, and soil; A combination that is perfected only in the context of Iranian architecture. Although in the process of losing the main parts of Iranian houses, few original decorations have been left, those few also deserve to be kept in their original place without any recommendation to add them for the purpose of completing them or embellishing them to attract the attention of the next users of historical houses. be fixed and not completed.

Conclusion

Reviving and giving new life to historical houses in the city bed can lead to the formation of a pattern of supporting cultural heritage from an economic-social point of view and bring economic

vitality to the cultural and social fabric of the society. The specific architecture of houses - due to their special function - is much more complicated than other historical buildings, and this has caused the creation of special spaces in them, by examining and analyzing these spaces and understanding the relationships between them, it is possible to revive and give appropriate use to historical houses. did it in the best possible way. The upcoming research will identify the effective criteria and options for intervention and revitalization of historical houses as the best option for the protection of historical houses.

Based on the table, the measures taken in both historical houses have been evaluated with eleven indicators and thirty-three sub-criteria. For example, other influential sub-criteria, such as earthquake improvement, did not have a place in the restoration intervention process of both houses. Vibration improvement is one of the most complex modern techniques for the stabilization of historical buildings, which is associated with many difficulties in terms of implementation in historical buildings and in practice has led to many interventions in the building and will sacrifice the originality of the stability. Collapsed buildings under restoration are perhaps the best opportunity to implement some vibration improvement in the building. This has not been done in both houses investigated. Identifying and redefining sub-spaces as the first sub-criterion in the most important index from the perspective of the evaluated expert community shows the importance of sub-spaces and perhaps it is more important than the main spaces such as Sarbineh, Hashti, and Miander as index components of old houses; But in the intervention process of Yaqoubieh House, the small spaces have been changed or removed in the first stage of the implementation process. This matter has been accompanied by more caution in Aghanaghi's house. Another profound difference between the opinions of the expert community and what has been achieved in practice in the intervention process of Yaqoubieh House has been the influence of the last indicator on the policy of intervention in the house. The development of the tourism industry as the eleventh indicator, in practice, has become one of the most important indicators, or in other words, the ultimate goal in the revival of Yaqoubieh House. This incident reveals the gap between the view of the specialized community and the policymakers and investors regarding the revitalization of historical buildings; A gap that is not limited to historical houses and practically includes all buildings subject to revitalization. In the historical houses of the Moghadamian neighborhood, the choice of a new function, although it did not conform to the original function of the building, has established a limited activity with the minimum requirement for change in the building.

Author Contributions

All authors contributed equally to the conceptualization of the article and writing of the original and subsequent drafts.

Data Availability Statement

Not applicable.

Acknowledgements

The authors would like to thank all participants of the present study.

Ethical considerations

The study was approved by the Ethics Committee of the Islamic Azad University, CT.C. The authors avoided data fabrication, falsification, plagiarism, and misconduct.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors declare no conflict of interest.

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IJAPAS

International Journal of Applied Arts Studies

Print ISSN: 2588-4506 Online ISSN: 2588-4670

Homepage: www.ijapas.ir

Islamic Azad University
Yazd Branch

Rereading the Reality of Graffiti Based on Hegel's Ideas in a Case Study from Banksy and Iranian Artists' Works

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Article Info

Article type:

Review Article

Article history:

Received May 16, 2025

Received in revised form June 17, 2025

Accepted July 05, 2025

Published online August 15, 2025

Keywords:

Hegel,
Graffiti,
Aesthetics,
Artifact,
Artwork,
The social.

ABSTRACT

Hegel's aesthetics has great potential for reading socially generated, the artwork that reflect the spirit of their times. Because of, for him, artworks are animated by an internally purposive form. He believed artifacts can't be regarded as a living being, in fact they have a given purposive with an external function, for example machine or shoes. Of course, we don't forget that artwork is a production of an artist's mind and specially his/her imagination and this is an inherently infinite possibility. Thus, we want to know the statue of graffiti from Hegelian perspective, especially since it is not a simple or a homogenous phenomenon, and also the relationship between content and form in it. For this reason, we selected some works of graffiti at random to describe and analyze in this qualitative research. Considering that art is one of the stages of Geist's self-consciousness, this could be a way to understand the relationship between beauty, social protest and collective self-consciousness in graffiti works as a whole organic and as artworks not artifacts. Because their purposive and function is as internal dynamics.

Cite this article: Sheibani Rezvani, F., & Bakhtiarian, M. (2025). Rereading the Reality of Graffiti Based on Hegel's Ideas in a Case Study from Banksy and Iranian Artists' Works. ***International Journal of Applied Arts Studies***, *10*(2), 127-144.

Publisher: Islamic Azad University, Yazd Branch.

Introduction

Hegel started from art to complete and carry out his philosophical project in the philosophy of the spirit. In fact, he is concerned with expressing the position of the Geist in reaching self-consciousness, where he leaves the philosophy of the nature for the philosophy of the spirit. The first step for the mind is to depart from the senses through art. Of course, discussion of art is always attached to beauty and truth. But truth is the first for this reason he uses from the term, that is, manifestation or same emanation. On Hegel's view art has only its essential nature, because art is a function of the artist's mind and imagination. Thus, he argues from ontology of art and epistemology of art; there is no doubt that he questioned the relationship between art and truth. Truth is the identity of being and thought, this truth or the Idea is the identity of absolute form and content. This Hegel's view is the ground of the theory of art. In the category of art courses, he mentions from symbolic art classic art and romantic art. Here must be said that classic art for a perfect balance between form and content is noteworthy, because of truth is expressed in the form of human-centered beauty.

For this reason, classic artworks have objectivity unlike modern art, and romantic works of art, in addition to objectivity, enjoy awareness and the manifestation of the spirit.

Hegel divides the arts from two perspectives: 1- in terms of historical-conceptual development (symbolic art, Classical art, and Romantic art); and 2- in terms of specific types of art, including architecture, sculpture, painting, music, and poetry. In this classification, it can be said that most paintings belong to the Romantic arts, because painting focuses on the interior and mental expression, and creates an inner experience with light and color on the surface. Painting tries to escape materiality, moves beyond pure beauty, and expresses spiritual depth along with various emotions.

Hegel's philosophical process in the division of the arts is not simply a historical sequence, but rather represents the gradual evolution of the relationship between idea or content and form: from the unfinished attempt to express the idea (symbolic), to its harmonious realization (classical), and finally, to the transition from tangible form to subjectivity and introspection (romantic). Stace explains: Hegel's philosophical project is the famous dialectical method, in that every idea may have its opposite hidden within it, and this opposite can be extracted or deduced from that idea. Therefore, to understand the process of classifying the art "we consider the first three pillars of Hegel's categories, namely, being, non-being, and becoming" (Stace, 2002: 120).

Then painting is artwork and not artifact. Artifact has decorative and functional aspect and technical skill and must not communicate something beyond itself for example, a cultural, political, social and economic reality or spiritual idea, and it is not its intellectual content. Now we ask from the true of graffiti, whether graffiti is an artwork or artifact?

We want to know what kind of phenomenon is Graffiti. No doubt it is a form from painting because of, graffiti forms through line, color and light on surface, but what is its function? Whether has it decorative aspect? Thus, we want to know the status of graffiti, especially since it is not a simple or homogenous phenomenon. We chose a few works for closer review as case study. Six works from Banksy the famous English artist, and some Iranian artists such as 1lone, GEO, Blackhand, Khamoosh, and Unknown artists, have been randomly selected to answer the main question: what is Hegel's view on artwork as an organic whole and, how does graffiti contribute to consciousness?

Hegel's View on Art

Hegel saw art as an evolving phenomenon. What is the reason for Hegel's evolutionary view? It must be said that everything returns to the Absolute and consciousness. In the words of this comment about consciousness:

It sees Absolute Being partitioning itself out in space, and Absolute Self-Consciousness developing itself in time; and by means of post-Cartesian philosophical concepts, it stands at the point of their fusion-no longer the passive pawn of appearance and accident, but in possession of pivotal reality, and weaving the threads of its own Fate. There still remain, of course, opacities, problems, obstacles; but these no longer appear as alien to consciousness, since consciousness, in full possession of itself and its roots, has the key to deciphering the full meaning of all that appears to it (Kainz, 1979: 184).

Accordingly, we must seek truth and the truth of art in this process. But what is his definition from truth or reality? In response, apparently, we are reaching another central concept, for example:

That the truth is only realized in the form of system, that substance is essentially subject, is expressed in the idea which represents the Absolute as Spirit (Geist) − the grandest conception of all, and one which is due to modern times and its religion. Spirit is alone Reality. It is the inner being of the world, that which essentially is, and is per se; it assumes objective, determinate form, and enters into relations with itself−it is externality (otherness), and exists for self; yet, in this determination, and in its otherness, it is still one with itself−it is self−contained and self−complete, in itself and for itself at once. This self−contained, however, is first something known by us, it is implicit in its nature (…); it is Substance spiritual. It has to become self−contained for itself, on its own account; it must be knowledge of spirit, and must be consciousness of itself as spirit" (Hegel, 2001: 10).

Here we come across the concept of Spirit (Geist). How can art be understood without this central concept, but does this level of abstraction, distance art from the social and reality? The

question is: How is it possible to emphasize on unity or plurality, abstract or concrete thinking in art?

Influence of Dualism or Monism on Art

The long-standing debate in the history of philosophy has always been ongoing between the two trends: dualism or monism. Each trend has been influential in defining art and beauty. It is essential to have both for a comprehensive philosophical system, which Hegel was trying to present, of course, ultimately, to achieve unity. In the words of one commentator:

Any such system must include (and reconcile) two seemingly opposed aspects: the world of physical nature and the world of mind. One is extended in space, the other in time. One is determined by physical forces and laws; the other is supposedly free. There are numerous ways of distinguishing between the two sorts of things which make up the cosmic inventory (Rauch, 1983: 15).

But what role does art play in this project? We have both man and nature in art or space and time and or freedom and lack of freedom. It seems “for Hegel it is the essence of consciousness to be the unity of opposites”, (ibid, 17) then, both sense and reason are necessary, both form and content, both subject and object. Thus, we have a collection in art. Now, the question arises that what is the real or actual, especially in art?

In his view, what is ultimately real (or, in his terminology, what is actual) is the self-knowing spirit. This is not to deny reality to the world in which we live or to ourselves as sensuous beings, but, although these are real, they are not, taken in and by themselves, actual. What is actual is not the real, but the ideal, and Hegel's point might be put, in his own paradoxical manner, by saying that the ideal is more really real than the real. The ideal is the synthesis of concept and reality, or, in art, of meaning and shape. This synthesis is what Hegel calls the Idea. 'The Idea existent in sensible form is the Ideal, i.e. beauty, which itself is truth implicit (Hegel, 1988, ix).

This is enough to know that art and beauty are not unimportant to him. He saw art as essential expression of absolute spirit (Geist) and a key mode of understanding reality. Thus, artistic form cannot be a decorative thing because of it must be expressed spiritual content through it in sensible way. Therefore, artwork is not without function, but what about artifact?

Artifact is a production with an objective end and function, for example, a shoe. It includes a form and a function or end. We don’t seek meaning in artifacts. But meaning or concept is important in artwork; because of art has a historical function in advancing freedom and awareness. Art is part of life human in individual and social dimensions. The distinction between artifact and artwork can be summarized in Table 1, considering the two aspects of form and content in the works of art:

Table 1. Distinction between artifact and artwork (Source: Authors, 2025).

Graffiti	Graffiti as an Artifact	Graffiti as an Artwork
Form	• Mechanical • Repetitive • Static	• Private • Creative • Transformative
Meaning	• Meaningless • Imitative • Decorative	• the carrier of Self-Consciousness • the carrier of dialectics

Art and the Social

Art is a medium to grasp truths about society and world or the human condition, then art cannot be without function, but this function is an essential part of art, because of, art is made by human mind; especially in modern art and Christian art that create a subjective and spiritual experience. In Hegel's thought this is related to the romantic period, in which content or concept is more important.

Although he argued, art loses its central role in modernity and instead philosophy and politics become more important, but how is it possible they're to function without the media? Therefore, it is an inevitable relationship between art and the social.

For Hegel: "…'ethical life', objective and social, i.e. living conscientiously in accordance with custom or established institutions" (Hegel, 1988: xiii).

It is claimed indeed similarly that the final end of the state and the social life of men is that all human capacities and all individual powers be developed and given expression in every way and in every direction (ibid, 48).

Art has the capacity and the vocation to mitigate the ferocity of desires (Ibid, 48) Therefore, considering the ability of art to act as a medium for the help of the whole, the impact of graffiti cannot be ignored. If a mural is a decorative thing, for example, just to decorate a wall, it is more of an artifact than a work of art. Such works are among official murals to coordinate with urban furniture and are made to order, but they are not seen among graffiti works that express the artist's personal or social expression. But other graffiti contains messages for different segments of society. Graffiti encompasses both the natural world and the human world, that is, space and time, and contributes to human self-consciousness and ultimately Geist. It can even be a tool for higher stages such as spiritual experience or a philosophical perception such as the study examples that we will discuss later in this research.

Graffiti and its Origins

Every time we enter an urban space, we are confronted with a multitude of images that are a wide range of commercial and cultural advertisements. Among them, we see informal and non-

commissioned works that are a different experience of underground art. Informal street art chooses the street walls as a medium and turns its back on formal art institutions. Since “the medium is the message” (Lemoine, 2021: 17) street art also has multi-layered meanings. “Graffiti is a form of visual communication, usually illegal, involving the unauthorized marking of public space by an individual or group” (Snyder, 2009: 21).

Despite its informal nature, graffiti is a well-known phenomenon in the world. The process of creating and producing graffiti involves risks such as arrest, injury to the artist, and ultimately the provision of free artwork to the public, which competes with official, commissioned wall art. Sandro Boccola classifies graffiti as a postmodern art form, explaining that the creative methods of graffiti pioneers in America were influenced by Abstract Expressionism and Pop Art (Bocola: 2008: 520-531).

Although the creation and production of graffiti works is initially carried out with individual motivations, it is then expanded with social motivations. The individual motivation in graffiti is related to emotions or feelings such as fear, attracting the attention of the audience, and a sense of liberation. Meanwhile, social expression in graffiti emphasizes the artist's right to the city in addition to his personal expression. In other words, graffiti is a tool for criticizing. Doing graffiti with individual motivations is associated with a feeling of excitement arising from the fear of being arrested while performing the work, while the rush to perform graffiti gives a special quality to the work. The feeling of liberation after expressing an idea in a visual form is one of the things that happens to a graffiti artist. A kind of mental discharge and, as a result, a kind of peace after mental activity is achieved for the artist.

But the origin of street art, including graffiti, emphasizes its social direction. Socially motivated graffiti artists freely choose the content of their work. The graffiti artist chooses the street to interact with people, which is different from a painter whose works are installed on the wall of a gallery or museum. Therefore, the audience of graffiti works is all people and not a specific segment of them. The content of these works deals with issues such as social justice, job security, attention to the oppressed, women's rights, environmental protection, animal rights, and the like.

Although graffiti works in Iran have a shorter history than in the West and are collected through online media due to the lack of official data and information about these works, with the spread of this street art in Iran, we see that these works are in line with street movements in the world. Therefore, studying and analyzing these works as part of world art is essential. Thus, a number of graffiti works with the central approach of this text were randomly selected from among the works of the well-known English artist Banksy and some works of Iranian artists such as 1lone, GEO, Blackhand, Khamoosh, and unknown artist.

In this section, we will attempt to examine and analyze the following works, considering the relationship between form and meaning in graffiti works, and taking into account Hegel's perspective and the social components of the text, including the presence and manifestation of "spirit" (Geist), the logical relationship with the objective world (historical and social reality), the aesthetic stage of the work (symbolic - classical - romantic), and the degree of freedom and self-awareness in the artist's path.

Graffiti Untitled: The Beginning of Expression

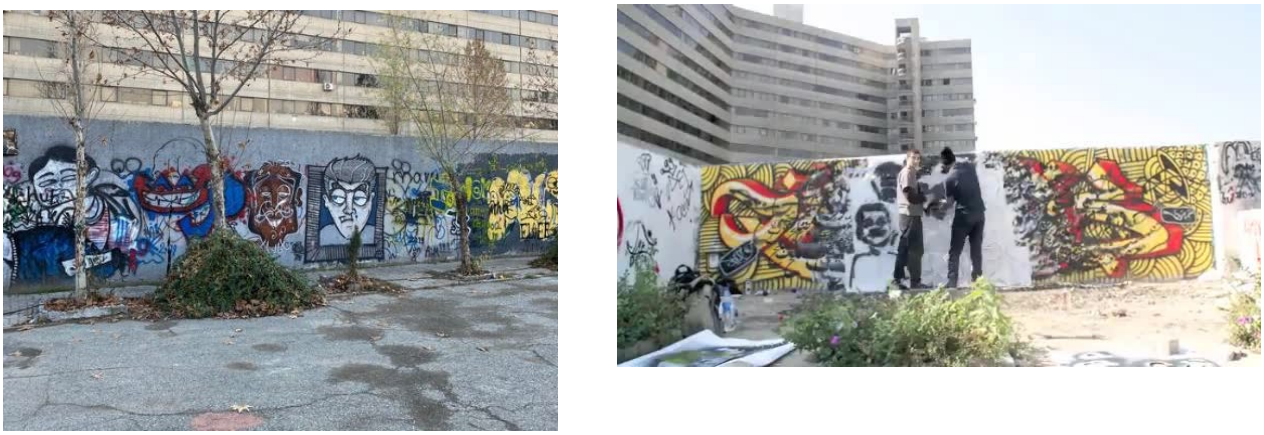

Figure 1. Left & right. (Unknown: 2003-2010) Untitled: Location: Ekbatan, Tehran. (https://mohit.art).

Graffiti with individual motives is usually executed on walls on the outskirts of the city and in informal places, and if its images are not published online, they will not be seen by many people. In Ekbatan, Tehran, walls are covered with meaningless words, incoherent shapes, strange signs, and writings that are often incomprehensible for passersby. This form of graffiti, which on the surface has no clear social message, obvious artistic skill, or coherent form, can nevertheless be considered at the initial stage (symbolic) of Hegel's aesthetic classification. In symbolic art, the Idea is in search of true artistic expression because the form is inadequate to the content (Hegel, 1975: 131).

That is why in Figure 1, the forms are often disproportionate and exaggerated. In crude and meaningless graffiti, there is also a kind of expressive confusion—a desire to say something without having a specific language to say it. At this stage, the graffiti artist registers his presence more than he speaks.

Although these writings and signs may seem meaningless at first glance, from Hegel's perspective, this very meaninglessness is a form of negation of the symbolic order of the city; a negation of the formal language, the dry architecture, the soulless spaces, and the symbolic order on which the city is built. In fact, the graffiti artist in Ecbatana – consciously or unconsciously –

enters into a dialogue with the walls, breaking their stony silence with meaningless writings. If we understand Hegel's philosophical project as a process by which the spirit moves from the unconscious to the conscious, we can say that these aimless graffiti are the initial moment of the spirit's movement. They are not the end of art, but perhaps the "birth" of art at a fundamental level. The spirit has not yet found its language, but it dares to write. In Hegel's logic, this initial movement prepares the ground for a renewed negation, a refinement of form, and the birth of meaning. These graffiti are often unsigned, have no clear identity behind them, and may simply be a teenager' work or a passerby who has decided to leave a mark on the wall to vent their emotional feelings. But from Hegel's perspective, this anonymous act can be a moment of the formation of the subject; a subject who does not yet have a fully developed individuality, but who wants to register itself in the world – even if it is with an invisible word or an endless form. Finally, Ecbatana's meaningless graffiti, despite its chaotic appearance, carries a kind of dynamism of the spirit; a human spirit that begins with wordless writing in its attempt to find language. This is the dialectical beginning that, in Hegel's philosophy is considered as a prelude on the formation of consciousness and meaning. Graffiti as (Figure 1), can hardly be classified as artworks because of its lack of personal style, its imitativeness, and its meaninglessness.

Artist's Signature: The Subject's Expression

Figure 2. Tanha (alone); Location: Ekbatan, Tehren. (1lone: 2003-2010). (https://mohit.art).

In the graffiti (Figure 2), the word "1lone" or "alone" (depending on the interpretation of the writing) is represented in a very abstract and formalistic style. The form here is either abstract or decorative. As a result, the inner content does not fit well with the form. Its readability for the general audience is difficult, and understanding the work requires prior knowledge of art and familiarity with the artist's style and personality.

Here, the forms carry a concept that has not yet been properly and clearly translated into a form understandable to the ordinary audience, just like the Egyptian statues that are for Hegel a

prime example of symbolic art: they appear massive, magnificent, but mute in terms of inner expression.

For Hegel in symbolic art the Idea is still more or less indeterminate and seeks expression in sensuous form, but the form remains incommensurable with the content. The unity of content and form has not yet been achieved (Hegel, 1975: 79).

But at the same time, the artist's signature, which manifests itself in the complex typographic representation, places the artist on the Hegelian dialectic path of transcending form. Here, the artist attempts to aesthetically place his subject in an objective and proportionate body. In the present work, a kind of suspension is seen between the street-social form of graffiti and the individual and mental expression of the artist. The form still carries personal aesthetics, but it is objectified in a public and urban context; this suspension is a sign of the transition from the symbolic to the classical stage. This graffiti can be seen as a manifestation of the dialectical process of art in Hegel's thought; where the idea begins with the impotent form, progresses in the suspension between beauty and meaning, and returns to subjective self-consciousness in the social context. In this work, the individual spirit rises from the complex forms and announces itself on the wall of society.

Since this work carries the idea of self-consciousness that has an aesthetic form and individual style; with its signature shows the creative identity of the artist, it passes through the symbolic stage. Therefore, it cannot be considered an artifact, because we are faced with a self-conscious manifestation of an idea that is non-imitative, dynamic, and therefore it is an artwork.

Water Crisis: Idea and its Manifestation in Form

Figure 3. Water of Life; Location: Tehran. (GEO: 2018) (https://mohit.art).

Figure 3, is one of the well-known graffiti, which has been executed by his graffiti artist several times on different streets of Tehran. In this graffiti, the artist depicted the logo of the

Iranian Water and Wastewater Company in four stages from 2003 to 2018, and visually expressed the gradual decrease in water.

The central idea of this work is the gradual depletion of water resources. In the graffiti, the form of the logo changes from a symbol filled with water to a completely empty symbol. This change is the same gradual manifestation of the idea in matter that Hegel considers the essence of artistic beauty (Houlgate, 2005: 84–87).

The artistic power of this work lies in the bitter humor that arises from the contrast between the formal form of the logo and the collapse of its content. The function of humor in creating this contrast is not only aesthetic, but also conceptual and, from Hegel's point of view, one of the ways to reach the truth (Pippin, 2014: 19)

Art should be a reflection of the cultural, historical, and social conditions of its time. According to Hegel, "No man can surpass his own time, for the spirit of his time is also his own sprit" (Hegel, 2004: 54). As a reflection of the environmental crisis and the general concern of society about water resources, this work is precisely the spirit of his time (zeitgeist) expressed in a visual form. Therefore, given the characteristics we listed for Figure 3, this graffiti is considered a work of art.

Cycling ban: The Spirit on the Path to Realizing Freedom

Figure 4. Cycling ban. Location: Tehran. (Black Hand: 2014) (https://mohit.art).

The Figure 4, depicts one of the most famous graffiti works by the anonymous Iranian artist known by the pseudonym Black Hand. Created in Tehran in 2014, the piece is conceptually considered one of the most important examples of protest street art in contemporary Iran. The graffiti portrays a modern woman wearing the state-mandated hijab, holding a yellow bottle of "Jam" dishwashing liquid in the shape of the FIFA World Cup trophy. Her outfit resembles the

jersey of Iran's national football team. The artist's signature, "Black Hand 2014," appears beside the work.

The work conveys a critical message about the status of women's rights in Iran, particularly highlighting the ban on women entering stadiums to watch football matches. The artist's ironic use of the word "Jam"—which is both the brand name of the dishwashing liquid and the Persian equivalent of the word "cup" or "trophy"—is both clever and sarcastic. It suggests that a woman's share in football is limited to "washing the dishes," rather than participating as a spectator. The juxtaposition of the hijab with the national team uniform symbolizes the tension between the desire for public/national participation and sociocultural restrictions.

From Hegelian perspective, as discussed in The Phenomenology of Spirit, a tragic situation arises when two legitimate but conflicting ethical demands confront each other—surpassing the simple opposition of good and evil. In the classical example of Sophocles' Antigone, Antigone represents the familial (divine) law, while Creon embodies the law of the state. Both positions have moral legitimacy, yet are practically incompatible (Hegel, 1977: 266). A similar structure is present in Black Hand's graffiti: on the one hand, the woman in a football uniform symbolizes the demand for civic engagement and public freedom; on the other, the sociopolitical system of the Islamic Republic claims to preserve religious-moral order by restricting women's presence in stadiums. Both claims possess relative legitimacy, and it is precisely this conflict that forms a modern cultural tragedy.

Hegel's concept of Aufhebung (sublation) simultaneously means "to cancel," "to preserve," and "to transcend." In the Phenomenology of Spirit, Hegel writes: "Aufheben in the German language has a dual meaning... it means both to cancel and to preserve... the resulting unity expresses a higher truth" (Ibid: 41). In this artwork, the substitution of the World Cup with a dishwashing liquid bottle challenges both traditional symbols of victory and gender roles. The domestic object is elevated into a symbol of public triumph. This transformation of meaning is a clear expression of the Aufhebung process: the meaning is not merely negated, but preserved and redefined at a higher level.

As Hegel notes in his Lectures on Aesthetics, "Art is the sensuous appearance of the Idea" (Hegel, 1975: 103). From this viewpoint, art serves as a medium for expressing complex philosophical and political ideas in an accessible form. In Black Hand's graffiti, the notions of gender exclusion, public protest, and political satire are all conveyed through a single visual image. The woman, within a context of social denial, appears bearing a symbol of victory. The piece manifests the Geist (spirit) in its historical self-revelation (Hegel, 1977: 41).

The artwork not only reflects cultural struggles but actively participates in the historical process—by exposing contradictions and opening a path toward their resolution.

Long Live Hope: Manifestation of the Spirit in Art

Figure 5. Long live hope Location: Tehran. (Khamoosh:2020) (https://mohit.art).

Figure 5, is an example of contemporary street graffiti in Iran, attributed to an unknown Iranian artist with the pseudonym "Khamoosh". This graffiti depicts a child (or teenager) running, wearing a face mask, holding two bottles of water. The background of the work is a concrete wall of the city, with an air conditioner visible in the corner of the image. Below the image are several bicycles (possibly rental or shared), which create an interesting composition with the image, as if the child is moving among them. On the right side of the image, spray-painted in red: "Life must go on" - a short but profound sentence, with a strong emotional and social charge. The face mask on the boy's face clearly refers to the era of the Corona pandemic. The running child is a symbolic sign of movement, life, continuity and hope, while the mask and water bottle indicate crisis and care. The phrase "life must go on" has a completely hopeful function, and the message is one of encouragement to persevere and continue in the midst of crisis.

In the Phenomenology of Spirit, Hegel explains that the progress of the spirit towards consciousness always passes through a path of contradictions and tensions. The contradiction between the critical biological situation (mask, epidemic, disease) and the movement of the child (sign of life, energy, future) is a manifestation of the contradiction between limitation and liberation, death and life, stasis and dynamism. The spirit reaches a higher level only through the conflict with itself and the resolution of this conflict (Hegel, 1977: 41).

As explained in the previous work, the key word Aufhebung, for Hegel, means the negation of something and its preservation at the same time. The child with the mask symbolizes the negation of the previous normal state, but his movement symbolizes the continuation of life and the passing of the crisis. The water bottles in his hands are both a reminder of caution and protection, and a sign of survival. It is as if the meaning is negated from the heart of the crisis, but redefined in a new and sublime way.

In Aufhebung, we both negate, we retain, and we elevate (Ibid: 41). Given that, for Hegel, art is the sensory manifestation of an idea, this graffiti is a concrete manifestation of the idea of resistance in a context of crisis. In the masked child, the general spirit (Geist) of society is manifested sensoryally; not in the language of logic, but in the language of images. As Hegel writes in his analysis of the classical tragedy Antigone, "tragedy arises from the conflict between two legitimate rights" (Ibid: 266). In this work, too, on the one hand, protection and distancing are essential (the right to collective health), and on the other hand, the need to live, move, and grow (the individual right of the child). Both are legitimate rights, but in conflict. This conflict turns the work into a modern tragedy—the tragedy of living in an age of crisis.

This work not only reflects a historical crisis (the coronavirus pandemic), but also participates in history as a ray of consciousness: by keeping hope alive in the midst of loss. This work, given its conceptual content, historical context, social message, and dialogue-oriented structure with the audience, is a clear example of an artwork, not just an artifact. From a Hegelian perspective, since the "Geist" (spirit) of the time is manifested in it, its place is established in the realm of genuine art.

Hole in the Wall: Romantic Art at its Peak

Figure 6. Hole in the wall. Location: The Segregation Wall Palestine. Left & right: (Banksy: 2005) (https://banksyexplained.com).

Figure 6, shows children playing next to the barrier wall, the border between Gaza and Israel, seemingly unaware of its nature. But the presence of the beach painting (as if the product of their imagination or hope) is the beginning of a self-awareness that can lead to liberation. Here, art is not simply a representation, but the actualization of the possibility of liberation. The barrier wall is not only a physical structure, but also a symbol of a closed, controlling, and freedom-denying military. From Hegel's perspective, this wall is the historical representation of the "other" against which the subject must take a stand.

In his lectures on aesthetics, Hegel considers art to be the manifestation of the spirit. This painting represents the spirit of freedom against the physical manifestation of the deprivation of freedom (the wall). By drawing an image of freedom on this hard surface, Banksy creates the visual and conceptual antithesis of this wall. He negates this structure not with a weapon, but with an image. His painting creates an imaginary crack in the wall through which another world can be seen. In the phase of negation, the artist, faced with the closed state of the wall, breaks it and from within creates a new meaning.

From a Hegelian perspective, Banksy's work constitutes a kind of aesthetic and moral synthesis: a form of art that opens a path to freedom in the midst of oppression. The viewer is confronted not only with the objective political situation, but also with a sense of liberation, childlikeness, and the possibility of transformation. This is the moment when art comes to express the idea of "freedom of the spirit"; that is, the moment when form, meaning, and protest are revealed simultaneously. This Banksy work can be seen as a clear example of the Romantic stage in Hegel's aesthetics: where form is broken, simple, even graphic, but carries a deep and subjective meaning. Here, the child's figure is a metaphor for the spirit in search of freedom; a spirit that transcends material and objective limitations and calls forth a new world. The spirit now finds the artistic shape not adequate to its inner life, and passes over from art into religion and from religion into philosophy (Hegel, 1975: 103). Ultimately, we can see that this artwork is beautiful not because of its form, but because of its liberating content.

Table 2. Analysis summary table (Source: Authors, 2025).

Case Study	Self-Consciousness	Aesthetic Stage	Manifestation of Sprit	Relation to Society	Realization of Freedom	Category of work
Figure 1	In the beginning	Symbolic	Natural spirit	Experience	Instinctive freedom	Artifact
Figure 2	Self-recognition	Classic	Subjective spirit	Individual awareness	Individualism	Artwork
Figure 3	Free consciousness	Romantic	Objective soul	Criticism	Awareness of the right	Artwork
Figure 4	Free consciousness	Romantic	Objective soul	Criticism and denial	The union of individual and general will	Artwork
Figure 5	Free consciousness	Romantic	Objective soul	Criticism and denial	The union of individual and general will	Artwork
Figure 6	Free consciousness	Romantic	Absolute Spirit-Art	Criticism, negation, and influence	Participation in the moral whole	Artwork

Conclusion

In confronting graffiti from Hegelian perspective, we realize that this form of urban art, beyond an act of protest or a crude aesthetic experience, it is a moment of realization of the

"spirit" in contemporary history. Graffiti, as a contradictory confrontation between individuality and social order, between beauty and violence, and between formal art and free expression, carries within itself the dialectic that Hegel considers the foundation of the movement of history. What is inscribed on the wall is not simply an image or a word, but a reflection of the struggle between mind and object, subjectivity and objectivity, which ultimately leads to a new synthesis in our understanding of art. From this perspective, graffiti is not a deviation from the path of art, but an authentic part of it; a manifestation of beauty that finds meaning and glory in the context of conflict and contradiction.

In a case study of six graffiti works, we conclude that the correspondence of form and concept is not the same in all works, and not all works are placed in the highest stage of art, i.e. romanticism, according to Hegel's classification of arts. It can be said that, the process of departure of graffiti works begins from the natural and instinctive stage of the artist's consciousness (Figure 1) and continues to the manifestation of the absolute spirit as a sublime work of art (Figure 6). In fact, this process is formed in relation to the subject's relationship with society. Graffiti in its early stages is influenced by the subject's experimental and instinctive encounter and gradually moves on the process of consciousness, criticism, and negation of the existing system. Ultimately, at the highest level of this process, is important the unity of the individual with society, which is influential and participation in a moral whole. Therefore, most graffiti works are considered artworks because they are in motion with characteristics such as the subject's individual consciousness, creativity, transformation, and interaction and unity with society.

Graffiti, as a contemporary form of urban art, is born in the context of social, political and cultural tensions and enters into a dialogue with public spaces in an informal but deeply meaningful way. Graffiti can be considered as a spontaneous manifestation of the spirit of the times (zeitgeist); an art that emerges on the walls of the city in the context of modern contradictions. From a dialectical perspective, graffiti is not simply a visual or protest praxis, but a scene of tension between formal art and free individual expression; between regulated beauty and the immediate outburst of aestheticism. In Hegelian logic, art is one of the forms of manifestation of the "absolute spirit"; a spirit that is realized in the world on its path from objectivity to subjectivity. In this framework, graffiti can be considered as a moment of the "objective spirit" that emerges through social, political, and spatial relations with subjective aspect. Graffiti, as art, leads to a synthesis between the thesis of institutional order and the antithesis of individual protest, in which the wall becomes canvas, and space becomes meaning. In this way, graffiti is not as a reduction of art, but as an organic whole a redefinition of it in the battlefield of meanings; where the dialectics of beauty, criticism, and liberation are intertwined.

Author Contributions

All authors contributed equally to the conceptualization of the article and writing of the original and subsequent drafts.

Data Availability Statement

Not applicable.

Acknowledgements

The authors would like to thank all participants.

Ethical considerations

The study was approved by the Ethics Committee of the Islamic Azad University, Isl.C. The authors avoided data fabrication, falsification, plagiarism, and misconduct.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors declare no conflict of interest.

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IJAPAS

International Journal of Applied Arts Studies

Print ISSN: 2588-4506 Online ISSN: 2588-4670

Homepage: www.ijapas.ir

Islamic Azad University
Yazd Branch

Analysis and Evaluation of Visual Components in Environmental Graphic Design of the Hospital (Case Study: Children's Ward of Emam Jafar Sadegh Hospital, Meybod

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Article Info

Article type:

Research Article

Article history:

Received May 28, 2025

Received in revised form June 10, 2025

Accepted July 05, 2025

Published online August 15, 2025

Keywords:

Environmental Graphic Design,
Environmental Design,
Visual Component,
Children's Hospital,
Meybod

ABSTRACT

Objective: The purpose of writing this thesis is to analyze and evaluate the visual components in the environmental graphic design of Imam Jafar Sadegh Meybod Children's Hospital. The standards and criteria of the system defined in the design of the hospital have created difficulties in communicating between the elements in the space and human factors.

Methods: In this research, with the overall goal of removing visual additions and focusing on visual components and other factors related to environmental graphics, such as facilitating communication and information, we will create a safe and relaxing environment not only for children but also for hospital staff and companions. The research method is descriptive and analytical. The method of field research is in the form of library studies, and the collection tools are direct observation of the hospital environment, interviews with children, companions and hospital personnel, and the preparation of questionnaires.

Results: According to the findings and results, it can be said that a graphic designer can try to create a visual element by keeping in mind the useful visual components and their performance in the space and precision in establishing the proportion, coordination and composition of the visual elements. The graphic effect provides an ideal environment to provide a pleasant and helpful environment for all those who use the hospital space.

Conclusion: With the help of graphic science and its superior components, the sensory richness of the environment can be increased. Due to the sufficient understanding of the child's developmental characteristics and the upcoming capabilities and limitations, it is possible to design an environment that matches the child's conditions.

Cite this article: Fallah, M., & Danafar, A. (2025). Analysis and Evaluation of Visual Components in Environmental Graphic Design of the Hospital (Case Study: Children's Ward of Emam Jafar Sadegh Hospital, Meybod. ***International Journal of Applied Arts Studies***, *10*(2), 145-168.

Publisher: Islamic Azad University, Yazd Branch.

Introduction

The emergence of store and organizational design in the mid-1980s marked a turning point in the evolution of wayfinding systems. In 1984, Romedi Passini—a figure distinguished by his dual expertise in architecture and environmental psychology—published Wayfinding: People, Signs, and Architecture, a work that introduced new dimensions to spatial planning by incorporating elements such as logical spatial structuring, sensory cues, and auditory components. This novel architectural design philosophy gave rise to a distinct layer of graphic design that not only underscored the functionality of spaces but also contributed to a unique and coherent visual identity (Dargahi and Rajabnejad, 2015). Today, environmental graphic design has become deeply embedded in urban life, encompassing key features of the urban landscape such as traffic signs, directional maps in public venues, warning signage, and advertising billboards. While environmental graphics intersect significantly with visual arts, urban planning, and architecture, they remain a field with distinctive characteristics and scope (Eslami, 2015).

Environmental graphic design serves a communicative function across numerous urban contexts, particularly in high-traffic environments such as hospitals. Hospitals are complex spaces marked by high volumes of visitors and elevated emotional and psychological stress, especially among pediatric patients, who represent a particularly vulnerable demographic. The emotional sensitivities associated with illness in children heighten the negative impact of inadequately designed, purely functional healthcare settings. Consequently, contemporary design efforts emphasize creating visually appropriate environments tailored to pediatric patients (Reshvand and Hamidi, 2013). Integrating environmental quality with technological and patient-centered considerations enables the development of therapeutic spaces that respond to children's psychological and physical needs. The spatial environment shapes human behavior, and well-designed spaces may enhance resilience and reduce treatment-related anxiety (Taslimi, 2021).

Professionals across disciplines—including architecture, medicine, nursing, and psychology—acknowledge the environment’s critical role in the healing process. Existing research underscores how healthcare environments directly influence patient recovery and psychological well-being, a factor that holds particular significance in pediatric contexts. For children, hospitalization in unfamiliar settings often generates fear and emotional distress, constituting a prominent source of stress during illness (Sattari and Eghbali, 2014). Against this backdrop, the present study explores environmental design factors that affect pediatric patients' treatment and hospitalization experiences in Meybod Hospital. It aims to propose a graphic design model compatible with children's emotional needs and conducive to a therapeutic environment. The study includes a comprehensive review of prior research and an analytical assessment of the environmental graphic element of the hospital in Meybod, culminating in key findings and actionable recommendations.

Theoretical Framework

Environmental graphic design represents a multifaceted discipline that interweaves aesthetic sensibility with functional utility in the built environment. Through the strategic and thoughtful application of visual components, it can elevate both the identity and sensory experience of a space. Designing pediatric healthcare environments necessitates a comprehensive understanding of children's cognitive and developmental attributes, which serve as the foundation for spatial planning in hospital settings. The realization of effective design outcomes is contingent on the graphic designer’s capacity to employ inventive and context-sensitive strategies, informed by a nuanced grasp of children's physiological and psychological states, and guided by stimuli recognizable to the human senses. Conversely, a mismanaged design process in healthcare environments may result in adverse effects, surpassing the intended functional benefits (Sedigh Akbari and Nouri, 2013).

Environmental graphic design acts as a medium of interaction among healthcare personnel, patients, and caregivers. Yet, hospital environments, due to their often overstimulating and chaotic nature, may inadvertently hinder the healing process. A significant number of pediatric patients are treated in spaces not tailored to their needs—conditions that contribute to elevated anxiety levels, negative emotional responses, and diminished satisfaction with both the care experience and the physical environment (Gorji Mahlabani and Saleh Ahangar, 2013). The imperative to integrate effective visual stimuli in fostering the well-being and recovery of pediatric patients is therefore undeniable. Due to the sensitive nature of this design context, graphic designers must engage in rigorous inquiry concerning graphical expressions, visual aesthetics, and the environmental health parameters that shape children's spatial experiences (Fallahi, 2015).

Given that medical treatment constitutes an integral part of a child’s life trajectory, and considering that children may spend prolonged periods in unfamiliar, isolating hospital environments—separated from family, familiar faces, and personal belongings—the emotional consequences of hospitalization often outweigh the clinical challenges of the illness itself. This underscores the necessity of employing well-considered visual components to enhance environmental quality and bolster satisfaction among both patients and clinical staff. Holistically, environmental graphic design in hospitals offers the potential to improve the visual and emotional landscape for all users while contributing to the overall reduction of environmental stress (Motallebi and Vejdanzadeh, 2015).

Positioned within a regional research context, this study focuses on the city of Meybod, where no pediatric hospital has yet been developed with environmental graphic design principles at its core. The research aspires to be a pioneering effort in this regard. The study specifically explores the perceptual and experiential needs of children in hospital environments, emphasizing the role

of creative engagement and pictographic communication. Drawing on existing literature on pediatric spatial design, pictograms, and the psychological effects of creative activities, the study conducts a visual analysis of the environmental graphic strategies employed in Emam Jafar Sadegh Children's Hospital in Meybod. The research is driven by the following central questions:

1. What visual design elements constitute the environmental graphics of a pediatric hospital?
2. How are these elements implemented within Emam Jafar Sadegh Hospital in Meybod?

Materials and Methods

This study is categorized as applied research in terms of its primary objective, as it aims to identify, analyze, and assess visual elements and graphic symbols within the pediatric hospital context in Meybod. Methodologically, the research aligns with a descriptive-analytical approach. In such frameworks, the researcher engages in a systematic description of the current state while gathering and evaluating the views of the study population concerning the characteristics under investigation.

The study population encompasses various units within the hospital, including pediatric inpatients, their families, medical personnel, and administrative staff. Due to the open-ended nature of the population, it is considered unlimited. Given the descriptive-analytical orientation of the study, the sample is composed of twenty visual instances of environmental graphic design taken from Emam Jafar Sadegh Children's Hospital in Meybod.

Data collection in this research was executed through a dual strategy combining fieldwork and library-based investigation. Field research instruments included direct observation of the hospital environment, structured questionnaires, and interviews with child patients and their accompanying family members. For the library research component, data were gathered from specialized texts, peer-reviewed scholarly articles, and authoritative digital sources. This integrative methodology facilitated a comprehensive understanding of the needs, lived experiences, and expectations of children and other stakeholders within the hospital setting, thereby contributing to the creation of a safer and more responsive environment.

The analytical process employed both quantitative and qualitative methods, supported by statistical analysis, to examine the environmental design aspects of the pediatric hospital setting.

Results

User Perception and Comprehension

The subject of this investigation centers on the pediatric unit of Emam Jafar Sadegh Hospital in Meybod. Recognized for its notable scientific and operational achievements, the hospital has consistently ranked as a first-grade medical institution over the past five years, based on periodic

evaluations conducted by the Ministry of Health's Supervision and Accreditation Center. This commendable status has earned it formal recognition from national health authorities.

The primary objective of the hospital is to cultivate a safe and tranquil environment for patients and their companions throughout the course of treatment, thereby allowing them to focus solely on recovery. Simultaneously, the hospital endeavors to foster a vibrant and healthy workplace for its staff.

A set of questions was formulated to evaluate the extent of user awareness and comprehension of environmental graphic design elements:

1. How familiar are you with environmental wayfinding signs?

2. Have you observed environmental graphic signs within the hospital?

3. To what extent do such signs assist you in navigating the hospital environment?

4. To what extent do these graphic signs contribute to maintaining spatial organization?

As illustrated in Table 1, the initial four questions of the survey collectively assess the respondents' general awareness and understanding of environmental graphic communication. The next phase of the study addresses responses to more technically focused questions, specifically analyzing and evaluating the visual design elements employed in the environmental graphic system of Emam Jafar Sadegh Hospital in Meybod.

Table 1. Number and Percentage of Respondents' Perception of Environmental Graphics.

User Perception Level	Number	Percentage
Very Low	49	12.8
Low	97	25.2
Moderate	103	26.8
High	105	30.3
Very High	19	4.9
Total	384	100

Has graphic signage been implemented in Emam Jafar Sadegh Hospital, Meybod?

Based on the data presented in Table 2, the findings indicate that out of the 384 surveyed participants, none consider that the use of graphic signage in Emam Jafar Sadegh Hospital, Meybod, is very limited.

Table 2. Number and Percentage of Respondents' Opinions Regarding the Compliance with Graphic Signage in Emam Jafar Sadegh Hospital, Meybod.

Level of Compliance with Graphic Signage	Number	Percentage
Very Low	0	0
Low	44	11
Moderate	194	51
High	127	33

Very High	19	5
Total	384	100

To what extent have graphic signs facilitated your navigation within Emam Jafar Sadegh Hospital, Meybod?

As indicated in Table 3, out of the 384 participants surveyed, 2% perceive that graphic signage contributes very little to the guidance of individuals within the hospital environment.

Table 3. Number and Percentage of Respondents Regarding the Impact of Graphic Signs on Audience Guidance.

Level of Impact of Signs on Guidance	Number	Percentage
Very Low	8	2
Low	54	14
Moderate	65	17
High	150	39
Very High	107	28
Total	384	100

The placement of the outdoor wayfinding signage in the hospital setting, currently positioned behind natural obstructions such as trees and rendered as a printed banner, compromises the legibility of its content and graphic symbols. Such inadequate visibility can contribute to disorientation, elevated anxiety, and psychological discomfort among hospital visitors. Implementing effective location-based signage equipped with route maps at the main entrance can significantly enhance spatial orientation and facilitate access to various hospital departments. From a design optimization perspective, relocating the signage closer to the apex of the triangular traffic island (as illustrated in Figure 1) would improve its visibility and overall communicative function.

Figure 1. Illegibility of the Wayfinding Sign at the Hospital Entrance.

To what extent have the developmental and psychological attributes of children been considered in the design of the spatial environment and graphic signage within the pediatric ward?

As shown in Table 4, out of the 384 respondents surveyed, 2% perceive that the design of the hospital's space and graphic signage has paid very limited attention to the developmental and psychological needs of children.

Table 4. Number and Percentage of Attention to the Developmental and Psychological Characteristics of Children in the Design of Space and Graphic Signs in the Children's Ward.

Level of Attention to the Developmental and Psychological Characteristics of Children	Number	Percentage
Very Low	8	2
Low	167	44
Moderate	140	37
High	53	14
Very High	12	3
Total	384	100

Hospital Façade

The architectural composition of the façade at Emam Jafar Sadegh Hospital in Meybod reveals a lack of systematic design, particularly in the inconsistent sizing and placement of windows and the varied opening mechanisms of doors. The irregularity in window forms, each outfitted with distinct curtains corresponding to specific departments, disrupts visual cohesion and fails to project a sense of organizational order or maintenance in both daytime and nighttime visual perspectives. Furthermore, the absence of aesthetic nighttime illumination—limited merely to two floodlights aimed at the exterior grounds—results in a dim, uninviting appearance after dark, contributing to a perception of neglect and unease within the surrounding urban environment.

Hospital Lobby

The lobby of the hospital comprises a relatively confined space, bordered by key functional areas such as the emergency unit, injection station, terminal points of the admissions hallway, discharge area, and entryways to various departments. Amenities within this area include an automated teller machine and several waiting chairs. The use of automatic glass doors is functionally appropriate for facilitating smooth access and egress. However, the interior design lacks engagement elements, with cream-colored walls devoid of visual illustrations or child-oriented motifs. Illumination is entirely reliant on artificial fluorescent lighting. Notably, there is an absence of comprehensive directional signage at the lobby entrance. Instead, communication is mediated through small, double-sided overhead signs, suspended from the ceiling via two wires. These signs, composed of white flex material with formal text rendered in white and blue, are inadequate for delivering effective navigational information (Figure 2).

Figure 2. Information boards installed on the ceiling of the hospital corridors.

To what extent has the hospital environment contributed to fostering a sense of belonging and psychological comfort in children?

As indicated in Table 5, among the 384 respondents surveyed, 75 participants, representing 19%, perceive that the hospital environment has had a very limited impact on establishing a sense of belonging and tranquility in children.

Table 5. Number and Percentage of the Impact of Space on Creating a Sense of Belonging and Peace of Mind in Sick Children.

Level of Impact of Space on Creating a Sense of Belonging and Peace of Mind in Children	Number	Percentage
Very Low	75	19
Low	150	39
Moderate	83	22
High	47	12
Very High	29	8
Total	384	100

The lobby of Emam Jafar Sadegh Hospital primarily functions as a continuation of the adjoining corridors that lead to other hospital departments, thereby limiting its capacity to accommodate the full range of functions typically required in a hospital lobby. Expanding the allocated space for this area is recommended to enhance its functional adequacy. Moreover, the installation of tinted glass barriers between reception personnel and patients disrupts the clarity and efficiency of interpersonal communication (Figure 3).

Figure 3. View of the Reception and Waiting Area for Visitors.

To what extent have the design elements, specifically form and color, employed in the hospital lobby contributed to alleviating stress in children?

As presented in Table 6, among the 383 respondents surveyed, 83 participants, representing 22%, perceive that the form and color utilized within the hospital lobby space exert a very limited influence on mitigating stress in children.

Table 6. Number and Percentage of the Impact of Form and Color Used in the Lobby of Emam Jafar Sadegh Hospital on Reducing Stress in Children.

Impact of Lobby Form and Color on Reducing Stress in Children	Number	Percentage
Very Low	83	22
Low	97	25
Moderate	106	27
High	68	18
Very High	30	8
Total	384	100

The signage utilized in the hospital lobby comprises suspended panels created using the flex-printing method, featuring blue text on a white background without integrated lighting. While appropriate for formal or administrative environments, this approach is incongruent with the intended function of a pediatric setting and may induce anxiety in children. Furthermore, the typographic style employed corresponds more closely with institutional rather than child-centered aesthetics. It is therefore advisable to incorporate flex-face printing techniques that offer a broader color spectrum and include stylized, simplified representations of animals, plants, and objects. Abstract and minimally detailed figures tend to resonate more effectively with children, facilitating visual engagement. Enhancing these signs with colorful lighting could further increase their visual appeal and suitability for a pediatric healthcare environment (Figure 4).

Figure 4. Identification and Directional Signs Guiding Individuals to Different Hospital Departments.

To what extent have the educational graphics employed at Emam Jafar Sadegh Hospital facilitated the progression of the child's treatment process?

As indicated in Table 7, among the 384 respondents surveyed, 38% perceive that the educational graphics provided by Emam Jafar Sadegh Hospital exert a very limited influence on the advancement of the treatment process.

Table 7. Number and Percentage of the Impact of Educational Graphics at Emam Jafar Sadegh Hospital on the Child's Treatment Process.

Impact of the Hospital's Educational Graphics on Completing the Child's Treatment Process	Number	Percentage
Very Low	144	38
Low	104	27
Moderate	47	12
High	58	15
Very High	31	8
Total	384	100

Hospital Corridors

Within the scope of environmental graphic design for hospital interiors, the preliminary design phase must prioritize the removal of extraneous components while focusing on elements that effectively facilitate communication with the intended audience. When design principles are neglected and visual elements are poorly structured on informational boards, the result is visual disorganization that impairs legibility and deters viewer engagement rather than encouraging interaction or information retention (Figure 5).

Figure 5. Visual Clutter on the Boards and Walls of the Hospital Corridors.

The hospital corridors are primarily illuminated through natural light sources, entering via windows and sliding doors that provide access to the central courtyards. In addition to daylight, direct fluorescent fixtures are mounted along the central axis of the ceiling to supplement the

lighting. However, this type of direct fluorescent illumination may induce discomfort for patients being transported on hospital beds. A recommended alternative involves installing linear fixtures that emit indirect light along both ceiling edges, thereby creating a more visually and physically soothing environment (Figure 6).

Figure 6. View of the corridors of Emam Jafar Sadegh Hospital, showing daylight and nighttime lighting conditions.

To what extent do the directional signs and pathway indicators at Emam Jafar Sadegh Hospital facilitate your navigation and successful arrival at the intended location?

As detailed in Table 8, out of 384 respondents surveyed, 31% perceive that the hospital's guide signs and pathway markings contribute very little to effectively guiding and directing individuals toward their objectives.

Table 8. Number and Percentage of the Impact of Guide Signs and Pathway Markings on User Navigation and Guidance in Reaching a Specific Destination.

Impact of Guide Signs and Pathway Markings on User Navigation and Guidance	Number	Percentage
Very Low	51	13
Low	173	45
Moderate	109	28
High	37	10
Very High	14	4
Total	384	100

The implementation of 5-centimeter colored guidance lines within the hospital's interior and interdepartmental pathways plays a critical role in wayfinding. These directional indicators,

applied to corridor floors and occasionally to walls, are intended to assist individuals in navigating toward designated units. Nonetheless, despite structural renovations and departmental relocations in recent years at Emam Jafar Sadegh Hospital, these visual cues have not been correspondingly updated. Notably, some sections, such as the infectious diseases unit, lack a dedicated color-coded path altogether. Such oversight reflects a disregard for the functional and communicative potential inherent in environmental graphic design (Figure 7).

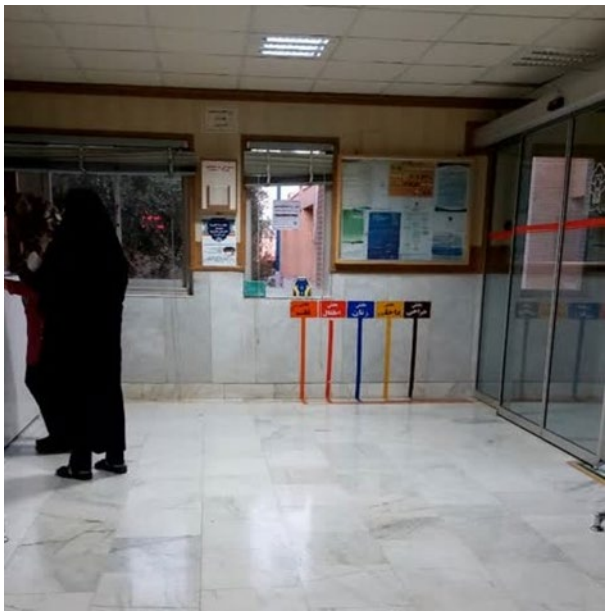

Figure 7. Colored pathway markings in the corridors of Emam Jafar Sadegh Hospital, Meybod.

To what extent have the graphic signage systems at Emam Jafar Sadegh Hospital in Meybod contributed to enhancing user performance?

As indicated in Table 9, among the 384 respondents surveyed, 12% perceive that the graphic signs at Emam Jafar Sadegh Hospital, Meybod, exert a very limited effect on the improvement of user performance.

Table 9. Number and Percentage of the Impact of Educational Graphics at Emam Jafar Sadegh Hospital, Meybod, on Improving User Performance.

Impact of Educational Graphics on User Performance	Number	Percentage
Very Low	46	12
Low	165	43
Moderate	98	25
High	61	16
Very High	14	4
Total	384	100

Corridors within inpatient units commonly serve as areas for positioning mobile furnishings and equipment, both near the nursing stations and outside patient rooms. To mitigate spatial

disorganization, a designated section of the corridor, differentiated through the use of distinctive color schemes and design, could be reserved for storing such auxiliary items. This intervention would reduce visual congestion and promote a sense of spatial clarity and openness throughout the hospital's circulation zones. While the primary corridors lack any form of illustrative decoration, minimal and sporadic imagery is present along the walls and nursing station within the pediatric ward (Figure 8).

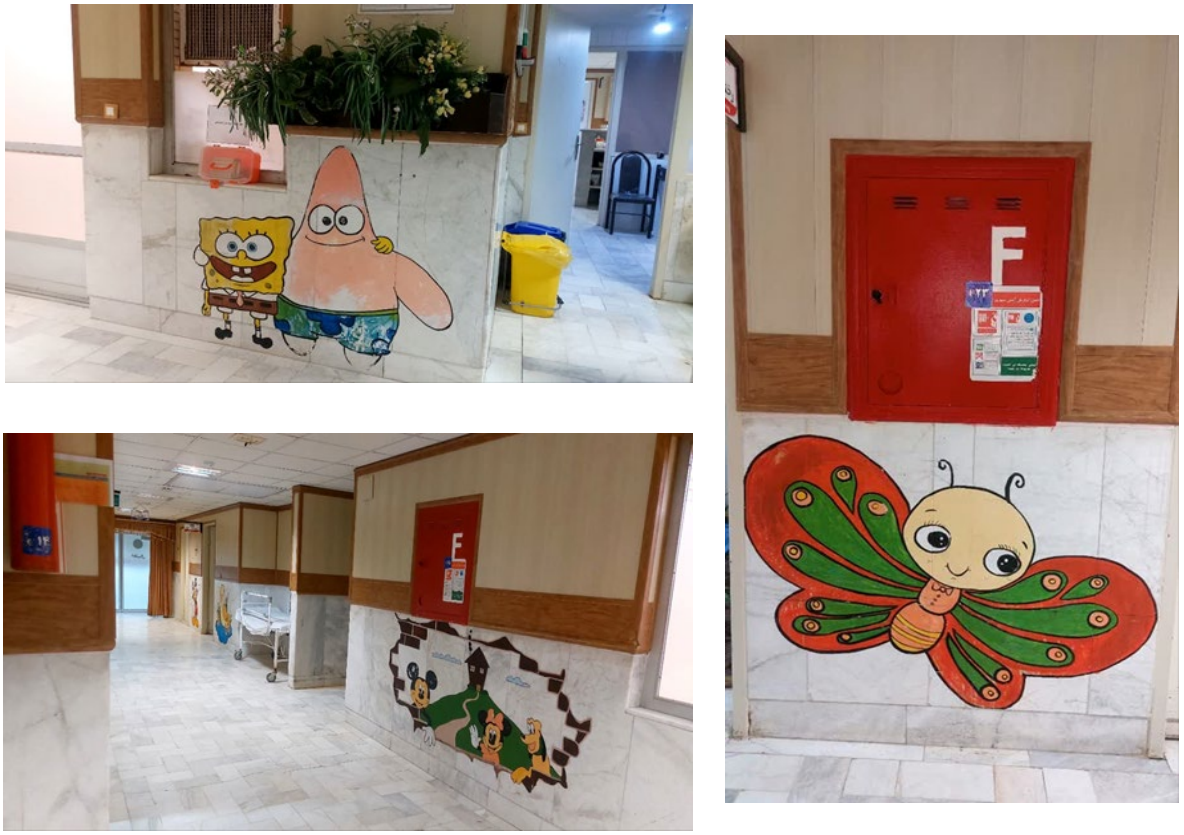

Figure 8. Illustrations related to the children's section of Emam Jafar Sadegh Hospital.

Within the pediatric ward corridors of Emam Jafar Sadegh Hospital in Meybod, signage consists of suspended panels produced via the flexographic method in red and green hues, incorporating visual symbols and lacking any form of illumination. The pictograms utilized reflect conventions typically aligned with administrative or corporate environments and are ill-suited for child-centered spaces, potentially eliciting anxiety or fear among pediatric patients (Figure 9).

Figure 9. Guide signs in the children's department of Emam Jafar Sadegh Hospital.

To what extent has the implementation of a suitable and calming environment specifically for hospital personnel been achieved in this hospital?

As presented in Table 10, among the 384 respondents surveyed, 2% hold the view that the design of a tranquil space within the hospital has a very limited effect on the well-being and performance of the staff.

Table 10. Number and Percentage of the Impact of Relaxing Space Design on Hospital Staff.

Impact of Relaxing Space Design on Hospital Staff	Number	Percentage
Very Low	7	2
Low	35	9
Moderate	163	43
High	97	25
Very High	82	21
Total	384	100

Hospital Nursing Station

The application of white on the ceilings within the hospital's nursing stations is considered highly suitable, as it visually expands the spatial perception of the area. Employing a softly saturated, deep-toned wall can direct visual attention toward an opposing surface where specific functions may occur. Despite their inherent busyness, nursing stations should be environments that foster positivity and emotional comfort. Color schemes incorporating blue, yellow, or muted green hues mixed with white are recommended to enhance the ambiance. Comprehension of and familiarity with the environment cultivates a psychological sense of control and agency among users—an effect that significantly contributes to the alleviation of stress, anxiety, and fear, thereby supporting the body's healing process, especially in pediatric patients.

Figure 10. Nursing station in the children's department of Emam Jafar Sadegh Hospital.

Assessing the Suitability of Color and Form Choices in the Nursing Station Design from a Child-Centered Perspective

Based on the data presented in Table 11, 39% of the 384 surveyed individuals indicated that the current color schemes and structural forms of the nursing station decor exert minimal influence on children's perception. To improve communication and emotional resonance with young patients, the nursing station signage should adopt a playful and vibrant aesthetic, incorporating bright, cheerful hues and fonts that are both rounded and sufficiently bold to ensure readability.

The existing use of stone in wall and floor finishes contributes to excessive acoustic reverberation, disrupting the tranquil atmosphere needed for patient recovery. It is therefore advisable to install soft, resilient flooring materials to mitigate noise levels. Furthermore, the use of stone cladding on walls should be replaced with medium-density fiberboard or wooden materials coated with high-density plastic, positioned at a suitable height to serve as effective impact-absorbing surfaces.

Table 11. Number and Percentage of the Impact of Nursing Station Decor in Terms of Form and Color on Children's Perception at Emam Jafar Sadegh Hospital.

Extent of the Impact of Nursing Station Decor in Terms of Form and Color on Children's Perception	Number	Percentage
Very Low	150	39
Low	116	30
Moderate	66	17
High	43	11
Very High	9	3
Total	384	100

Inpatient Room Design Evaluation

The inpatient rooms are uniformly painted in a cream tone resembling light mustard yellow, with no variation or accent colors applied to the four surrounding walls. The absence of any visual imagery or artistic elements on both the walls and ceilings results in a sterile and unengaging atmosphere. Ceiling design is limited to a broad pink border encircling a white central field, without any illustrative or thematic features.

The inclusion of large windows plays a beneficial role in maximizing daylight penetration within the space. To moderate incoming light, the rooms are equipped with fabric curtains in cream shades adorned with pink floral motifs. The rooms utilize ceiling-mounted fluorescent fixtures that emit direct lighting, which may not provide optimal comfort for bedridden patients due to their harshness (Figure 11).

Figure 11. View of the pediatric inpatient rooms at Emam Jafar Sadegh Hospital.

To what extent can the stress and anxiety experienced by pediatric patients be mitigated through innovative design in the hospital's environmental graphics?

As shown in Table 12, among the 384 respondents surveyed, 8 participants (representing 2%) consider that creativity in environmental graphic design has a very limited impact on managing the fear and stress of children.

Table 12. Number and Percentage of the Impact of Creativity in Environmental Graphic Design on Controlling Fear and Stress in Sick Children.

Impact of Creativity on Children's Fear and Stress	Number	Percentage
Very Low	8	2
Low	6	2
Moderate	67	17
High	126	33
Very High	177	46
Total	384	100

Impact of Color and Form on Pediatric Patient Distraction in Inpatient and Corridor Spaces

According to Table 13, 35% of the 384 respondents (a total of 136 individuals) indicated that the form and color schemes utilized in the hospital's inpatient rooms and corridors exert minimal influence on distracting pediatric patients. However, the uniform application of a single color across all four walls within patient rooms has the potential to induce visual monotony and psychological fatigue in children.

To mitigate this, it is advisable to implement a color scheme based on harmonious tonal variations within a consistent hue family, thereby maintaining visual coherence while avoiding dullness. Wall paint should ideally reflect 50% to 60% of light to maintain adequate brightness levels. Furthermore, particular attention must be paid to the chromatic treatment of walls containing windows: wall colors should be selected to minimize contrast with incoming daylight, as heightened contrast can cause these surfaces to appear disproportionately dark. In addition, walls directly opposite windows should remain light in color to prevent the absorption of natural light, thereby enhancing the room's overall illumination and atmosphere.

Table 13. Number and Percentage of the Impact of the Form and Color of the Inpatient Space and Hospital Corridor Walls on Child Distraction.

Impact of the Form and Color of the Inpatient Space and Corridors on Children's Distraction	Number	Percentage
Very Low	136	35
Low	33	9
Moderate	18	5
High	54	14
Very High	143	37
Total	384	100

To what extent has the designer considered the child's scale and point of view in designing the pediatric ward of the hospital?

As reported in Table 14, only 29% of the 384 surveyed participants (equating to 112 individuals) indicated that child-appropriate spatial scale and visual perspective have been minimally accounted for in the design of Emam Jafar Sadegh Hospital's pediatric ward.

The inpatient rooms accommodate between one to four beds, all of which are designed with adult-scale dimensions (220 cm in length, 100 cm in width, 57 cm in height, and a 39 cm high

guardrail). Constructed from metal with an electrostatic powder coating, these beds are fitted with low protective rails, rendering them ill-suited for pediatric patients. Furthermore, televisions in the rooms are positioned to suit the line of sight of a supine child but fail to consider the visibility requirements of caregivers or accompanying adults. While bedside cabinets measuring 56×55×92 cm in white-blue tones are provided, additional furniture, including storage units and seating, should be scaled to accommodate children's ergonomic needs and physical proportions, ensuring a more child-centered and accessible environment.

Table 14. Number and Percentage of the Extent to Which the Scale and Child's Point of View Are Observed at Emam Jafar Sadegh Hospital, Meybod.

Extent of Observance of Scale and Child's Point of View	Number	Percentage
Very Low	112	29
Low	139	36
Moderate	68	18
High	52	14
Very High	13	3
Total	384	100

To what extent does innovative design in the arrangement and furnishing of inpatient rooms alleviate the child's perception of the stressful atmosphere at Emam Jafar Sadegh Hospital?

As indicated in Table 15, out of 384 respondents surveyed, 188 participants (representing 49%) consider that creative design elements in the inpatient room layout exert a minimal influence on redirecting the child's attention away from the hospital's stressful environment.

Table 15. Impact of Creativity in Layout Design on Diverting the Child's Mind from the Stressful Hospital Environment.

Impact of Creativity in Layout Design on Redirecting the Child's Attention Away from the Stressful Hospital Environment	Number	Percentage
Very Low	188	49
Low	131	34
Moderate	37	10
High	21	5
Very High	7	2
Total	384	100

The inpatient room equipment in this hospital is characterized by sharp and bulky geometric forms. Besides the short cabinets currently utilized, it is recommended that child-sized wardrobes be integrated into the walls. Each hospital room is equipped with a handwashing sink, above which instructional posters illustrating and describing proper handwashing procedures are displayed. However, these sinks are notably shallow, and the high-pressure water flow from the faucets results in water splashing onto surrounding surfaces, thereby potentially facilitating the transmission of infections. To mitigate this risk, a protective barrier should be installed between the sink and the inpatient area to prevent water dispersion (Figure 12).

Figure 12. Handwashing sink in inpatient rooms.

To what extent can the treatment process be enhanced by fostering closer communication between the medical team and the child's active involvement in their care?

As indicated in Table 16, out of 384 respondents, 4% perceive that close interaction with the healthcare staff has a minimal effect on the child's engagement in the treatment process. The nursing station should be designed with consideration for the child's stature, thereby promoting a stronger sense of belonging. Fundamentally, this design strategy aims to facilitate meaningful interaction and collaboration between the child and medical personnel, thereby encouraging the child's participation in their treatment.

Table 16. Impact of Child Participation in Treatment through Closer Interaction with Medical Staff.

Impact of Child Participation in Treatment through Closer Interaction with Medical Staff	Number	Percentage
Very Low	16	4
Low	45	12
Moderate	89	23
High	108	28
Very High	126	33
Total	384	100

To what extent does the creativity demonstrated in the design and quality of the hospital's play area meet the needs of pediatric patients?

As shown in Table 17, out of 384 respondents surveyed, 176 participants (representing 46%) contend that the play area's layout and quality exhibit minimal creative consideration and are fundamentally unsuitable for hospitalized children.

Table 17. Level of Creativity and Quality of the Play Area at Emam Jafar Sadegh Hospital.

Impact of Creativity in the Layout and Play Area in This Hospital	Number	Percentage
Very Low	176	46
Low	138	36
Moderate	54	14
High	11	3
Very High	5	1
Total	384	100

Hospital Playroom

The playroom serves as a distinct environment where children can momentarily detach from the clinical atmosphere of the hospital. It plays a crucial role in alleviating stress and facilitating the recovery process among pediatric patients. However, this hospital lacks a dedicated space designed for children's recreation. Additionally, the outdoor areas of the hospital are devoid of play equipment intended for children's amusement. Creating an environment that fosters psychological well-being by providing moments of happiness and joy-while accommodating the unique needs of hospitalized children an integral component of therapeutic care and is therefore indispensable. Employing soft furnishings with rounded edges, vibrant colors, and forms without sharp corners can establish a setting that promotes active movement and vitality along circulation paths. Such a design also enables effective supervision of children's physical activities.

Discussion

The present study, which focused on environmental graphic design in pediatric healthcare settings through the case of Emam Jafar Sadegh Hospital in Meybod, highlights the pivotal role of design elements in organizing the hospital's physical environment for young patients. Rather than concentrating solely on facilitating a calm and favorable atmosphere for children's treatment, the investigation emphasizes that enhancing the interior spatial quality significantly influences the operational efficiency and collaborative engagement of hospital staff and caregivers throughout the therapeutic process.

The findings identify light, form, and color as fundamental components within the framework of pediatric hospital environmental graphics. Each element substantially contributes to the spatial identity and sensory enrichment of the environment. When combined with other key organizational principles—such as balance, symmetry, harmony, unity, variety, emphasis, and texture—these elements enable the formation of hospital environments that not only perform effectively but also offer aesthetic and psychological comfort. Such integration ensures that pediatric hospitals, like other child-oriented spaces, are perceived as secure and welcoming by their intended users. Graphic designers achieve success when they intelligently orchestrate spatial elements to cultivate a positive emotional response in both patients and visitors. The efficacy of

their work depends on the thoughtful and harmonious integration of visual elements tailored to the specific context.

Effective environmental design relies on close interdisciplinary collaboration among architects, interior designers, lighting professionals, and environmental graphic specialists. Their unified objective is to create environments that are visually appealing while ensuring optimal functionality. Architectural planning in the absence of graphic and interior design input is either inefficient or falls short of its potential. While lighting designers may enhance visibility and spatial articulation, graphic designers, with creative insight, can synthesize their concepts with lighting to maximize artistic and communicative impact. Lighting, in particular, enhances environmental aesthetics and psychological comfort, underscoring its indispensable role in comprehensive design.

Ultimately, the role of an environmental graphic designer involves structuring space according to an intentional, functional plan. By employing form and color within the discipline of visual art principles, designers can facilitate rapid and effective communication. Color, when applied skillfully, evokes emotional responses and serves as a potent communicative medium. Additionally, pictograms used in signage and wayfinding systems considerably accelerate information transmission. These visual messages resonate with viewers beyond their aesthetic appeal, establishing deeper cognitive and emotional connections.

Design approaches that integrate the local and cultural identity of a community play a significant role in fostering effective and accelerated communication. It is evident that, based on the function, spatial characteristics, and institutional identity of any given environment, the selection of form and color is intentionally directed toward conveying specific messages to a target audience. In the context of Emam Jafar Sadegh Hospital, design strategies take into account the age and psychological sensitivities of pediatric patients. Consequently, the communicative elements are presented through child-oriented expressions—utilizing soft, rounded forms and a palette of vivid, cheerful colors—carefully applied throughout the physical setting.

Given that the human brain can process an image in approximately 13 milliseconds, the strategic use of imagery becomes crucial for the swift transmission of information. Factors such as font size and style, color selection, iconography, and the positioning of signage are all critical to effective communication. The influence of form and color extends to visual tools such as infographics and wayfinding maps, reinforcing their importance in environmental graphic design. When used appropriately in combination with lighting, these elements yield visually compelling and functionally coherent spatial experiences. A key consideration in their integration is the preservation of visual harmony across all spatial components.

Conclusion

The findings of this research indicate that environmental graphic design principles have not been adequately implemented across the hospital, not just within the pediatric unit but throughout its various departments. As such, the development of a well-engineered, systematic spatial environment necessitates the application of a structured design methodology. This approach should enable designers to propose concepts that are coherent, problem-oriented, and capable of reinforcing key messages and meanings in the minds of users.

Based on the empirical analysis of visual elements and associated data, it is evident that satisfaction with the environmental graphics at Emam Jafar Sadegh Hospital, Meybod, is limited. Accordingly, it is recommended that a thorough evaluation and critical analysis of the hospital's environmental graphic design be undertaken. Furthermore, it is advised that the interior design of the hospital incorporate insights derived from an in-depth study of Meybod's cultural identity.

Additionally, this study recommends the integration of visual components specifically suited to pediatric interior spaces and the implementation of color-coded systems to promote organizational clarity among staff. For instance, the use of multicolored wristbands can effectively communicate important patient-specific information, such as a yellow-coded band indicating a drug allergy, enabling medical personnel to exercise heightened caution during treatment.

Author Contributions

All authors contributed equally to the conceptualization of the article and writing of the original and subsequent drafts.

Data Availability Statement

"Not applicable"

Acknowledgements

The authors would like to thank all participants of the present study.

Ethical considerations

The authors avoided data fabrication, falsification, plagiarism, and misconduct.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors declare no conflict of interest.

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