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Applied Research Article

Role of Green Spaces in Promotion of the Sense of Belonging to the Place in Residential Complexes (Case Study: Qom City)

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ABSTRACT: The correlation between urban green space and a sense of belonging has been investigated in research; However, few scholars have mentioned the relationship between the designable physical components of vegetation and a sense of belonging. This study investigates a relationship between three physical parameters of green space - "Visual density of vegetation," "Weighted height of vegetation," and "per capita ratio of green space to an open common area of the complex" - and a resident's sense of belonging through five subjective and objective independent variables - transparency," "proportion and scale," "physical and visual diversity," "flexibility" and "privacy and Enclosure " - in four residential complexes in the Qom city - the center of Iran. Data were extracted from a survey study (n=320), documents, and written sources, and it was analyzed using second-order confirmatory factor analysis and hierarchical linear regression. Based on the research literature review and identified gaps, a conceptual model was presented to explain the factors contributing to promoting a sense of place through greening in residents. In the results, the level of a perceived sense of belonging of the residents of the samples in the central courtyard was higher than in the scattered courtyard. Also, a positive correlation was observed between the psychological and physical components of the green space and the feeling of belonging to a place. Findings showed that among the psychological components, the "transparency," and among the physical components, the "Per-Capita Green Area" had the most positive effect on the resident's sense of belonging.

Keywords: *Residential Complex, Sense of Belonging to a Place, Green space Factors.*

INTRODUCTION

The relationship between humans and settlements is an essential issue in environmental psychology(Lawrence, 2002)."Environment" influences the type of human decisions, choices, and even individual and social democracy(Netto, 2016). In a built environment, physical infrastructure - especially green space (GS)- has many effects on the lives of its inhabitants - including aesthetics, entertainment, and visual diversity(Cho et al., 2006; Gómez et al., 2010). For many people, residential environments - due to the level of communication and length of stay - are the most important places to experience a sense of belonging. In some studies, public perception of the quality of GS is directly related to the quality of the sense of place(Arnberger & Eder, 2012; Hur et al., 2010). The level and volume of residential GS directly relate to residents' general health. GSs can improve people's mental health(WHO, 2016). Also, research has shown that living and being in a place "with a direct view of GS" has a direct effect on well-being and reduces the side effects of diseases(Burton et al., 2015; Lehberger et al., 2021; Pasanen et al., 2023). These results can also be extracted about the access to GSs and their permeability in residential places(Barber et al., 2021; Stigsdotter et al., 2010). In today's societies, due to the increasing activities, people need more GSs, but these spaces are decreasing in quality in residential complexes (RC)(Addas, 2023; Knobel et al., 2021; Maas et al., 2006). In different articles, different qualities have been expressed in defining GS. In a human-oriented article, the quality of GS has been received as naturalness(Groenewegen et al., 2012; Reyes-Riveros et al., 2021). Another article summarizes GS quality as a forest and its effect on environmental cooling(Kong et al., 2014; Q. Zhang et al., 2022). In another article, the integrated and unified definition of GS is rejected, stating that "GS" should be defined uniquely for each study. From a qualitative and quantitative point of

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view, only the definitions are generally divided into order, culture, and comprehensibility(Taylor & Hochuli, 2017). However, limited studies have investigated the relationships between the physical components of GSs with the SBP in RCs and their impact.

Sense of Place:

Sense of place means experiences that can be perceived through the five senses, apart from the physical characteristics of the place, to create a sense of belonging to the spirit of the place(Carmona, 2021; Carmona et al., 2010). Place attachment and similar definitions - such as sense of place, place identity, place dependence, home territory, and placemaking - are "links between people and meaningful environments for them"(Scannell & Gifford, 2010). The location itself is insufficient to create a sense of place. To create this feeling, a long and deep experience of a place is needed, and it is necessary to be involved in it(Lavy & Zavar, 2023). A "sense of place" is a complete sensory experience connecting a person (consciously or unconsciously) to a specific place, like a package of signs and concepts. If the architectural space is mixed with meanings, concepts, and attachments, the space becomes a place in architecture at a higher level. Every human's interaction with the environment in which he is constantly active affects his circumstances, future opportunities, identity, and even sense of belonging to his place(Allen et al., 2021; C. Montgomery, 2014; Speak, 2013).

This research mainly focuses on "the relationship between the physical quantities of GS and the SBP (creation and promotion) as an objective or subjective matter." Experience a sense of place has three stages: First, "belonging to the place," then "attachment to the place," and finally, "commitment to the place."; Usually, these three stages are not easily separated, but they are divided according to a certain trend concerning the place, from no sensation to the most sensation(Convery et al., 2012). In other articles, the SBP includes three components: place identity, place attachment, and place dependence(Francis et al., 2012; Jorgensen & Stedman, 2006). The "place identity" component defines people's perception of their identity concerning the physical environment(Proshansky, 2016). The definition of "attachment to place" is an emotional relationship between people and place that goes beyond recognition, preference, and judgment(Jiao et al., 2023; Scannell & Gifford, 2017). The "place attachment" component is a perceived positive or negative attachment for the individual between him and a specific place(Gibbeson, 2020). A stable and positive relationship between humans and the environment is two-way - related to human tendencies and the characteristics of the environment. Also, the objective and subjective characteristics of a place affect the development of the sense of belonging to the place. "Availability of facilities" is one of these characteristics(Buffel et al., 2014). David Canter's theory has sufficient validity among the "aspects of place" models. According to the proposed structure, the city bed is like a place, including three intertwined factors: body, imagination, and activities. Based on this proposition, he considers the sense of place to include meaning, form, and activity(Canter, 1977). A model based on which - and the opinion of many thinkers - the components of a "SBP" can be found in these three groups of the form (physics)(Chen & Sekar, 2018; ICOMOS, 2008; Khettab & Chabbi-Chemrouk, 2017; J. Montgomery, 2007; Savić, 2017; Stedman, 2016; Turner & Turner, 2006), activities(Chen & Sekar, 2018; J. Montgomery, 2007; Salvesen, 2002; Savić, 2017), and meaning(Khettab & Chabbi-Chemrouk, 2017; Stedman, 2016; Turner & Turner, 2006).

According to the authors, unlike the sense of belonging to the place mentioned in the title of this research, "The SBP" in this research includes all the fundamental and conceptual aspects of this phrase - from belonging to a place and being connected to a place to a complete commitment that is intertwined with the dynamism and identification of a place. Apart from perceptual and cognitive factors, physical factors are considered the most important factors that form the sense of place. Considering the importance of physical factors in creating a sense of belonging, some physical components are presented in Table 1.

According to Table 1 of the components that scholars have repeatedly mentioned, it can be said that the availability of GS is a determining factor in a "SBP." The research novelty of this paper lies in developing a new approach that focuses on three specific physical characteristics of GSs in residential complexes (RCs) and their relationship to residents' sense of belonging to the place. This paper introduces a novel model for examining the relationship between the GSs of residential complexes and residents' sense of belonging. This model differs from previous ones, offering a new perspective on the impact of urban GSs on the "sense of community." The paper focuses on three distinct physical

Table 1: Some of the Physical Factors Affecting a Sense of Place from the Thinkers' Perspective

Theorist	Perspective
Fritz Steele	Size of Place, Enclosure, Contradiction, Scale and Proportion, Distance, Texture, Theme, Voice, and Visual Diversity(Steele, 1981)
Kevin Lynch	Composition of Components, Compatibility, Availability, Transparency (Lynch, 1981)
Christian Norberg-Schulz	Materials, Texture, Color, Shape (Norberg-Schulz, 1985)
Ian Bentley	Permeability, Diversity, Transparency, Flexibility, Visual Compatibility, Sensory Enrichment, and Customizability (Bentley et al., 1985)
Irwin Altman	Scale, Exclusivity, and Availability (Altman & Low, 1992)
David Salvesen	Physical Personality of the Place, Use of Nature (Water, Plants, Sky, Sun), Enclosure (Salvesen, 2002)
Jane Jacobs	Diversity of Activities, Combination of Functions, Permeability, Flexibility (Jacobs, 1992)

components of GSs in RCs - Visual density of vegetation (VDV), Per-Capita Green Area (PCGA) to open space, and weight height of vegetation (WHV). These components have not been commonly considered in previous studies, and their combined analysis represents a novel approach to understanding the relationship between GSs and residents' sense of belonging.

Sense of Place and Green Space:

GSs have social benefits - such as increasing social interaction between residents and improving mental health and overall well-being(Enssle & Kabisch, 2020; Pasanen et al., 2023). GSs can also indirectly positively affect residents' sense of belonging in RCs(Bjerke et al., 2006; Žlender & Gemin, 2020). Natural cover is considered a central component in the neighborhood's sense of place; It is even defined as a factor affecting the regular communication between neighbors - a sense of security and compatibility -(Bonaiuto et al., 2003). In some articles, the quality of access to GS, presence in it, and proximity to it have been accepted as an influencing factor in the quality of sense of place(Arnberger & Eder, 2012; McCunn & Gifford, 2014; Stessens et al., 2020; Y. Zhang et al., 2022); The presence and proximity of GS is an influential factor in the growth and development of the sense of place(Kim & Kaplan, 2016; Łaszkiewicz et al., 2018). Finally, Matthew Carmona(Carmona, 2002), in the book " Quality of Residential Design, "explains the three aspects of place in urban design and expresses an eight-sided prism. He also enumerates the components of place with fifteen characteristics. According to his assumptions and the things stated before, the open space of a residential complex - having some components of the urban environment - can be effective as a more controlled society.

To better understand the physical components taken from the GS, we first define them. Most experts consider population density as the number of people in each area(Kasanko et al., 2006; Nelson et al., 2008). Therefore, in this article, we consider the meaning of "vegetation density" to be the aggregation of vegetation in the common open space in RCs, which expresses the possibility of influencing the perception of space, the feeling of satisfaction, and finally, the sense of belonging to the place of the residents

By summarizing the topics presented, including the physical components of Table 1, Designability of GSs in RCs of Qom city - considering the inclusion of physical and semantic fields, climatic conditions, having traditional and religious origins, and following the path of industrialization of Qom city - includes five components: "transparency," "flexibility," "Proportion and Scale," "Physical-Visual Diversity" and "Privacy and Enclosure" were considered as variables to be measured in this article:

1. The meaning of "transparency" is spatial transparency, which means understanding different spatial locations simultaneously. GS, readability, access, basic facilities, walkability, and along the path following other components measure transparency.

2. In this research, flexibility includes the propositions of adaptability, transformability, and transformability, which are considered through the GS in the open spaces of RCs. Holding national religious ceremonies in RCs in Qom doubles the need to pay attention to flexibility.

3. "Proportions and scale": in this research, this variable is investigated as the residents' view on the effect of GS and their exposure to the dense space of the residential complex.

4. " Physical-Visual Diversity " means observing and paying attention to residents' presence, activity, and enjoyment due to the presence of GSs.

5. "Privacy and enclosure" is one of the integral components of traditional Iranian architecture; this statement shows the effect of a built environment on the defensibility of a place, the feeling of security, peace, and quality of life. Also, this article examines this statement through the density and height of GS in RCs.

This research mentions two terms, "central courtyard" and "dispersed courtyard." The term central yard in this research refers to the GS surrounded by buildings on four or at least three sides, while the term scattered means a GS with a free plan and no peripheral restrictions. Although most of the research examines the role of GS on health and thermal comfort, the present research intends to reach a proper

Fig 1: Map of the Case Study, District 4 of Qom in Central Iran (Qom Municipality, 2021)

understanding of how these components affect the residents' sense of belonging by considering the role of the physical components of the GS as well as examining the psychological factors related to the form; And which physical component has a more significant impact on the residents' unconscious perception and sense of belonging to the place. After reviewing the research literature, the following question was asked: What is the relationship between a SBP and the components of GS in the RCs of Qom?

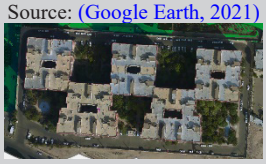
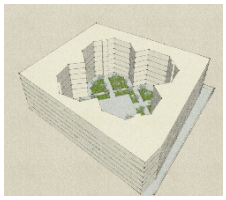
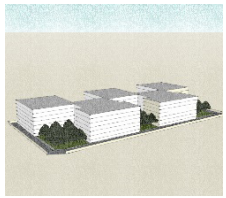
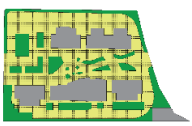
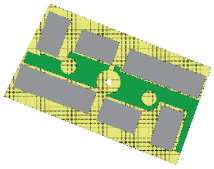
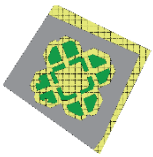
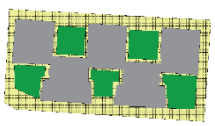
Study Area

The city of Qom is considered the seventh metropolis of Iran. Also, this city ranks sixth in attracting immigrants to Iran and is considered one of Iran's two important religious cities. The total area of GS in the city of Qom is 6,177,558 square meters; Therefore, the recreational GS per capita is 2.66 square meters for each citizen, unfavorably compared to the global average. District four is the largest urban region among the eight regions - Qom. With a population of 203,000 people, it is the center of attention of the residents of this city (Fig 1). In the last two decades, the construction of RCs in the 4th district of Qom has been increasing. According to the statistics of Qom Municipality - 2018 - the highest population growth rate - with an average of 3.17 percent - was in this region (Qom Municipality, 2021).

Based on this, the target population in this study was selected from among the residents of RCs in District Four of Qom City. With the population expansion of Qom and the desire for more people to live in RCs, more attention should be paid to GSs.

However, most of these complexes do not have noticeable GSs. In the limited cases that can be mentioned, generally in terms of quality and quantity, the use of open spaces of RCs has become worthless and cannot be sampled. Since the written statistics about the number of RCs

Table 2: Results of Surveys on the RCs

Row	Results, impressions	The residential complex			
		Laleh Residential Complex	Bahar Residential Complex	Tasnim Residential Complex	Yasaman Residential Complex
1	Layout type	Scattered	Scattered	Central courtyard	Central courtyard
2	Satellite image	Source: (Google Earth, 2021) 	Source: (Google Earth, 2021) 	Source: (Google Earth, 2021) 	Source: (Google Earth, 2021) 
3	Perspective				
4	Picture				
5	Schematic plan of GS				

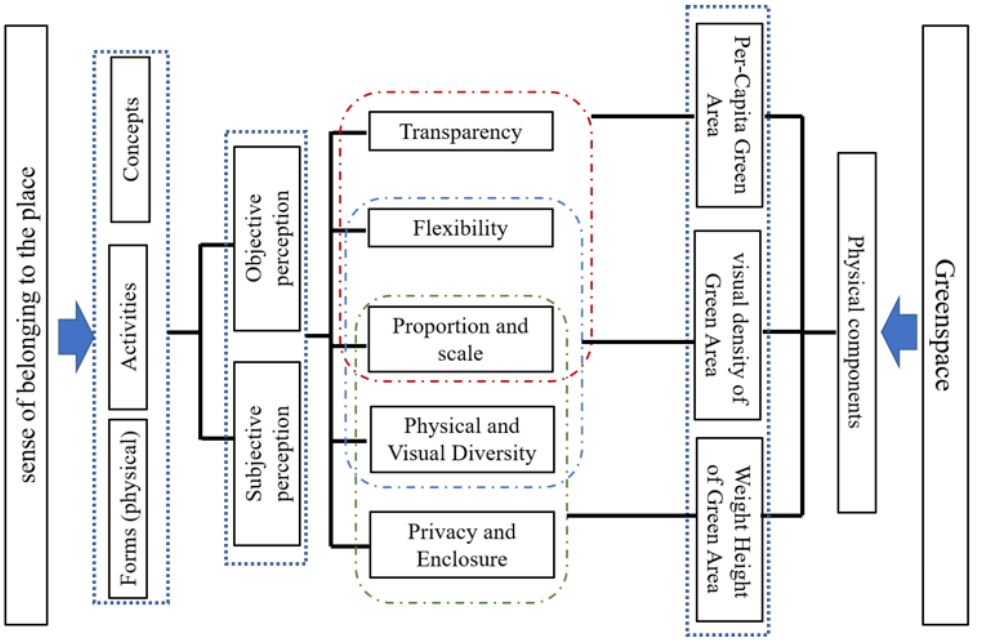


Fig 2: Conceptual Model of the Research

in this urban area are unavailable, the authors have tried to identify the complexes with sufficient GS by taking a detailed field survey.

MATERIALS AND METHODS

The study focuses on four distinctive residential complexes in Qom, chosen to represent a spectrum of urban living environments. Data was collected through structured questionnaires, incorporating various scales and indicators to measure the sense of belonging and the decisive factors contributing to it. Descriptive statistics were utilized to thoroughly understand the data, encompassing parameters such as frequency, abundance ratio, standard deviation, and column diagrams. These statistics offer a detailed view of the dataset's characteristics.

Advanced inferential statistical techniques were employed to understand the relationships and factors at play better. Confirmatory Factor Analysis (CFA) was conducted to validate and refine the sense of belonging measurement model, ensuring its reliability and construct validity. Structural Equation Modeling (SEM) assessed the structural relationships between the identified factors and the sense of belonging. This advanced statistical technique helps unravel the intricate web of causal relationships. The Pearson correlation coefficient was calculated to discern the strength and direction of associations between variables, shedding light on the interconnections among factors. The one-sample T-test was employed to examine whether the sense of belonging in each residential complex significantly differed from the population mean. Variance Analysis (ANOVA) was utilized to explore differences in the sense of belonging across the selected residential complexes, enabling a nuanced comparison of the various factors at play. Hierarchical linear regression was used to determine the unique contribution of each factor to the sense of belonging while controlling for other variables. The ANOVA (F-test) was conducted to evaluate whether there are significant differences between the residential complexes regarding the sense of belonging. The data analysis was conducted using advanced statistical software tools, Minitab 19 for descriptive statistics and AMOS 26 for structural equation modeling, ensuring the robustness and accuracy of the findings. To maintain the study's rigor, the alpha error level for testing the hypotheses was set at 0.05 ($p < 0.05$), reducing the likelihood of Type I errors and fortifying the validity of the results.

Based on the question raised, investigating the effect of psychological components on the sense of belonging based on the resident's perception of the GS and also investigating the difference in the effect of yard morphology - central and scattered - on the perception of the resident's sense of belonging to the GS is the aim of the research. Based on this, the GSs of the RCs of Qom and the components of the GSs are introduced as independent variables and the sense of belonging to the place as dependent variables. Several individual and demographic variables, such as age, education level, and length of stay in the residential complex, are introduced as control variables. Fig 2 shows the conceptual model of the research.

Descriptive Data

The scholarly research article delves into the assessment of four prominent residential complexes in the region, specifically named "Yasman," "Tasnim," "Bahar," and "Laleh." The methodological approach employed in this study involved categorizing these complexes based on the architectural configuration of their courtyards, distinguishing them as either "Central Courtyard" or "Scattered Courtyard" layouts. The final selection of "Tasnim" and "Yasman" (characterized by central courtyards) and "Bahar" and "Laleh" (with scattered courtyards) was made, factoring in considerations such as the complexes' social standing, the socio-economic status of their

Table 3: Demographic characteristics of the samples by percentage (N = 320)

Properties		Yasaman Residential Complex	Bahar Residential Complex	Tasnim Residential Complex	Laleh Residential Complex	Total
Sex	Female	40	46	54	50	47.5
	Male	60	54	46	50	52.5
Age	Under 18	24	14	18	14	17.5
	to 30 18	12	28	18	26	21
	to 45 30	16	34	50	40	35
	to 60 45	34	18	12	16	20
	Above	14	6	2	4	6.5
Education	Middle school or blew	36	26	17	20	24.5
	Diploma	20	20	40.4	26	26
	University degree	34	34	36.2	40	35.5
	Master's degree or above	10	20	6.4	14	12.5
Occupation	self-employment	22	32	10	18	20.5
	Employee	12	16	22	24	18.5
	Retired	22	4	8	2	8.5
	Housekeeper	16	26	32	36	27.5
	Student	28	22	28	20	24.5

Table 4: Normality of Variables Distribution

Variables	skewness	kurtosis
Transparency	-1.01	1.58
Flexibility	-0.193	-0.422
Proportion and Scale	-1.42	2.45
Physical-Visual Diversity	-0.341	-0.336
Privacy and Enclosure	-0.455	-0.208
Total Score	-0.352	0.523

residents, and due attention to the temporal aspects of construction and habitation. These chosen complexes are geographically proximate to each other, thereby mitigating variations beyond the scope of control, including unit pricing and regional temperature fluctuations, thus minimizing potential sources of error. The findings in Table 2 encapsulate the perceptions of residents residing within these four distinct complexes.

The study sample consists of approximately 2,700 residents. Data on each complex's physical attributes were meticulously gathered through comprehensive field investigations, Geographic Information System (GIS) mapping, and AutoCAD software applications. Furthermore, the study examined residents' GS (GS) utilization patterns and subjected this data to rigorous analysis. To gauge the sense of belonging and the physiological dimensions of GS, a survey instrument was designed following Morgan's table, yielding 320 questionnaires. This instrument comprised 20 closed-ended inquiries employing a five-point Likert scale, enabling respondents to express their levels of agreement, ranging from "completely agree" to "completely disagree." The complexes were subsequently categorized into two groups, specifically "Central Courtyard" and "Scattered Courtyard," with 80 respondents within each category, yielding a total respondent count of 320 individuals. The questionnaires were administered individually, in cooperation with the management of the respective complexes, following the comprehensive elucidation of the research objectives to the participants. Random selection was employed to secure participants for questionnaire completion, with an average duration of 22 minutes allocated for each respondent. The assurance of the confidentiality of personal information was provided to all participants. The data collection and analysis spanned a duration of approximately 75 days, specifically between the months of June, July, and August in the year

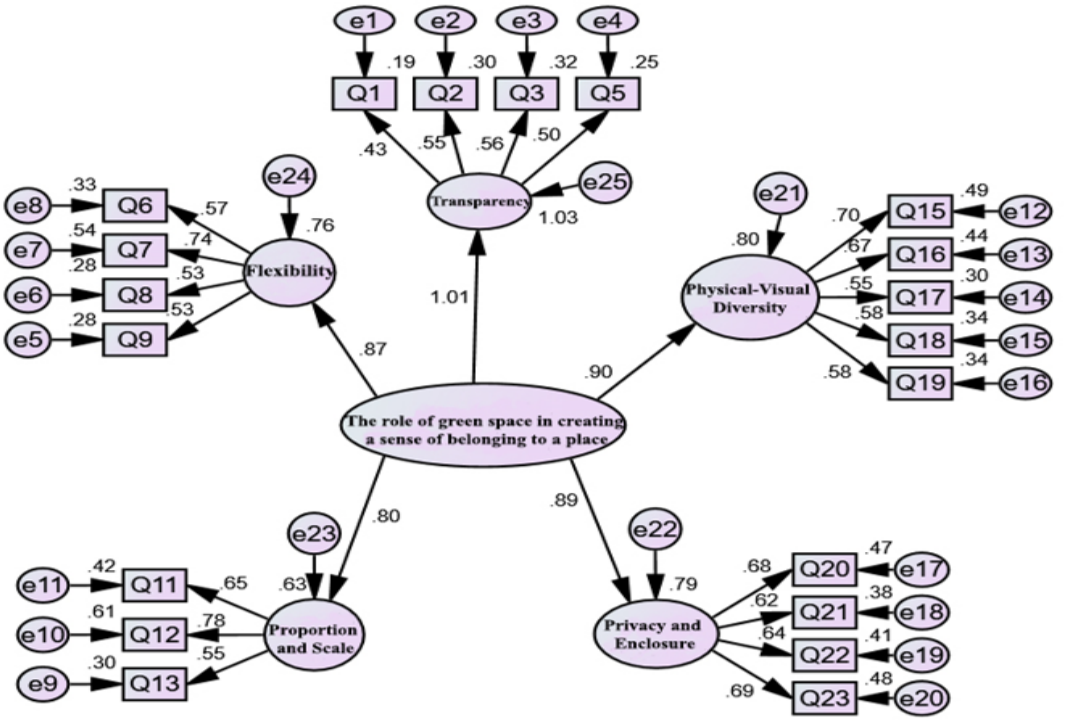


Fig 3: Components Measurement Model in Standard Coefficients mode (factor loading)

Table 5: Model Relationship Test

Question	Standard Coefficient	Non-Standard Coefficient	Standard Error	t value	p-value
Transparency <--> GS	1.01	-	-	-	-
Flexibility <--> GS	0.87	1.40	0.321	4.35	<0.001
Proportion and Scale <--> GS	0.80	1.23	0.285	4.31	<0.001
Physical and Visual Diversity <--> GS	0.89	1.92	0.393	4.87	<0.001
Privacy and Enclosure <--> GS	0.90	1.62	0.337	4.82	<0.001

Table 6: Fit Indicators of the Research Model

Fit Indicator	AGFI	PGFI	IFI	NFI	CFI	GFI	RMSEA	Chi-Square to Degree of Freedom Ratio
Criterion	>0.70	>0.70	>0.90	>0.90	>0.90	>0.90	<0.08	In the range of 1 to 5
Result	0.77	0.75	0.92	0.88	0.89	0.92	0.071	3.20

2021. Table 3 shows the demographic characteristics of the samples

RESULTS AND DISCUSSION

Based on Table 4, it is possible to infer a normal or close to a normal distribution of all variables - only the "Proportion and Scale" component has a slight skew, which can be confirmed by tolerance.

The second-order confirmatory factor analysis technique assessed the research model and the relationship between the main structure and other factors. Fig 3 shows the measurement model in standard coefficients mode.

Research model Fig 3 - with standard coefficients - and factor loadings Table 5 observations show a strong relationship - more than 0.40 shows

Table 7: Variance Analysis Performed to Compare Average Factors in the Four RCs

Variables	Average in terms of complex				F value	p-value
	Central courtyard		Scattered courtyard			
	Yasaman	Bahar	Tasnim	Laleh		
Transparency	4.03	4.31	4.02	4.11	1.86	0.137
Flexibility	3.38b	3.99a	3.15b	3.83a	11.70	0.001>
Proportion and Scale	4.11	3.96	4.01	4.05	0.25	0.858
Physical and Visual Diversity	3.48b	3.83ab	3.86ab	3.92a	3.17	0.026
Privacy and Enclosure	3.78	3.78	3.70	4.03	1.42	0.239
Total Score	3.69	3.94	3.76	3.93	1.92	0.128
PCGA	3.99ab	3.81a	4.23a	3.77b	5.41	0.001
VDV	4.05	3.91	3.94	3.74	1.59	0.193
WHV	3.97	3.89	3.90	3.64	2.07	0.106

Table 8: Comparison of the average sense of belonging among the complexes with a central courtyard and Scattered with the T-test of independent groups

Variables	**Complex type**						**Total Score**	**Mean difference**	**Standard error**	**p-Value**
	Yasaman	Tasnim	central courtyard	Bahar	Laleh	Scattered courtyard				
Transparency	4.11	4.31	4.21	4.02	4.03	4.02	4.12	0.19	0.100	0.060
Flexibility	3.83	3.99	3.91	3.15	3.38	3.26	3.58	0.64	0.114	<0.001
Proportion and Scale	4.05	3.96	4.01	4.01	4.11	4.06	4.04	-0.06	0.128	0.658
Physical-Visual Diversity	3.92	3.83	3.88	3.86	3.48	3.67	3.77	0.20	0.113	0.073
Privacy and Enclosure	4.03	3.87	3.90	3.70	3.78	3.74	3.82	0.16	0.120	0.178
Total Score	3.93	3.94	3.93	3.76	3.69	3.73	3.83	0.21	0.088	0.020
PCGA	3.99	4.23	4.11	3.81	3.77	3.79	3.95	0.32	0.091	<0.001
VDV	4.05	3.94	3.99	3.91	3.74	3.82	3.91	0.17	0.103	0.096
WHV	3.97	3.90	3.94	3.89	3.64	3.77	3.85	0.17	0.101	0.094
Total Score	4.00	3.87	4.01	4.02	3.71	3.79	3.90	0.22	0.093	0.018

a relationship and more than 0.70 shows a solid and direct (positive) relationship between the main structure with five components, which can be considered as a significant relationship between the components and the main structure (GS) ($p>0.05$). Due to the scaling of the GS structure, the readability and transparency components were defined as the reference variable. The fit indices of the model are also checked in Table 6.

Because of the equal size of the samples, the Tukey Test was used for the range comparison of the groups. ANOVA test results are provided in Table 7.

Findings

The present study in Table 8 employed a T-test of independent groups to assess the statistical differences between several key variables, including "flexibility," "total score of psychological components," "PCGA," and "total score of physical components" ($p<0.05$). Notably, complexes with central courtyards exhibited significantly higher averages in these components than complexes with scattered courtyards. Among these components, "flexibility" and "PCGA" displayed the most substantial average differences between the two complex groups.

A hierarchical linear regression (table 9) analysis was conducted to predict the sense of belonging, encompassing five sequential steps. The first step introduced background variables, revealing that only age significantly impacted the sense of belonging. In the second step, including physical factors resulted in a significant increase in the coefficient of determination ($p<0.05$), confirming the influence of per capita green area and height on the sense of belonging. The third step

Table 9: Hierarchical linear regression to test the impact of predictor variables on the sense of belonging in general and by separating two complex groups.

Criterion variable	Steps	predictor variable	B	SE	Beta	F	R^2	R2 changes
Sense of Belonging	First step	Gender	0.137	0.099	0.105	1.83	0.040	0.040
		Age	0.099	0.044	0.174*			
		Education	0.043	0.052	0.065			
		Staying Time	0.001	0.011	0.004			
	Second step	Gender	0.020	0.035	0.015	195.02**	0.886	0.847**
		Age	0.000	0.016	0.001			
		Education	0.016	0.018	0.024			
		Staying Time	0.000	0.004	0.001			
		PCGA	0.249	0.042	0.253**			
		VDV	0.046	0.079	0.050			
		WHV	0.644	0.083	0.684**			
	Third step	Gender	0.024	0.030	0.018	160.37**	0.919	0.032**
		Age	0.011	0.014	0.020			
		Education	0.012	0.016	0.018			
		Staying Time	0.001	0.003	0.010			
		PCGA	0.314	0.088	0.318**			
		VDV	0.033	0.110	0.036			
		WHV	1.088	0.131	0.355**			
		Transparency	0.363	0.055	0.391**			
		Flexibility	0.180	0.037	0.241**			
		Proportion and Scale	0.105	0.058	0.140			
		Physical-Visual Diversity	0.162	0.091	0.194**			
		Privacy and Enclosure	0.065	0.029	0.084			
	Forth step	Gender	0.024	0.030	0.018	147.17**	0.919	0.000
		Age	0.011	0.014	0.020			
		Education	0.012	0.016	0.018			
		Staying Time	0.001	0.003	0.010			
		PCGA	0.314	0.089	0.318**			
		VDV	0.033	0.111	0.036			
		WHV	1.088	0.132	0.355**			
		Transparency	0.363	0.056	0.391**			
		Flexibility	0.181	0.038	0.241**			
		Proportion and Scale	0.105	0.059	0.140			
		Physical-Visual Diversity	0.162	0.091	0.194*			
		Privacy and Enclosure	0.065	0.029	0.084			
		Complex type	0.001	0.033	0.001			
		Gender	0.027	0.030	0.021			
		Age	0.016	0.014	0.028			
		Education	0.008	0.016	0.012			
		Staying Time	0.001	0.003	0.006			
		PCGA	0.393	0.092	0.398**			
		VDV	0.039	0.117	0.043			
		WHV	1.212	0.136	0.286**			
		Transparency	0.486	0.070	0.523**			
		Flexibility	0.127	0.046	0.169**			

Continiue of Table 9: Hierarchical linear regression to test the impact of predictor variables on the sense of belonging in general and by separating two complex groups.

Fifth step	Proportion and Scale	0.116	0.063	0.154	111.59**	0.925	0.006*
	Physical-Visual Diversity	0.249	0.106	0.298**			
	Privacy and Enclosure	0.145	0.045	0.189**			
	Complex type	0.158	0.198	0.121			
	Transparency* complex type	0.164	0.064	0.530**			
	Flexibility* complex type	0.105	0.052	0.278**			
	Proportion and Scale* complex type	0.062	0.048	0.198			
	Physical-Visual diversity* complex type	0.004	0.058	0.012			
	Privacy and Enclosure* complex type	0.106	0.051	0.321**			

of the regression analysis unveiled further insights. It demonstrated statistically significant changes in the coefficient of determination ($p<0.05$) and affirmed the impact of per capita variables, height, transparency, flexibility, and diversity on the sense of belonging.

In contrast, adding the predictor variable of complex type in the fourth step did not induce any significant change in the coefficient of determination ($p<0.05$). The fifth step introduced an interaction effect between psychological factors and complex types into the regression model. This step led to statistically significant changes in the coefficient of determination ($p<0.05$). It confirmed the influence of numerous predictor variables, including "PCGA," "Weighted height of vegetation," "transparency," "flexibility," "Physical-Visual Diversity," "Privacy and Enclosure," "transparency in interaction with complex type," "flexibility in interaction with complex type," and "Privacy and Enclosure in interaction with complex type" on the sense of belonging. Remarkably, the variables incorporated in the fifth step collectively accounted for 92.5% of the variance in the sense of belonging. The F-test value in this step, with a significance level of at least 99%, indicated the suitability of the regression model in predicting the sense of belonging ($p<0.01$). These findings emphasize the complex interplay of physical and psychological factors and the type of complexity in shaping the sense of belonging among individuals in different residential settings.

Among the observations and presence of authors in these RCs, in addition to the importance of the presence of green space, the quality of interactions of the residents is different due to the GSs. The interpretation is based on the fact that prominent GSs surrounded by the form of buildings amplify the sense of place. Such green yards (central or semi-central yards) are more personal and have a feeling of home for the residents. The lively afternoons are the most important of these differences. The next important point was the residents' preference for the height of the green space (shading) instead of dense green space. It was distinguishable based on the selection of places for gatherings.

Conclusion: Within the purview of this scholarly inquiry lies the empirical scrutiny of the intricate nexus between the constituents of GSs and the residents' sense of place attachment within four residential complexes in Qom City. This research endeavor has engendered findings that lucidly elucidate the positive correlation between the constituents of GSs and the profound construct of place attachment within the residential domains of Qom City.

Upon meticulous deconstruction of the psychological and physical elements within these complexes, the variables denominated as "Transparency," "Flexibility," "Physical-Visual Diversity," and "Privacy and Enclosure" have emerged as prominent determinants of the residents' place attachment. It is essential to acknowledge that while the "proportion and scale" component exerts some influence, its potency pales compared to the abovementioned variables. It assumes a relatively subordinate role in reinforcing the intricate construct of place attachment. In physical constituents, "PCGA" is paramount in engendering a robust sense of place attachment among residents. "WHV," though substantial, resides as the secondary factor, albeit with a considerable gap in its influence coefficient. This observation signifies that the residents' place attachment is predominantly stoked by the presence and extent of green foliage and, subsequently, by the height of this vegetation.

Conversely, the "Visual density of vegetation" barely registers as a substantial determinant in the panorama of place attachment. The study remarkably reveals that elements such as visual barriers, spatial isolation, and the purposeful creation of blind spots through GSs wield no discernible influence on the establishment of place attachment. While aesthetically appealing, these features do not resonate prominently in the hearts and minds of residents.

A salient revelation emerges in the context of courtyard design forms. The "central courtyard" design is pivotal in eliciting and magnifying the residents' place attachment through GSs when contrasted with the "scattered courtyard" alternative. The centrality of courtyards, as exemplified by the "Tasnim" complex with a four-sided enclosure, emerges as crucial in contrast to the "Yasman" complex with a three-sided enclosure. The degree of centrality in courtyard design confers a heightened significance to the sense of place, thus enhancing place attachment. Conversely, a greater dispersal of the complex diminishes the resonance of this sense.

Furthermore, this study underscores the preeminent influence of the "transparency in interaction with the type of residential complex" variable in shaping place attachment. Within this domain, "Privacy and Enclosure" and "Flexibility" stand as salient contributors to the efficacy of place attachment. It is imperative to underscore that, within the ambit of this investigation, two additional variables, while not bereft of effect, evince a limited impact on place attachment, especially in the

context of courtyard design.

This comprehensive inquiry expounds upon the complex interplay between GS constituents and the intricate construct of place attachment within Qom City's residential complexes. The narrative discerns and delineates the nuanced facets of these relationships, affording an erudite comprehension of the underlying dynamics that underpin the emotional and psychological bonds between residents and their built environment.

AUTHOR CONTRIBUTIONS

M. Rasfijani performed the literature review and experimental design, analyzed and interpreted the data, and prepared the manuscript text and edition. F. Alborzi and A. Amini evaluated, supervised, and guided the experimental parts and citations of the project.

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CONFLICT OF INTERESt

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication or falsification, double publication and, or submission, and redundancy, have been completely witnessed by the authors.

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