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Study of environment-behavior in three types of the urban context of Tehran — Comparative analysis of the Chizar, Narmak, and Khazane neighborhoods' context using survey and space syntax methods

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Abstract

Environment-behavior studies are among the important theoretical fields in environmental design sciences. The concepts of territory, behavioral setting, and environmental affordance are essential and reliable in examining the relationship between humans and the environment, especially in the space of a residential neighborhood. The primary purpose of this study is to search for common physical attributes in three types of residential contexts that affect the daily behavior of residents. Also, a system of attributes with a significant correlation between the results of studies in these two areas can lead to constructing a design assistance software. This paper applies a survey method and space syntax analysis to study three types of contexts: organic (historical), orthogonal (modern) with a combination of urban squares, and orthogonal combined with hierarchical passages. The survey study includes field observation and questionnaire techniques. Besides, software analysis is carried out using Depthmap10. The scale of the study area in each context is home-based space. The results are represented as values from each method and correlation tables. There is also a system of attributes with correlations between the results of the questionnaire and the analysis for each of three contexts and a system for common correlations in all three contexts. The system is set up as a matrix which represents the most important and influential attributes and spatial properties that are predictable through software analysis.

Keywords: E-b studies, space syntax, urban context, behavioral setting, environmental affordance.

Introduction

E-B studies, a widespread interdisciplinary field (also called Environmental psychology) addresses all those interested in the relationship between the physical environment and human behavior (Churchman, 2002). How human behavior is affected by the environment is the central issue of these studies. Although attention to this issue was initiated with the study of humans and their behavior, it has soon become a strong potential for predicting this behavior and design based on new findings. Concepts like behavioral setting (Barker, 1968) and environmental affordance (Gibson, 1979) explore the innate capabilities of the environment and its relevance to human behavior, mainly within residential neighborhoods. The analysis of the physical aspects of the environment and their association with particular behaviors is a reliable approach for acquiring data for forthcoming designs. This is typically achieved by observing current behaviors or gathering input from users.

However, there are several notable limitations in the application of studies in this field. Some experts have blamed environmental psychologists for ignoring real-life design issues and others for reluctance to apply the findings of environmental studies. Others have cited communication problems between the two groups as the main reason for this failure (Hubbard, 1992). For example, while environmental psychologists consider personal issues on a micro and personal scale, urban designers address macro and mainly quantitative problems, such as growth and development control, transportation, economics, and the environment (Churchman, 2002). Despite extensive efforts to establish a relationship, researchers today believe that these findings do not significantly affect the decision-making and design process (Beer, 1991; Churchman, 2002).

Space syntax theory is a way to study the relationship between human behavior and the physical environment (Marcus, 2018). Hillier & Hanson introduced space syntax theory, emphasizing its social aspect (Hillier & Hanson, 1984). This theory, which is based on spatial configuration, is considered an analytic theory (Hillier, 1996b). Space syntax, widely used today in urban design studies, is primarily an architectural theory (Marcus, 2018). This syntax links these two domains (Hillier, 1989) and simultaneously examines micro and macro scales.

However, the space syntax method also has some limitations, despite its many advantages, such as providing software systematic study for researchers and designers and the need for fewer data than other methods of human behavior studies. For instance, it is criticized for overlooking some aspects that affect the relationship between humans and the environment. According to some researchers, one of the weaknesses of space syntax is that it prioritizes orientation over other influential fields, such as aesthetics and variety (D'Acci, 2019). Others have introduced the inattention to metric spatial attributes, including distance and direction and superficial appearance of the environment, lack of special attention to the different choices of individuals personally or in groups, and overlooking the height and 3D qualities as the limitations of this method (Montello, 2007).

The primary purpose of the present study is to search for common physical attributes in three types of residential contexts that affect the daily behavior of residents. Considering the characteristics of the space syntax method and its relationship with E-B studies, we applied software analysis based on space syntax theory as a parallel method. This paper comparatively studies three types of urban residential context in Tehran. It seeks to identify the relationship between humans and the environment through the parallel use of observation and questionnaire methods, on the one hand, and space syntax analysis, on the other. Finally, correlation coefficients between the findings of the two ways are extracted. Social interactions are of particular importance in this comparative study. Thus scale under investigation was selected regarding the matter of the joint architectural space and urban space. This area is the smallest territory around the house or home-based space (Einifar, 1996). This research is unique in studying the selected contexts comparatively and by the presented methods. Moreover, future applications of the study can be used to set up a system of E-B attributes and achieve a design assistance algorithm.

Research limitations include the limitations of the space syntax method mentioned above and the intrinsic limitations of the observation and questionnaire methods (Groat & Wang, 2002). The parallel use of the two ways is set to cover these limitations.

The remainder of this paper is structured as follows. In Section 1, the literature is reviewed in different areas, and the present research position in the existing body of knowledge is clarified. In Section 2, the definitions and details used in both survey and software methods are described. Section 3 introduces the three selected contexts, their characteristics and the reasons for choosing

them. In Section 4, the research findings are presented directly in the form of appropriate tables and graphs. Section 5 comparatively studies the results in three contexts, expected and unexpected outcomes, and compares the results with previous studies. Finally, in Section 6, the most important results obtained in the study of these cases, the generalizability horizons of these results, and suggestions for future research are presented.

Literature Review

The complete literature review of two areas of E-B studies and space syntax is outside the scope of this research. Therefore, in this paper, we address works with an interdisciplinary approach similar to the present study and comparative studies of different urban contexts.

Some of the first attempts to apply the findings in E-B studies were reviewed in an article by Hubbard (Hubbard, 1992), where referring to the book "Creating Architectural Theory: The Role of the Behavioral Sciences in Environmental Design" by John Lang is important as a source for providing an environmental-behavioral approach in the design process. In addition to some references at the end of the 20th century (Beer, 1991), this gap has also been addressed in later sources (Churchman, 2002). Some of these studies have identified the reasons for this gap (Churchman & Ginsberg, 1984), and others have provided solutions to this problem. Among these efforts, the proposal presented by Davidovitch-Marton & Churchman (1997) is essential to us because of its connection to Altman-Rogoff's transactional theory (Altman & Rogoff, 1987). This research proposes a model based on the principles of transactional and contextual approaches, focusing on the concepts of event and context.

Space syntax, developed by Bill Hillier et al. in the 1970s and 1980s, is a set of techniques for analyzing spatial layouts and human activity patterns in buildings and urban areas. The principal value of this approach lies in a social theory of space and the configuration of space (Karimi, 2018).

Some comparative studies theoretically investigate or, in other words, support space syntax methods based on different theories, such as the relationship between space syntax and Gibson's environment affordance (Marcus, 2015, 2018), spatial cognition (Marcus et al., 2016; Penn, 2003), urban morphology (Marcus, 2010; Pont & Marcus, 2015), and environmental psychology (Montello, 2007). While having a comparative approach, these studies are different from the present study, which is not a theoretical investigation. Some studies take a comparative approach to investigate the cases using different methods. For example, one can refer to a comparative study of spatial configuration, spatial cognition, and spatial behavior using space syntax and questionnaire methods (Kim, 1999), a study of elderly spaces using space syntax and observation methods (Esra & Alper, 2015), a study of context using space syntax and location-based methods (Morales et al., 2019), a study of perceived safety using space syntax and other methods (Ottenby, 2017), a study of anti-social behavior using space syntax and observation methods (Friedrich et al., 2009), a study of visibility with isovist area in space syntax method and accessibility with depth attribute (Desyllas et al., 2003), and a study of the human-environment relationship with isovist attribute in space syntax method (Franz & Wiener, 2008). This research is like the mentioned studies in terms of approach and method while being different from them in terms of objectives. While most of these studies seek to support and test space syntax and generalize the results, the present study seeks to use space syntax and questionnaire methods as complementary and achieve a more complete and accurate information system. Employing these two methods allows overcoming the shortcomings of both. The purpose of calculating the correlation between the methods is not to accurately classify space syntax findings but to identify accurately comparable attributes of contexts. In any case, the results of these studies can be compared with those of the present study in the scope of this paper.

Some studies have explored specific urban contexts or compare different contexts using the space syntax method or alongside parallel methods. One of the most important examples is the contextual study of different cities and Hillier's discussion of spatial culture (Hillier, 1989). This study alongside the social aspect of space syntax theory, highlights the importance of the present research in the comparative study of three urban contexts with their own culture and community. In this regard, some examples of research are more relevant to the present study; e.g., comparing pre-modern and modern (Omer et al., 2015) or traditional and contemporary (Lerman & Omer, 2016) contexts in Israel, and inner-city and modern housing state in Izmir, Turkey (Can & Heath, 2016). While some examples focus on the evolution of contexts and expanding the historical cores of cities with newer boundaries with orthogonal contexts, the present paper recognizes the similarities and differences of contexts independently. Examples include the study of six classic towns in Iran and the UK, now the core of modern cities (Karimi, 2000), the study of organic urban forms surrounded by grid systems in Barcelona (Yoo & Lee, 2017), and the study of historic areas in Chinese cities with contemporary transformations (Han, 2009). The results of these studies will be comparable to those of the present study regarding differences between contexts.

Research method

First, the research was conducted by the survey method through field observation and deep study techniques, including the study of spaces and activities in the study area in 14 days.

Based on this study and by applying the observations in all three contexts, a questionnaire was prepared and given to 32 residents of each neighborhood. They were selected deliberately and as a non-probabilistic choice based on maximum coverage of house types in the context and providing appropriate dispersion in terms of individual characteristics of respondents (e.g., age, gender, marital status, level of education, and family size). The 32 for each context was assigned based on having more than 30 samples to apply parametric methods for calculating the correlation coefficients. The questionnaire is a closed type with 6 sections. The data of parts 2, 3, 5, and 6 are used in this research. Parts 2 and 3 are related to the concept of territory (Altman, 1975), part 5 to behavioral setting (Barker,
1968), and part 6 affordances (Gibson, 1979). A brief introduction of the questionnaire is presented in [Table 1].

Table 1. The questionnaire's structure.

PART	concept	number of questions	Type of responses	How is determined
1	Individual information	8	Diverse	-
2	Social relation level per family unit	4	4 social areas (families)	Observation and field study
3	The physical territory of social relations (Altman, 1975)	4	6 spatial areas (territories)	Observation and field study
4	Territory of activities (Altman, 1975)	20	4 spatial areas	Observation and field study
5	Behavioral setting (Barker, 1968)	9	5-degree scale	Likert
6	Affordances (Gibson, 1979)	28	5-degree scale	Likert

In the space syntax section, the analysis is done using UCL Depthmap10 software and the experimental method. The area map is prepared based on the online map of Tehran Municipality1 and in AutoCAD software. Axial analysis method, and visibility graph analysis method, was performed regarding the comparative studies with environmental psychology. Topological and geometric attributes have been used rather than metric attributes and the attributes where selected widely due to the exploratory nature of the study. The analysis results are presented in color spectrum graphs and tables of maximum, minimum, average, and standard deviation values. The attribute values are calculated in two ways due to the need to have the total area values and values specific to the 32 houses. These values are then used to calculate the correlation with the survey results.

After achieving the results of the two methods used, the correlation coefficients between the findings were calculated based on the position of each house. To calculate the correlation between the values of space syntax and the results of the social interaction part, we applied the Spearman correlation coefficient due to the non-parametric data of this part. In the behavioral setting and environmental affordance parts, the Pearson correlation coefficient was used. All calculations were performed using SPSS software, and the results were set as table of correlation values with a statistical significance of 0.01. All research data are available and shared.

The studied contexts

In this study, three residential neighborhoods with different characteristics in the geometry of streets, formation background, structure, and social background were selected. The selection includes an organic (historical) context in Chizar, an orthogonal (modern) context with a combination of urban squares in Narmak, and another orthogonal context combined with hierarchical passages (dead-ends) in the Khazane neighborhood. A summary of characteristics of each context is given in [Table 2]. All three contexts are now a combination of single-unit homes and multi-unit apartments. Increasing population density and building density are among the problems or at least hazards that can affect the properties of contexts (Azizi, 2007; Eskandari Dorbati, n.d.; Sharifi fard, 2013). [Figure 1] shows the area studied in each context in the form of satellite images based on Google Maps. The location of houses in google kml files and images of the selected areas are presented in research data.

Table 2. Characteristics of the contexts

Neighborhood	Geometry of passages	age of contexT	Total area (hectares)	Approximate total population	Studied area (hectares)
Chizar	Organic with curved alleys	Old village	120	20000	2
narmak	Orthogonal network and urban squares	1952-1958	540	150000	6
Khazane	Orthogonal network and hierarchical passage	Qajar - 50s	150	45000	6

Figure 1. The studied area in a) Chizar, b) Narmak, c) Khazane.

Results

[Table 3] shows the graphs of visibility analysis and axial analysis belonging to the three contexts in the main attributes and at both global and local scales. In these graphs, red and blue denote the highest and lowest values for each attribute, respectively. The study area in each case is marked with a red box, but for more accuracy, the analysis was performed by drawing a larger area.

Figure 2 shows survey results in three parts, social interaction (a), social territories (b) and behavioral settings with environmental affordances (c). Tables 4 and 5 show the space syntax analyses results and figure 3 shows the internal correlations of the attributes (R^2).

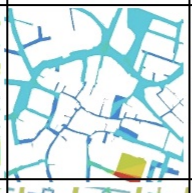
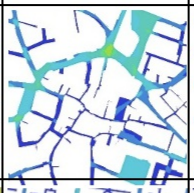
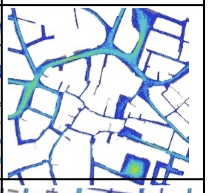
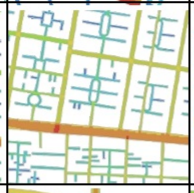
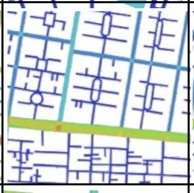
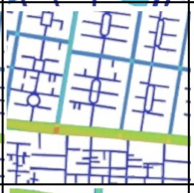
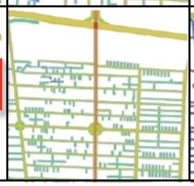
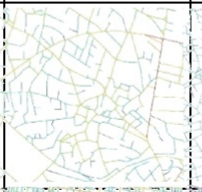
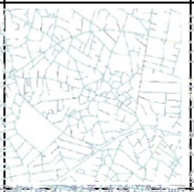
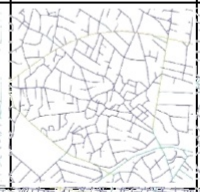
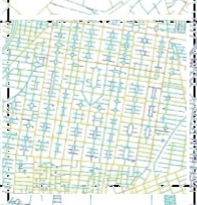
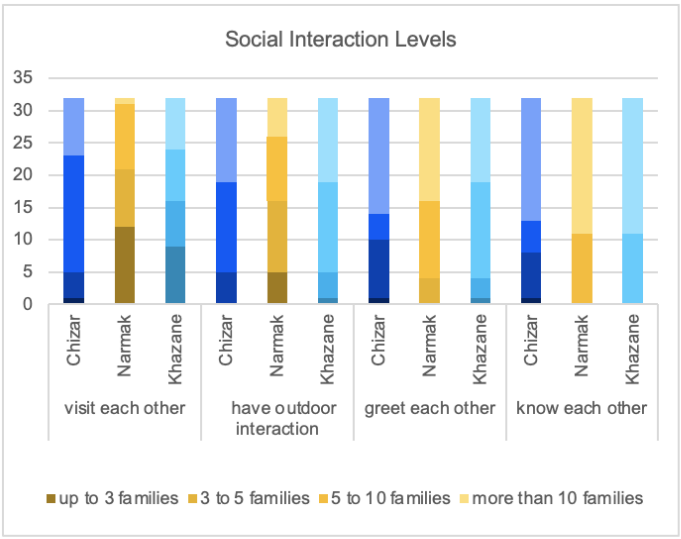
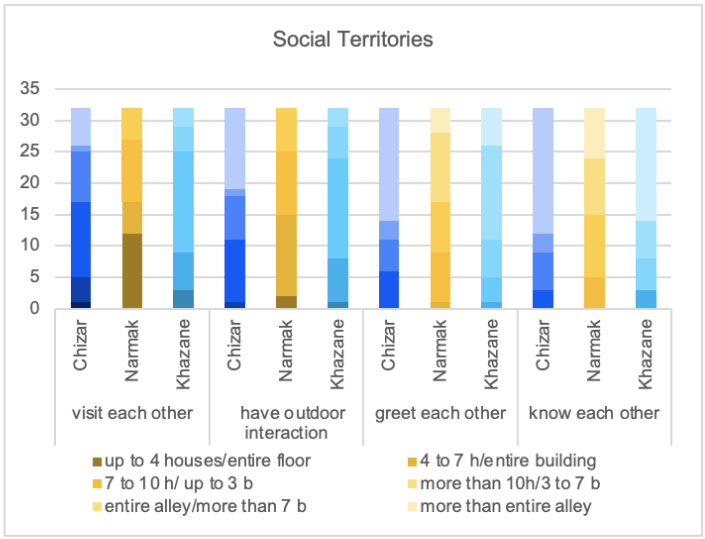
Context/ Attribute	VISIBILITY GRAPHS				
	Integration	Integration R3	Connectivity	Isovist Area	Gate Counts
Chizar					
Narmak					
Khazane					
Context/ Attribute	AXIAL GRAPHS				
	Integration	Integration R3	Connectivity	Choice	Choice R3
Chizar					
Narmak					
Khazane					

Table 3. The visibility and axial analysis graphs

Results, including the survey results' correlation coefficients and software analysis is presented next. [Table 6] shows correlation coefficients between the questionnaire results and visibility attributes and [Table 7] presents these correlations with the axial attributes.





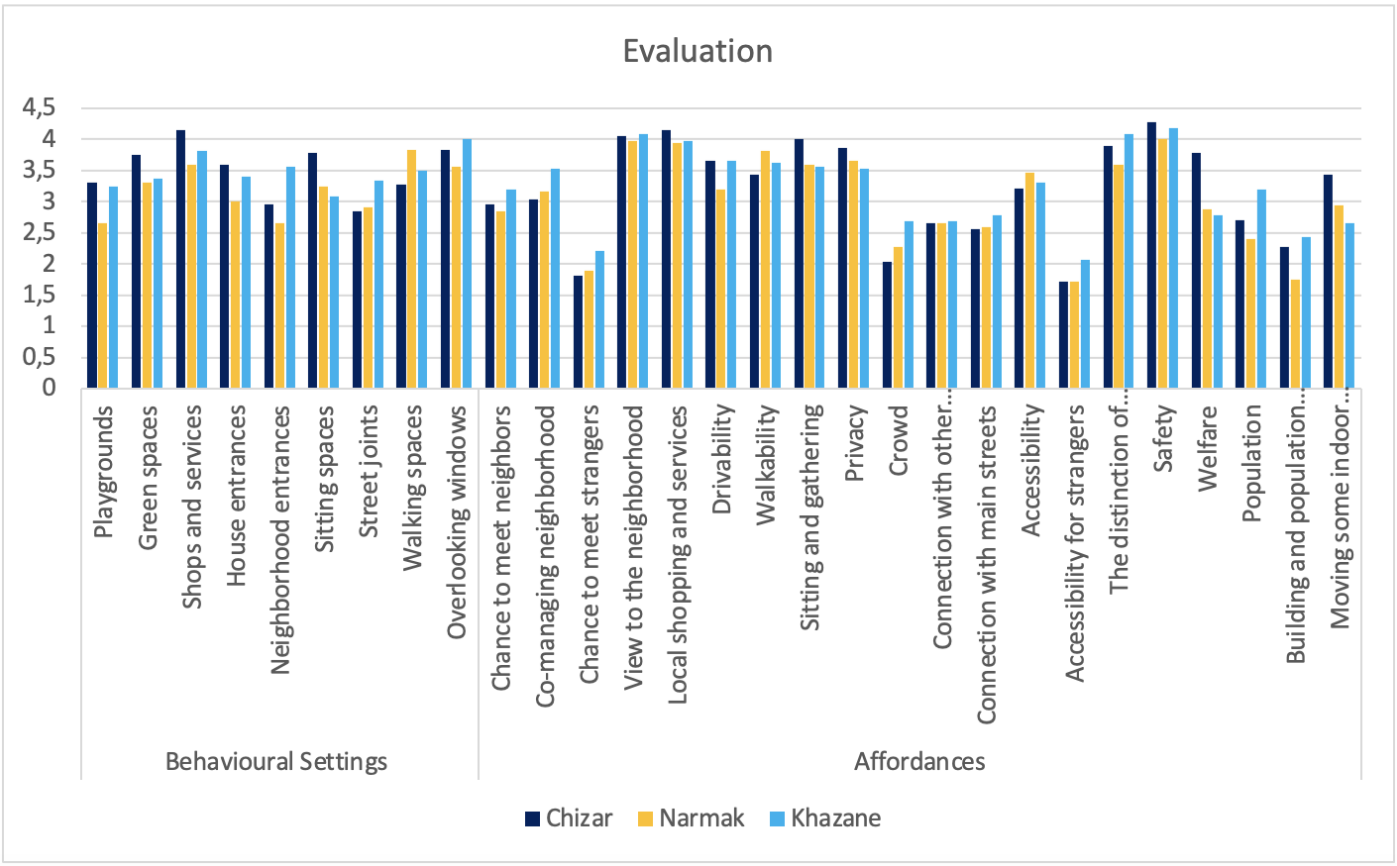


Figure 2. The questionnaire results a) social interaction, b) social territories and c) behavioral settings and environmental affordances

Table 4. Visual graph analysis results

Context/ Attribute		VISIBILITY GRAPH ANALYSIS										
		Integration	Integration R3	Connectivity	Mean Depth	Mean Depth R3	Control	Controllability	Entropy R3	Isovist Area	Gate Counts	Clustering Coefficient
Chizar	maximum	3.88	7.36	1441.00	7.19	7.36	1.87	0.39	1.25	5075.44	19.00	1.00
	minimum	2.09	2.86	4.00	4.32	2.86	0.20	0.04	0.68	19.88	1.00	0.42
	average	2.96	5.46	211.96	5.43	5.46	0.86	0.16	0.95	799.17	5.85	0.76
	std dev	0.38	0.79	216.12	0.58	0.79	0.26	0.05	0.13	779.56	3.97	0.14
Narmak	maximum	5.20	7.56	659.00	6.76	2.93	2.08	0.49	1.38	10603.50	20.00	1.00
	minimum	2.29	3.57	16.00	3.50	2.42	0.27	0.02	0.37	294.12	0.00	0.43
	average	3.21	5.06	103.19	5.22	2.77	0.97	0.22	0.78	1682.07	4.12	0.82
	std dev	0.59	0.93	83.95	0.70	0.12	0.28	0.13	0.26	1347.33	3.96	0.16
Khazane	maximum	7.00	9.04	2820.00	6.72	2.93	2.05	0.60	1.44	46912.00	51.00	1.00
	minimum	2.30	2.58	6.00	2.88	2.28	0.37	0.03	0.36	137.93	1.00	0.44
	average	4.39	6.37	334.76	4.11	2.78	1.02	0.08	0.75	5417.37	4.54	0.88
	std dev	0.77	1.06	407.63	0.60	0.12	0.33	0.08	0.22	6677.85	5.52	0.10

Table 5. Axial analysis results

Context/ Attribute		AXIAL ANALYSIS																
		Integration	Integration R3	Choice	Choice R3	Connectivity	Mean Depth	Mean Depth R3	Choice Norm	Choice Norm R3	Control	Controllability	Total depth R3	Harmonic Mean Depth R3	Entropy R3	Relativised Entropy R3	Intensity R3	RA R3
Chizar	maximum	0.50	1.85	41227.00	74.00	5.00	19.48	2.58	0.02	0.29	0.29	0.50	59.00	19.75	1.53	2.05	1.36	0.30
	minimum	0.46	0.92	0.00	0.00	1.00	17.91	2.22	0.00	0.00	0.00	0.25	28.00	11.97	1.20	1.61	0.87	0.11
	average	0.48	1.39	15109.40	27.80	2.90	18.85	2.39	0.01	0.14	0.14	0.34	42.50	16.26	1.39	1.82	1.12	0.19
	std dev	0.01	0.33	14096.00	24.47	1.37	0.52	0.11	0.01	0.09	0.09	0.07	12.21	2.60	0.10	0.15	0.15	0.07
Narmak	maximum	1.12	2.15	117680.00	58.00	6.00	13.83	2.67	0.01	0.33	2.25	0.50	171.00	17.86	1.57	2.48	1.98	0.53
	minimum	0.73	0.64	0.00	0.00	1.00	9.40	1.88	0.00	0.00	0.33	0.17	14.00	8.76	1.05	1.23	0.64	0.05
	average	0.87	1.46	17880.00	17.63	3.19	11.96	2.27	0.00	0.11	0.96	0.36	41.62	14.07	1.44	1.64	1.34	0.21
	std dev	0.09	0.45	27418.50	19.52	1.43	1.04	0.20	0.00	0.11	0.51	0.08	32.08	2.89	0.12	0.29	0.31	0.14
Khazane	maximum	0.87	2.64	129951.00	558.00	12.00	14.08	2.77	0.07	0.38	7.93	0.50	179.00	39.04	1.53	2.58	2.04	0.83
	minimum	0.64	0.42	0.00	0.00	1.00	10.60	2.00	0.00	0.00	0.08	0.08	9.00	7.86	0.82	1.14	0.52	0.04
	average	0.74	1.49	10883.80	49.13	2.75	12.41	2.51	0.01	0.07	1.17	0.30	66.67	19.23	1.22	2.08	0.93	0.19
	std dev	0.05	0.51	27897.30	121.92	2.60	0.78	0.17	0.01	0.10	1.62	0.14	37.84	8.30	0.18	0.35	0.35	0.16

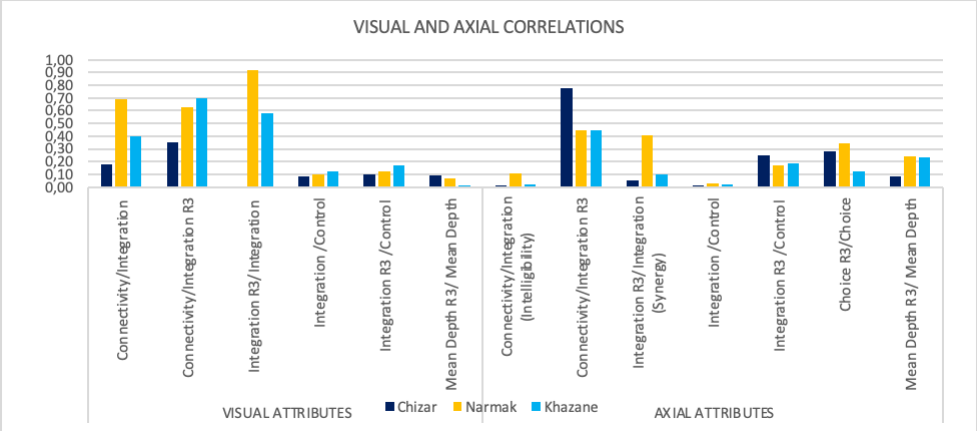


Figure 3. Internal correlations of space syntax attributes (r^2)

Table 6. The correlations' coefficients between questionnaire results and visibility analysis

Correlation			VGA & ISOVIST ANALYSIS																				
			Integration			Integration R3			Connectivity			Mean Depth			Mean Depth R3			Control			Controllability		
			Chizar	Narmak	Khazane	Chizar	Narmak	Khazane	Chizar	Narmak	Khazane	Chizar	Narmak	Khazane	Chizar	Narmak	Khazane	Chizar	Narmak	Khazane	Chizar	Narmak	Khazane
Questionnaire Results	Social Relation Level	Visit each other		-0.65			**-0.71**						0.65									0.65	
		Have outdoor interaction		**-0.72**			**-0.75**						**0.72**									0.67	
		Greet each other	0.56	0.61			0.67		0.56			-0.55	-0.61									-0.66	
		Know each other	0.45						0.52													-0.60	
	Physical Territory	Visit each other		**-0.75**			**-0.77**			-0.46			**0.75**									0.61	
		Have outdoor interaction	0.49	**-0.72**			**-0.73**		0.50	-0.45		-0.49	**0.72**									0.52	
		Greet each other		0.63			0.65	0.49			0.50		-0.63							0.56		-0.61	
		Know each other		0.55			0.56						-0.55									-0.58	
	Behavioral Settings	Playgrounds		0.49			0.52						-0.57									-0.51	
		Green spaces	0.67			0.46	0.49		0.49			-0.69	-0.53		**-0.79**							-0.49	
		Shops and Services	**0.72**		0.58	0.51		0.59	0.60		0.57	**-0.72**		-0.58	-0.68			0.50					
		House entrances		-0.60	-0.58		-0.62	-0.57			-0.43		0.65	0.60								0.67	
		Neighborhood entrances	-0.67	-0.55	-0.54	-0.55	-0.58	-0.57	-0.50		-0.51	**0.70**	0.62	0.54	0.52							0.61	
		Sitting spaces	**0.83**			0.61			0.64			**-0.85**			**0.79**	0.52							
		Street joints	-0.69		-0.66	-0.62		-0.63	-0.53		-0.53	**0.70**		0.66	0.53							0.46	
		Walking spaces	**-0.75**	-0.59	-0.68	-0.53	-0.66	**-0.71**	-0.60		-0.67	**0.76**	0.65	0.67	**0.72**			-0.45		-0.55			
		Overlooking windows	**0.70**		0.56	0.60		0.57	0.50		0.59	**-0.73**		-0.55	-0.67								
	Affordances	Chance to meet neighbors	**-0.82**		-0.55	-0.67	0.46	-0.56	-0.66		-0.50	**0.84**	-0.50	0.55	0.67								
		Co-managing neighborhood	**-0.77**	-0.50		-0.61	-0.51		-0.55			**0.80**	0.51		0.67							0.61	
		Chance to meet strangers		-0.56	-0.49		-0.65	-0.61			0.60		0.58	0.5			0.56			-0.49		0.54	
		Views to neighborhood	**0.73**	0.47	**0.73**	0.53	0.53	**0.75**	0.56		0.69	**-0.74**	-0.48	**-0.73**	-0.64		-0.5	0.45		0.51			-0.49
		Local shopping and services	**0.72**		0.46	0.55			0.61			**-0.72**			-0.66			0.50					
		Drivability	0.66		0.44	0.49		0.46	0.45			**-0.70**			-0.68								
		Walkability	**-0.76**		-0.65	-0.57		-0.54	-0.63		-0.67	**0.77**		0.58	0.67		0.55			-0.65			
		Sitting and gathering	**0.79**			0.61	0.50		0.63			**-0.79**	-0.50		**-0.78**								
		Privacy	0.66	0.55	0.46	0.48	0.66	0.49	0.51			-0.67	-0.61		-0.68	0.47		0.48				-0.47	
		Crowd					-0.49	-0.48		-0.47	-0.51												
		Connection with other neighborhoods	-0.65	-0.60	**-0.71**	-0.48	-0.62	-0.72	-0.46		**-0.75**	0.68	0.62	**0.7**	**0.73**		0.57	-0.51		-0.60		0.48	
		Connection with main streets	**-0.74**	-0.56	-0.55	-0.61	-0.61	-0.61	-0.54		-0.66	**0.77**	0.57	0.54	0.64		0.55			-0.46		0.64	
		Accessibility	**-0.75**	-0.51	-0.62	-0.65	-0.58	-0.65	-0.66		-0.66	**0.76**	0.55	0.6	0.64		0.52			-0.51		0.46	
		Accessibility for strangers	-0.46		-0.66	-0.51		-0.63			-0.65	0.48		0.65									
		The distinction of neighborhood signs	**0.74**		0.59	0.65		0.59	0.58		0.53	**-0.76**		-0.56	-0.62					0.48		-0.46	
		Safety	**0.79**	0.59	**0.74**	0.65	0.65	**0.74**	0.62		**0.72**	**-0.80**	-0.61	**-0.73**	**-0.74**		-0.51	0.46		0.50		-0.62	
		Welfare	**0.73**			0.55			0.60			**-0.74**			**-0.72**			0.51					
		Population	**0.77**			**0.73**			**0.71**			**-0.75**			-0.46								
		Building and population density	0.68			0.54			0.60			**-0.70**			-0.56								
		Moving some indoor activities to outdoor	0.62	-0.64		0.47	-0.62					-0.65	0.64		-0.55							0.59	

Table 7. The correlations' coefficients between questionnaire results and axial analysis

Correlation			AXIAL ANALYSIS																			
			Integration			Integration R3			Connectivity			Mean Depth			Mean Depth R3			Choice			Choice R3		
			Chizar	Narmak	Khazane	Chizar	Narmak	Khazane	Chizar	Narmak	Khazane	Chizar	Narmak	Khazane	Chizar	Narmak	Khazane	Chizar	Narmak	Khazane	Chizar	Narmak	Khazane
Questionnaire Results	Social relation level	Visit each other		-0.69			-0.61	_		-0.53	_		0.68						-0.68			-0.68	
		Have outdoor interaction		**-0.75**			**-0.72**			-0.62			**0.75**						**-0.77**			**-0.78**	
		Greet each other	0.67	0.64		**0.79**			**0.71**	0.66		**-0.70**	-0.64		**-0.76**			**0.78**	**0.82**		**0.79**	**0.83**	
		Know each other	0.61	0.46		**0.71**	_		0.61	_		-0.62			-0.65			0.68	0.50		**0.70**	0.51	
	Physical Territory	Visit each other		**-0.70**			-0.63			-0.54			**0.72**						**-0.70**			-0.64	
		Have outdoor interaction	0.67	-0.66		**0.75**	-0.63		0.66	-0.59		-0.68	0.68		**-0.75**			**0.74**	**-0.71**		**0.75**	-0.67	
		Greet each other	0.46	**0.70**		0.56	**0.72**	0.46	0.53	0.67	0.48	-0.48	-0.70	_	-0.62	_		0.54	**0.78**		0.57	**0.76**	
		Know each other		0.60			**0.70**	0.44		**0.70**	0.47		-0.60		-0.52				0.68		0.45	**0.75**	
	Behavioral Settings	Playgrounds		0.45			**0.74**			**0.86**			-0.51			-0.45						0.79	
		Green spaces	**0.70**			**0.77**	0.69		**0.80**	**0.81**		**-0.73**	-0.49		**-0.79**			**0.77**			**0.81**	0.74	
		Shops and Services	0.55			**0.70**	0.56	0.49	0.67	**0.74**		-0.59			-0.68	-0.55		0.64			0.68	0.52	
		House entrances		-0.52			-0.64	-0.47		**-0.70**	-0.45		0.55						-0.46			-0.81	
		Neighborhood entrances		-0.46		-0.66	-0.60	-0.46	-0.60	-0.68	-0.49	0.46	0.49		0.52			-0.56			-0.57	-0.76	
		Sitting spaces	0.59			**0.77**	0.51		**0.77**	**0.71**		-0.64			**-0.79**	-0.51		0.68			**0.74**	0.57	
		Street joints				-0.60	-0.57	-0.63	-0.55	**-0.70**	-0.61				0.53			**-0.51**		-0.48	-0.54	-0.65	-0.48
		Walking spaces	-0.60	-0.55		**-0.78**	**-0.83**	-0.57	-0.69	**-0.80**	-0.57	0.63	0.58		**0.72**			**-0.70**	-0.52		**-0.73**	**-0.83**	
		Overlooking windows	0.60			**0.75**	0.52	0.48	**0.70**	0.62		-0.63			-0.67			**0.74**			**0.76**	0.64	
	Affordances	Chance to meet neighbors	-0.52			**-0.74**	**0.76**		**-0.72**	**0.78**		0.57	-0.45		0.67			-0.65			-0.67	0.61	
		Co-managing neighborhood	0.61			**-0.79**	-0.46		**-0.77**	-0.51		0.65	0.46		0.67			**-0.73**			**-0.74**	-0.69	
		Chance to meet strangers		-0.51			-0.47						0.50						-0.56			-0.68	
		Views to neighborhood	0.52			0.66	0.66	0.63	0.58	0.66	0.56	-0.56	-0.45		-0.64		-0.51	0.62	0.50		0.65	0.77	
		Local shopping and services	0.55			**0.73**			0.64	0.48		-0.58			-0.66	-0.54		0.65			0.68		
		Drivability	0.55			**0.73**	0.56		**0.72**	**0.73**		-0.59			-0.68	-0.48		0.65			0.68	0.50	
		Walkability	-0.58		-0.53	**-0.78**	-0.65	-0.64	**-0.70**	**-0.70**	-0.67	0.61		0.53	0.67		0.50	-0.68		-0.56	**-0.70**	-0.69	-0.55
		Sitting and gathering	0.59			**0.74**	0.68		**0.73**	**0.77**		-0.64			**-0.78**			**0.70**			**0.76**	0.69	
		Privacy	0.57	0.52		**0.70**	0.67	0.49	**0.71**	0.63		-0.61	-0.55		-0.68			0.68	0.52		**0.70**	0.72	
		Crowd																	-0.53			-0.48	
		Connection with other neighborhoods	-0.68	-0.54		**-0.83**	**-0.71**	-0.60	**-0.79**	-0.69	-0.55	**0.72**	0.55		**0.73**		0.49	**-0.79**	-0.53		**-0.80**	-0.80	
		Connection with main streets	-0.62	-0.50		**-0.80**	-0.62	-0.46	**-0.73**	-0.63	-0.46	0.65	0.51		0.64			**-0.76**	-0.49		**-0.76**	-0.76	
		Accessibility	-0.55	-0.45		**-0.75**	-0.68	-0.51	**-0.71**	-0.69	-0.54	0.59	0.47		0.64		0.52	-0.66	-0.47		-0.69	-0.77	
		Accessibility for strangers			-0.46			-0.54	-0.46		-0.49			0.46								-0.48	
		The distinction of neighborhood signs	0.52			**0.74**	0.55	0.52	0.64	0.57	0.51	-0.56			-0.62			0.67			0.68	0.65	
		Safety	0.63	0.54	0.45	**0.83**	0.57	0.66	**0.75**	0.54	0.51	-0.67	-0.55	-0.45	**-0.74**			**0.75**	0.55		**0.78**	0.75	
		Welfare	0.64		0.58	**0.79**			0.69		0.53	-0.67		-0.56	**-0.72**			**0.74**		0.63	**0.77**		0.62
		Population			0.47									-0.48	-0.46								
		Building and population density				0.66		0.47	0.54			-0.45			-0.56			0.53			0.56		
		Moving some indoor activities to outdoor	0.46	-0.61		0.62	-0.50		0.61			-0.49	0.61		0.55			0.58	-0.55		0.59	-0.62	

Discussion

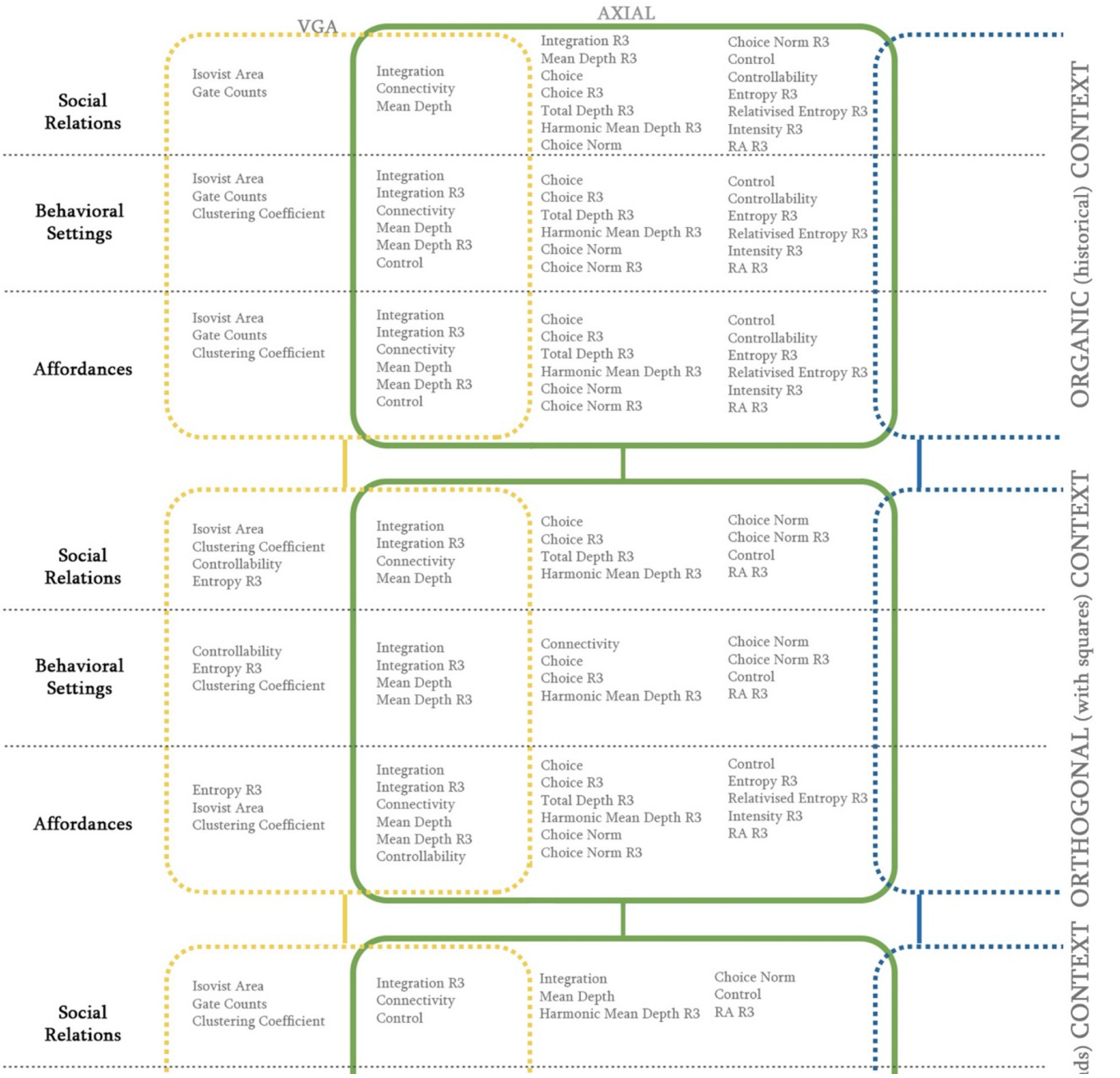
Studying the correlations obtained from the analysis of each context in terms of micro and macro scale, visibility and axial analyses, and common attributes between them reveals the unique

characteristics of each of the three types of context, including organic, orthogonal with a combination of urban squares, and orthogonal with a variety of hierarchical passages. The results of this study and the presented classification of human behavior at different scales (Eslami Mojaveri et al., 2021) are given in [Figure 4]. The space syntax attributes that are interrelated with the territory of social relations, behavioral settings, and environmental affordances can be used to study or design these and similar contexts. It can also be concluded that these attributes are more significant and have a higher impact on human social behavior at the home-based space scale compared to the non-correlational attributes in each type of context.

Comparing the new results with previous studies on the types of organic and geometric contexts is even more important than direct studies of cases. To understand these findings correctly, one should note that the modern context of Narmak is not a simple grid type but a combination of orthogonal network and urban squares and that the other modern context (Khazane) regarding its unique features and establishing upon a spontaneous context, must be considered a combination of orthogonal network and hierarchical (dead-end) passages.

Comparing historical and modern contexts (Can & Heath, 2016) reveals that local integration, global integration, and connectivity correlate strongly with stationary and movement behaviors and social interactions. Furthermore, according to these results, synergy has a stronger correlation with long-duration activities. According to the present study results, these results are confirmed because the correlation of these attributes with behavioral settings and environmental affordances for stationary behaviors is higher than other attributes, and the connectivity attribute has a higher correlation with these options compared to the movement.

Furthermore, the local integration has stronger correlations than the global type. According to the results of the same study, historical contexts have more social interactions than modern cases. According to the present study results, social interactions in the modern context of Narmak are not inferior to the historical context of Chizar. The correlation of the attributes of integration and connectivity with social interactions is even more significant in some cases. In the visibility analysis, this superiority is even stronger. The correlations of these two attributes with sitting and walking



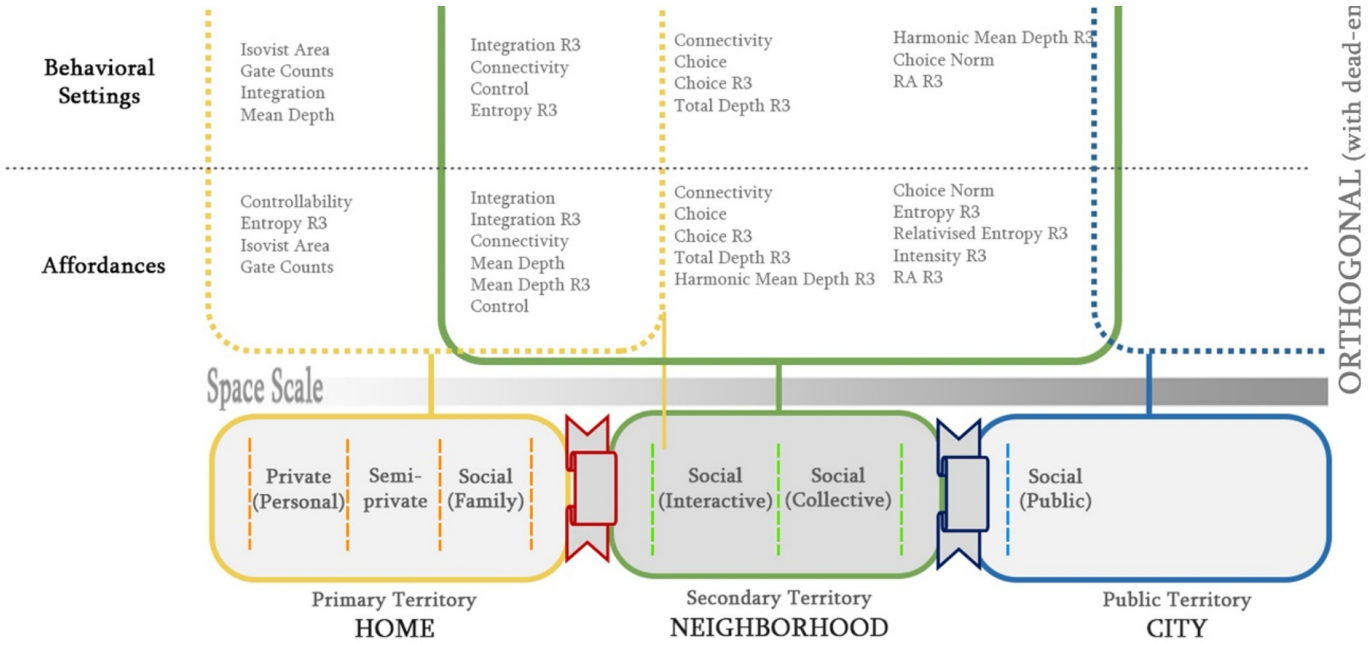


Figure 4. The platform of correlated attributes in each of the three contexts.

spaces and the environmental affordances for walking and gathering do not indicate a remarkable distinction for one of the two contexts and are high in both.

Another finding of this study is the lack of connection between the activities of adults and children, which suggests that active spaces with high social interactions do not mean active use of children's play spaces. The present study confirmed an apparent detachment between adult behavioral settings and children's play space and their correlation with the space syntax attributes.

According to the results of a study in pre-modern and modern contexts (Omer et al., 2015), pre-modern contexts are more suitable for walking, the values of space syntax attributes in them are higher, and the correlation of attributes with observations is higher compared to those of other contexts. In our study, the pre-modern context of Chizar, despite having high values in the rate of walking and its correlation with the axial attributes, does not have a significant advantage over the two modern contexts studied. But, in the visibility analyses of this context, higher correlations are seen with behavioral settings and environmental affordances related to walking. The mentioned study also shows a higher correlation between space syntax attributes and social interactions in pre-modern contexts. However, this result is not confirmed in the present study, as the modern Narmak context shows a much higher correlation.

According to Friedrich et al. (2009), orthogonal contexts have higher safety than organic contexts. In comparison, our studies showed that the safety of the Chizar context as an organic context is higher than the other two cases, although it is slightly different from them. Previous results show that security in the orthogonal context is directly related to integration. In the present study, the correlation coefficient of the Chizar organic context with global and local integrations is higher than Narmak and Khazane's orthogonal cases. One reason for this difference is that safety is more affected by social issues than other components, and physical characteristics only provide a suitable context for security or insecurity (Nes & Yamu, 2018).

According to the results of the mentioned study, the high correlation between the connectivity and local and global integrations is related to security, and great global and local depth is related to insecurity. Besides, the present research results confirm this relationship by the correlation of connectivity and local integration. The correlation of security with local and global mean depth is negative (i.e., inverse relationship) in all three contexts, especially in the global type.

According to the results of previous studies, the correlation between movement and integration is stronger in intelligible contexts (Kim, 1999). Meanwhile, in complex (non-grid) and unintelligible contexts, there is less correlation between movement and integration (Penn, 2003). The results showed that the correlations of Chizar context – which is of non-grid organic type and has the lowest intelligibility according to Hillier's definition – are not inferior and even are stronger than the other two cases. If we consider the relationship between local integration and connectivity as a criterion for recognizing intelligibility, the context of Chizar will have the highest value compared to the other two contexts. On the contrary, this result seems true for the Khazane context, which is the result of creating a grid network in a context that suffers from some physical and social problems and complexity. The correlations of this context are lower and weaker than the other two cases. Thus, intelligibility and synergy are very low in both Chizar and Khazane contexts. The first is organic and geometrically complex, while the second is unpredictable or unintelligible, suggesting the weak correlations between the questionnaire results and the space syntax analysis.

Another result of this study is the effect of familiarity with the environment on the type of choice. In examining the correlations of the present study, it can be seen that accessibility has medium and high correlations with all kinds of choices while accessibility for strangers does not correlate with choice attributes.

Cumulative results of the study of the three contexts show that, as expected, the axial attributes of integration and choice have a higher correlation in most contexts. However, regarding the micro-scale of the study area, stronger correlations were expected in visibility analysis. The results showed the opposite and more correlations in axial analysis in general and concerning social relations and their physical territories in particular. Because the scale of the study area is micro, the local attributes are expected to be more important. However, in the visibility analyses, more correlations were observed with global attributes. This issue needs attention due to the visibility nature of studies and their relationship with micro-scale. [Figure 5] represents the study results for all three contexts or the common correlations. The attributes in each section of this diagram can be considered more critical for all three contexts. These attributes can be compared with results represented in the general studies of the space syntax alongside the details of the correlation table.

According to the platform drawn in [Figure 5], most of the attributes are axial and correlate with environmental affordances. Examining the correlation more closely based on the rows of [Table 6] & [Table 7] shows that in the social relations rows, the correlations are scattered by cases but are similar in the two types of analysis. In behavioral settings, walking spaces and neighborhood

entrances, and in the environmental affordances, security and connection with other neighborhoods, connection with main streets and accessibility have the highest correlations. The only exceptions to further correlations are the neighborhood's visibility in visibility analysis and the walkability in the axial analysis, which is deeply related to the titles of this type of analysis.

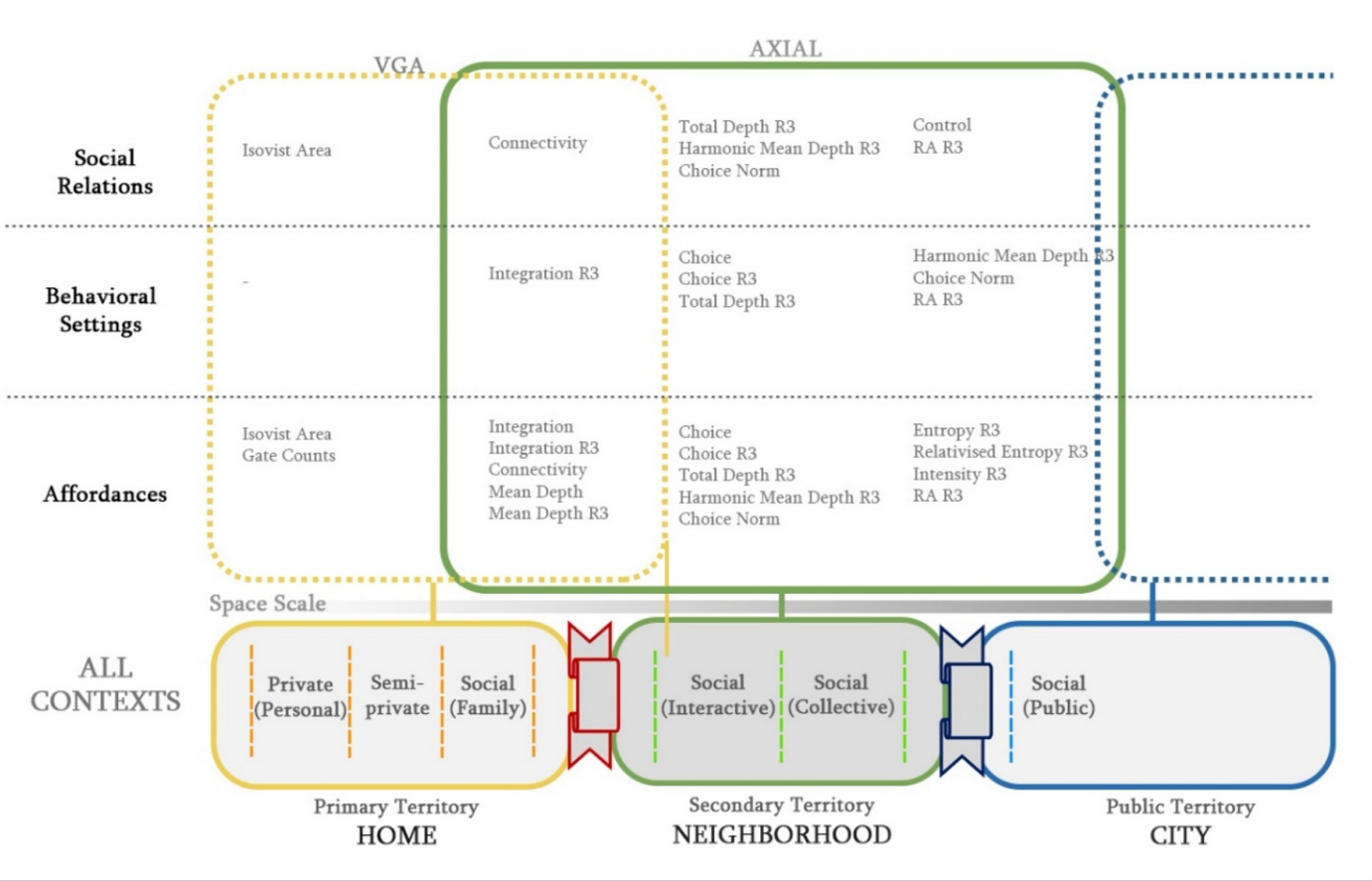


Figure 5. The platform of correlated attributes in all three contexts.

These results confirm the results of previous studies (Marcus, 2018) in the direction of correlation of axial analyses with visibility and accessibility. Considering the significant correlations with the integration attribute in both visibility and axial analysis, we can confirm another result from previous research (Batty, 2001) about the relationship between the integration attribute and accessibility. Observing the commonality of the three contexts in the principal attributes correlations, despite the differences in Figure 4, confirms Hillier's finding that the common features of different contexts occur at the global scale and the differences at the micro-scale (Hillier, 1989).

According to a previous study, high integration indicates a high possibility of walking (Hillier, 1996a). In comparison, in the present study, the relationship between walking and local integration is inverse in all three contexts. Indeed, this relationship is positive for drivability as in previous studies (Morales et al., 2019). Therefore, the relationship between walkability and drivability in contexts studied has an inverse relation.

In another research (Ottenby, 2017), a correlation was found between the axial choice and the visibility attribute with security. According to our study, this result is confirmed by the choice attribute. In addition, there is a stronger correlation between local choice in both simple choice and norm choice. Regarding visibility, the correlation between the isovist area and safety is strong in the Khazane context, moderate in Chizar, and non-significant in the Narmak context. Hence, no general findings can be made in this regard.

Conclusion

In this study, three types of contexts, including organic (historical) in Chizar, orthogonal (modern) with a combination of urban squares, and orthogonal combined with hierarchical passages in the Khazane, were compared in two survey and software analysis methods with space syntax method. The results were reported in the form of some tables and a system of correlations between the results of the two methods. These results add analyzable information to the existing knowledge about these contexts regarding significant relationships between the features that can be studied with the space syntax and behavioral science topics. First of all, the study results show that there is mostly a strong relation between someone's home location space syntax characteristics and environmental behavior in neighborhood.

In general, very high correlations were obtained between space syntax attributes and survey results in Chizar and Narmak cases. Therefore, it can be concluded that this type of context is more predictable based on software analysis (Chizar and Narmak), while the Khazane context (which has weaker correlations) is more complex or less predictable. In addition, the presented results can be considered and used to study or design similar contexts.

Apart from the context and comparative results, a cumulative analysis or a system of common correlations between all is also presented, which is the scientific contribution of the present study in the field of space syntax studies. Among these, unexpected results are of particular significance, e.g., stronger correlations of axial attributes than visual attributes and stronger correlations of global attributes in visual analysis, despite the micro-scale of the study area. Furthermore, the inverse relationship between integration and walking in all contexts contradicts the major findings of previous

research. Eventually, different results were obtained regarding context characteristics compared to the complex and organic contexts mentioned in previous research. Some of these results are about discrepancies with higher values, correlations, walkability, and social relations in historical contexts compared to the modern contexts, differences with higher security in orthogonal contexts, and stronger correlation of security and integration in orthogonal contexts and discrepancy with the higher correlation between integration and movement in more intelligible and orthogonal contexts.

Finally, it is noteworthy that contextual analysis of the results of this study based on the details of physical characteristics and its relationship with the social features of each context is the subject of another analytical research. To consolidate, refine, and expand the results of this study, especially regarding these different results, we propose a series of studies in the future. To consolidate the results for each sample, it will be effective to repeat the study in more sections of the context, for the results of each context type, it will be useful to study more similar samples, and to consolidate and generalize the cumulative findings it will be helpful to study more types and more context samples. Such studies clarify if each finding is exceptional, unique, or belongs to whole contexts or similar contexts. Eventually, they show whether important differences, such as inverse relation between integration and walking, result from specific surveying and analysis conditions or a particular “space culture” feature. It is also suggested to extend the correlation system by developing the study attributes, especially the metric attributes, and recording the results in different radii. Eventually, it is recommended to set up the research to test this platform as a Design assistant method.

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The research data are available and shared in: Eslami Mojaveri, Babak Nasr (2021), “E-B & Space syntax, Context Studies in Tehran”, Mendeley Data, V1, DOI: 10.17632/d223wddrs5.1

Footnotes

[1] https://map.tehran.ir/

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- https://www.spacesyntax.online/
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