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ORIGINAL ARTICLE

Pedestrian accessibility in spatial gridiron organisations: a measure by regarding visual graph analysis

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Abstract

For a walkable square, it is essential to thoroughly assess the physical environment with patterning, specifying aspects, gridiron organisations' effect evaluations, and successful relationships. This research reveals the spatial pattern of Taft City square regarding graph theory and its indicators. Given a network representation, we aggregate spatial pattern aspects and indicators into a sophisticated description of a social space in which everything may be connected to everything else in the vicinity. Then, we encode it into the adjacency matrix and attribute and organise it according to analytic skills. Extracting physical patterns helps us rearrange public spaces and make the city a better host for its users' activities, maintaining and sustaining them from ongoing destruction. This article analyses historical square typologies and their elements to form patterns for planning processes required to support the desired change or growth over time. Research indicates that smaller squares are preferable for pedestrians and walkability. Using the specified pattern and square measurements, the maximum accessibility level for walkability in each local community is 20 m in length and 15 m in width. Therefore, the square area in Taft City is seen as a public space that can be used for new gridiron subdivisions.

Keywords Patterning · Public space · Spatial pattern · Graph theory · Spatial gridiron organisations · Walkability

Introduction

The effects of shaping material things on ambient space are mathematically and quantitatively defined. Understanding these impacts will help us better understand urban form (Hillier 2002) and human-scale spatial cognition (Hillier 2007). It enables us to demonstrate that human movement is directed by geometrical and topological rather than metrical considerations and that spatial structure influences movement strongly (Hillier and Iida 2005; Turner and Penn 1999; Turner et al. 2001; Figueiredo and Amorim 2005). Porta and Xie developed a collection of geographical graph indices (Porta et al. 2006, 2012; Xie and Levinson 2007). The Axwoman toolbox (Jiang et al. 1999), the SANET toolbox (Okabe et al. 2006; Okabe and Sugihara 2012), and other custom-built GIS applications (Miller and Wu 2000) were made to make spatial network investigations work (Peponis et al. 2008).

Other studies also link space to urban variables, including land-use patterns and density. Urban space patterns shape movement and land-use indicators, leading to the city's generic form—a foreground network of linked centres at all scales. As demonstrated by Hillier (1999), the logic of a network generates centres and sub-centres, each of which is influenced by its connections to others (Batty 2004). At this level, configurational concepts and predictive analysis of space suggest that these concepts may be beneficial to other fields where similar problems exist, such as some aspects of cognitive psychology and sociology. Regretfully, in this subject, researchers cannot advise designers on how structures and settings should be and are too little concerned with how they are. However, this research tries to grasp better the phenomenon of architecture and its influence on people's lives (Hillier 2007).

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Diverse methodologies, models, techniques, and multi-temporal datasets are used to determine city land-use changes. To exemplify, comparative research employed UA data (Urban Atlas) to identify and analyse urban changes (Aksoy et al. 2022b). Land usage and spatial development alter throughout time (Akengin and Kayki 2013; Aksoy et al. 2022a). How cities adapt to individual and societal demands is a basic subject. Now, when people are more aware of the environment than ever before, new ways need to be found to build the cities of the future (Ortakavak et al. 2020).

In addition to providing physical protection, buildings also embody social organisation as physical configurations of shapes and components that we perceive. Constructional features of space, building elements, and geometrical coordination make it lucrative to replicate culturally established spatial and formal patterns since these are geometrical spatial patterns that seldom feel "wrong" (Hillier 2007). In fact, for almost a century, these physical patterns provided the best climatic solution. Their devastation has lowered the quality of the areas, causing residents to flee. That is a spatial "long model" generated by this accurate system of spatial relationships and chronological movements. The shape of public space, the two- and three-dimensional geometries of built form, and the roads that connect them are all important factors that urban planners use to configure change and development. We can make public places more lovely, generous, just, and functional by presenting the city's infrastructure. We developed a pattern by rearranging ancient public spaces that makes each portion and the overall city better hosts for its users' activities. Activities, location, intensity, and the rate of change may all be factored into the city planning process (Hillier 2007).

A vernacular urban infrastructure needs to accommodate rotating tenants and allow these rotations to occur frequently. However, its main drawback is that their physical degradation affects their patterns, leading to a looming crisis. This article examines square typologies and their aspects in order to adapt planning patterns to changes or expansion over time. Several advantages have been demonstrated for urban gridiron groups. They encourage rectangular building forms that are easier to build than oblique ones (Steadman 2006); they are easy to navigate and remember (Gell 1985; Sadalla and Montello 1989); and they allow an axial organisation of places of symbolic importance (Gell 1985; Sadalla and Montello 1989). These and other advantages have lasted through shifting social and technical regimes, proving grids' viability in many modern cities (Grant 2001). Despite the wealth of information on grid history, design, and implementation (Anderson 1993; Castagnoli 1971; Figueiredo and Amorim 2007; Marshall and Gong 2005; Moughtin 2007; Reps 1965; Shpuza 2007; Habitat 2013), the problem of grid dimensions has been mostly ignored. Cities' grids vary significantly in size (Sevtsuk et al. 2016).

Human adaptability to attain climate comfort based on human activities is also required. Historical places' spatial plans may teach us about energy saving for future urban architecture and planning (Cetin 2020a, b; Cetin et al. 2018). Walkable cities save energy (Newman and Kenworthy 1999; Zegras 2004; Frank and Pivo 1994; Krizek 2003); improve public health (Forsyth et al. 2008; Rundle et al. 2007; Hoehner et al. 2005; Kalayci Onac et al. 2021; Cetin 2015; Ortakavak et al. 2020; Cetin et al. 2018).

Few studies have shown grids, their specific dimensions, and their potential repercussions (Castagnoli 1971; Hillier 1999; Moudon 1986; Panerai et al. 1997; Reps 1965; Siksna 1998). Many urbanists promote smaller blocks for their perceived "walkability". According to Leon Krier, tiny city blocks provide greater urban variety and complexity. In a multidirectional horizontal structure of urban areas, urban blocks should be as short and wide as typologically practicable (Sevtsuk et al. 2016). According to Jacobs, shorter blocks would allow for more contacts and exchanges between grid dwellers (Jacobs 1961a, b, 1993); Planners and designers have come to agree that small blocks are easier to walk around (Sevtsuk et al. 2016).

The article covers four questions: (1) How do grid block, plot, and square sizes impact pedestrian accessibility? (2) What is the maximum walking accessibility level utilising the supplied layout and square dimensions in two-entry or tree-entry rectangular grids? (3) How close are existing vernacular and historical urban grids to the greatest attainable pedestrian accessibility levels with current block widths? (4) What are the best proportions for new gridiron subdivisions to maximise pedestrian accessibility? (Sevtsuk et al. 2016).

In this vein, we addressed the spatial pattern problems in one of the specific urban spaces in Iranian culture. After the advent of Islam in Iran, this new physical pattern emerged: an open public area where individuals may do social activities—social rituals—to develop relationships or communicate. Their spatial patterns have evolved through time, changing the body's functions and structure. Public structures with limited functions, such as contemporary squares, have difficulty attracting inhabitants and meeting social demands. Iranian Hosseiniyah, a key component of the square, influenced Taft's socio-historical framework. It was one of the urban religious spaces in Muslim culture and a social centre. The squares do not fulfil their crucial function as a social hub or a focal point for social activity in the city. These public places in Taft were appropriate for public meetings, but currently, they are solely used for parking or restricted uses like tourism or shopping. Modern construction has caused the disappearance of these social spaces.

After extracting the spatial pattern of 12 Taft square samples using graph theory, their similarities established standards that helped us form the final graph. The research

Table 1 Key indicators and various methods used in the empirical work. *Source* author as cited in Hall (1969), Sommer (1969), and Scheflen (1972)

Aims	Methods	Tools	Indicators
To identify the spatial patterns in the case study To collect detailed data on the qualitative and quantitative aspects of space	Observations	Camera field notes field surveys	Tie-signs and spatial distance
To examine the spatial circumstances	Spatial analysis	**App:** Excel 2019 AutoCAD 2022	Degree of spatial aspects
To analyse the spatiality of the squares		Interview/note taking	physical orientation

shows that the collective open space pattern correlates to a square space.

Research method

Due to the widespread and complex topic, we used a combination of methodologies; the method discussed in the conceptual document review phase of the project was described through library and document research. We collected information from the sample measures through observation, photography, interviews, and other records and field survey methods. In the qualitative and quantitative analysis of the study area, the pattern components were analysed through field observation and perception. In the material stage (case study), the fuzzy synthetic evaluation method was used to calculate, analyse, and evaluate (Tables 1 and 2).

This study allows us to extract configurational aspects from space plans directly related to the square space's social and cultural purpose. In other words, culturally determined patterns are imprinted in the physics and spatial "objectivity" of buildings in urban space via spatial design. By examining places and functions in terms of their configurational relationships and comparing patterns across samples, we may examine how urban settings communicate common cultural trends via their spatial shape (Hillier 2007).

Software

The maps were developed and edited with AutoCad: All maps and figures were exported as multi-layers from AutoCad to Rhino3D, and then they were exported to UNA Toolbox, which is installed on Rhino3D and developed by the City Form Lab at MIT.[1] The pdf format included finishing elements such as combining all single visualisations, relabelling visualised data, standardising fonts, strokes, and symbols, and adding legends, labels, titles, and logos. Due to the absence of reliable architectural maps for case studies in Iran's Cultural Heritage Organization, five weeks of field investigations were conducted. ArcMap and Excel were used for data preparation and visualisation. We made the maps in AutoCAD, and then we used Rhino3D and UNA Toolbox to turn them into paper and graph patterns.

Basal theory: (Graph theory)

We used the network and the graph to pattern the square because of their common features, maintaining and sustaining spatial patterns from ongoing destruction. We consider a square as a network in an evolutionary state where many factors affect its balance and imbalance. We portrayed and introduced one of the theory's applications and questioned its importance in this science in an innovative way. In graph theory, a "path" is a sequence of vertices with an edge between two adjacent vertexes. Relationships between the vertices are presented with a matrix of "zeroes and ones", where the rows are the vertices' names and the columns are the names of edges (Fig. 1). Accordingly, a path is a patch with no duplicate vertices (and repetitive edges). A vertex degree is the number of edges connected to the vertex in graph theory. In other words, the vertex represents the adjacent number of the vertex. Since each edge connects two vertices, the sum of the vertex's degree is twice the number of edges in each graph (Rajabi and Shrifian 2022).

The graphs show how spatial elements of a pattern can relate to each other and how users can experience urban spaces. Therefore, the relationship between activity and space leads to the relationship between the spatial configuration that defines communication and the social interaction of the audience (Rismanchian and Bell 2010; Hillier 2007).

The inability of current network analysis technologies to produce alternate geometric configurations is a critical issue. Most geographical network analysis techniques are good at describing existing geometric networks but poor at improving them under certain constraints (Raford 2010; Schneider; Bielik et al. 2012). Thus, an analyst will often employ before-and-after simulations and network analysis to demonstrate the benefits of planned urban changes. It is less evident how the insights will help the design. This is a

[1] https://unatoolbox.notion.site/

Table 2 A description of the main method steps (spatial pattern). *Source* authors

A description of the main method steps (spatial pattern), source: authors.

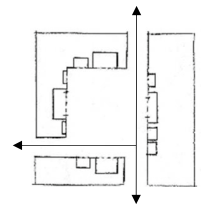
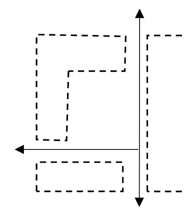
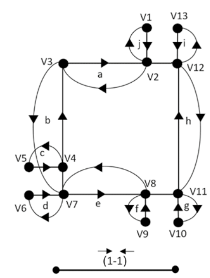
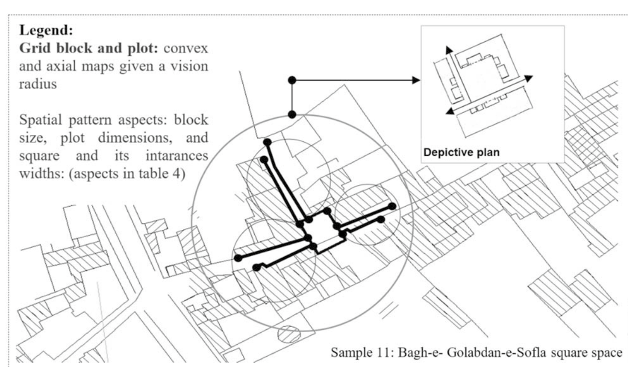
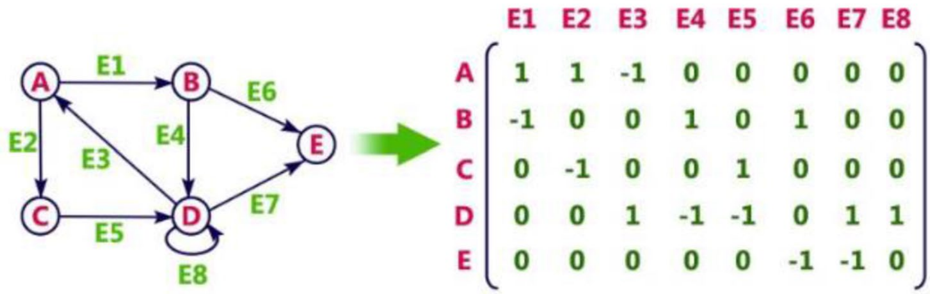
<table>
<tr><th>Step</th><th>Descriptions</th><th>Depictive plan and pattern graph sample 11: Bagh-e- Golabdan-e-Sofla square</th></tr>
<tr><td>1</td><td>The researchers first surveyed 12 samples over the course of three to five months, collecting quantitative data (the number of Nakhl / Takaya / mosque / Aza khaneh, length, width, the number of stories, height, the junction of the main paths, proportions) as well as qualitative data, including information on the following: period, elongation, orientation, and enclosure degree. According to Table (4), these details are spatial pattern aspects that, when combined, may create a final pattern for the Taft City neighborhoods. This pattern contains both quantitative and qualitative data that explain how a pattern could appear. Using graph theory, the model was quantitatively examined to verify that this pattern is accurate. Graph theory (weighted directed graph) may also be used to examine orientation and elongation, which are two of the most important parts of making a spatial pattern.</td><td>
</td></tr>
<tr><td>2</td><td>- X represents the weight of each vertex and edge.
- The weight of neutral nodes that don't have any parts that make up the spatial pattern is set to 0.
- An edge is represented by two adjacent vertexes with the direction of exit = 0.
- (V2-V3) = (1-1) = when each edge contains information such as the number of Takaya, mosque, and Aza khaneh.
- (V10-V11) = (1-0) = when an edge gives an indication of orientation: with the direction of entering the square.
- According to graph theory:
$0<q< (13/2)$
$P=13$
$q=10$
$0<x<1$
X= weight of each vertex and edge</td><td></td></tr>
<tr><td>3</td><td>At this stage, 12 square plans were turned into graphs; based on the previous step's study of square space equivalency to weighted directed graphs, the more details the spatial pattern has, the more weight the pattern has.
<table>
<tr><th colspan="4">Face A1</th></tr>
<tr><th>edge</th><th>Edge degree</th><th>Vertex (node)</th><th>Vertex degree</th></tr>
<tr><td>a</td><td>(1-1)</td><td>V1</td><td>0</td></tr>
<tr><td>b</td><td>(1-1)</td><td>V2</td><td>1</td></tr>
<tr><td>c</td><td>(1-0)</td><td>V3</td><td>1</td></tr>
<tr><td>d</td><td>(1-0)</td><td>V4</td><td>1</td></tr>
<tr><td>e</td><td>(1-1)</td><td>V5</td><td>0</td></tr>
<tr><td>f</td><td>(1-0)</td><td>V6</td><td>0</td></tr>
<tr><td>g</td><td>(1-0)</td><td>V7</td><td>1</td></tr>
<tr><td>h</td><td>(1-1)</td><td>V8</td><td>1</td></tr>
<tr><td>i</td><td>(1-0)</td><td>V9</td><td>0</td></tr>
<tr><td>j</td><td>(1-0)</td><td>V10</td><td>0</td></tr>
<tr><td>-</td><td>-</td><td>V11</td><td>1</td></tr>
<tr><td>-</td><td>-</td><td>V12</td><td>1</td></tr>
<tr><td>-</td><td>-</td><td>V13</td><td>0</td></tr>
</table></td><td>
</td></tr>
<tr><td>4</td><td>The number of the graph's vertices, which is called the "Vertex Degree" and is shown by the symbol (V (G/,
The number of edges of the graph, which is called "Edge Degree" and presented by the abbreviation symbol (E (G/,
Potential future research directions: This research has the potential to match the spatial patterns of the squares with their activity patterns. Given "matching" in graph theory, it will give useful information about how much space people in a neighborhood need for their local activities.</td><td>(Rajabi and Shrifian, 2022)</td></tr>
<tr><td>5</td><td colspan="2">
</td></tr>
</table>

Fig. 1 An example of a graph. *Source* Gross and Yellen (2003)



disadvantage of all spatial analysis methods, not only network analysis. There are no new designs generated; instead, current ones are analysed. Procedural urban models are a potential recent advancement in this subject (Parish and Müller 2001; Vanegas, Garcia-Dorado, et al. 2012). Based on input parameters, these models may produce geometric configurations of urban forms on the fly and display the geometric outputs to get a more desirable input parameter combination (Rajabi and Shrifian 2022).

Accordingly, it is possible to classify the types of graphs according to their spatial patterns. We used simple weighted graphs for side A1 and sides A2, A3, A4, and A5 with simple synchronic or simple asymmetric graphs. To prove it, here is how the weight of the wall transfers to the plan of Bagh Golabdan Sofla square (Fig. 2):

Theoretical foundations

The physical/spatial pattern

Architects can understand the structure of social spaces by analysing their spatial arrangement and users' activities. Not only does the geometric pattern in the manufactured ambiance have a spatial system, but the spatial content of the environment also has a collective pattern (Hillier and Hanson 1984). Each pattern describes a neat solution to a problem in our environment to be used repeatedly (Yang and Goodyear 2004). The pattern usually consists of three ground-level geometric shapes: points (nodes), lines and regions, and geographic surfaces. In the classification of urban spatial morphology, the three main shapes of square, circle, and triangle are considered influential adjustment factors, such as angle, fragmentation, union, fusion, interference, or element combination and deformation. These factors can create a variety of spaces with regular and irregular shapes. Therefore, there is no reason why these vernacular patterns are not used today. These spaces must be rediscovered (Krier and Rowe 1979; Krier 2005).

Alexander believes: "The comprehensive pattern, including space and events, is an element of human culture". This pattern is made and spread through culture, and then it takes root in space (Alexander 2008). In Radberg's study of urban block morphology, he used indices such as lot coverage, the floor space ratio (FSR), and building height as the main variables. In addition, Dutch researchers also considered four indicators: floor area ratio, lot coverage, an open space ratio, and the number of floors. Thus, by presenting the mathematical relationship diagrams between them, the existing texture of the city was classified (Farkisch 2017). To get the physical pattern, we looked at quantitative aspects such as shape, proportion, length, width, enclosure degree, height, the number of stories, permeabilities, and entrances to space.

Hosseiniyeh: the second role of an ancient Iranian square

In Iranian cities, an ancient square is located along the vital passageway, existed as a public space, a significant part of the essential passage, or an enclosed era, but was connected to the passageway. They are rectangular or square, and their main characteristics are simplicity and cleanliness. In terms of spatial organisation, squares connect a network of channels. Squares are a physical pause and a spiritual memorial space, which enable people to get in touch with their "god.[2]"

Research on Iranian cities has shown that urban structures have undergone considerable changes. One of the changes is pertinent to a square created based on the

[2] As a sacred location in Iran during the Islamic period, Hosseinieh's architecture adheres to Islamic teachings and values. The Hosseinieh structures are among the most prominent examples of this sort of public space, whose purpose is connected to one of the most influential religious collective festivals, namely the mourning for the Third Shi'a Imam. Our findings demonstrated that establishing a "relationship between behavioral patterns of communal rituals and the spaces in a Hosseinieh" contributed to making collective memories — mourning for the Third Shi'a Imam for three months each year — a sense of belonging to space through social interactions, which leads to interactions between memorial space and people for the duration of the year (Rajabi et al. 2022. Functional Patterns in the Spaces of Hosseiniehs of Taft. *Journal of Iranian Architecture Studies,* 8, 181–203.).

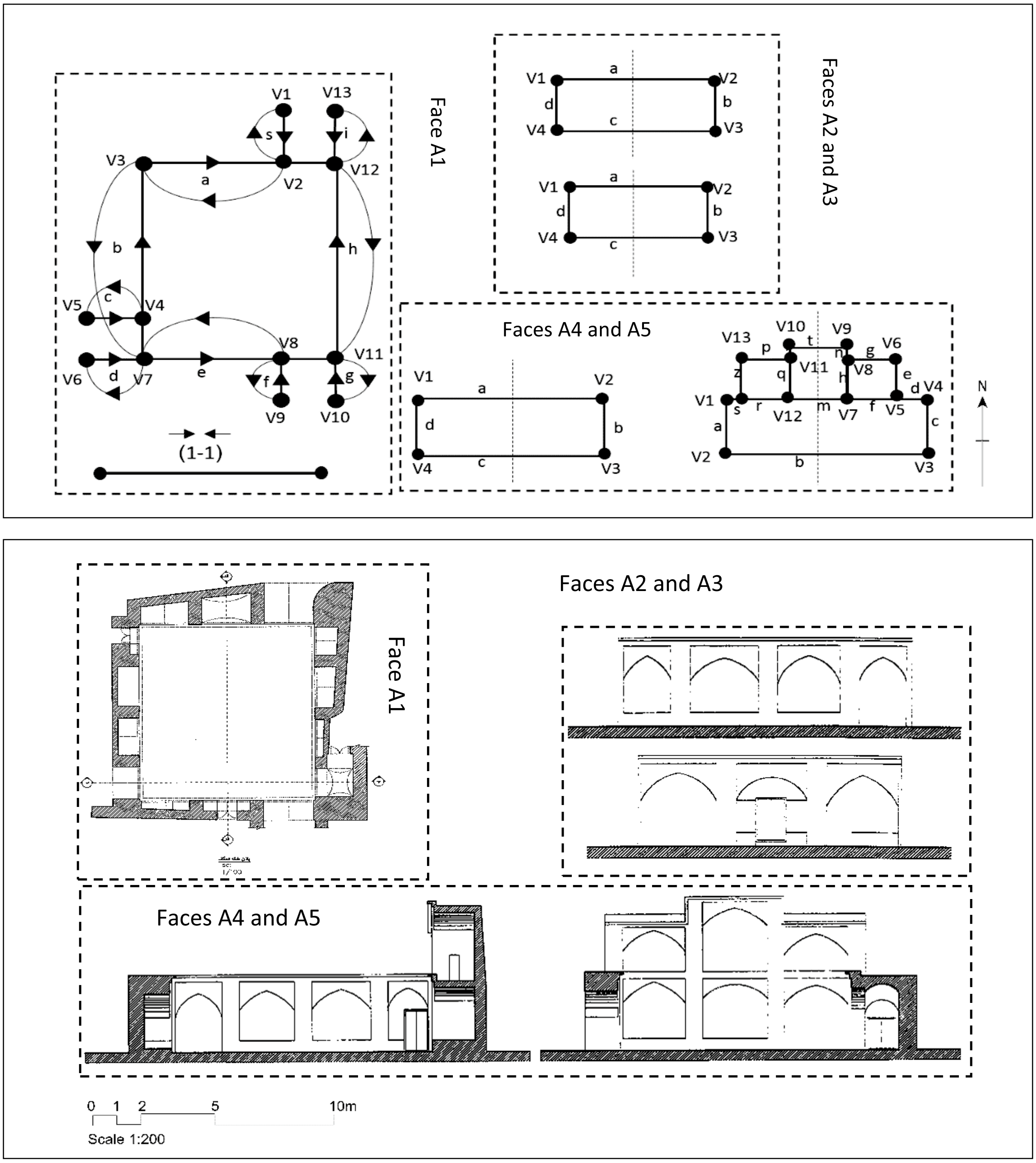
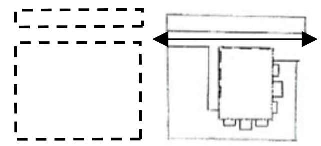
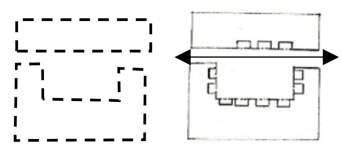
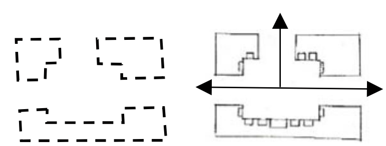
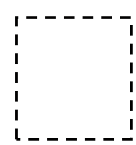


Fig. 2 The pattern graph in the different levels of Bagh-e- Golabdan-e-Sofla square (space)—the eleventh case study. *Source* authors

“most important urban social event”. Table 3 summarises the changes in the structure of Iranian squares over time.

The spatial pattern is achievable by analysing various aspects, commonalities, and classification types. In this way, we looked at the square's shape, size, proportion, length, width, degree of enclosure, height, the number of stories, and permeabilities to get the square's spatial pattern (Table 4).

Table 3 The evolution of the square. *Source* authors

Period	The historical evolution of square	The historical evolutionary: the physical aspect of the square
al buwayhid	In the Al-Buwayh and Al-Ziyar periods, the hot focus was on religious ceremonies due to the growth and excellence of the Shiite government at the time: setting up tents as temporary places of mourning, using wooden or metal scaffolding, and covering them with cloth.	**without physical dimension** 
Safavieh	The Safavid period was undoubtedly marked by the square's spatial growth and restoration and the revived ceremonies and celebrations in the city.	
Qajar era	Mourning rituals and religious ceremonies were held in buildings such as mosques, tombs, Emamzades, bazaars, Takayas, and Hosseiniyah, all of which surrounded the square.	
Pahlavi	In the fourteenth century, with the beginning of the Pahlavi dynasty, the urban planning of this period changed drastically. Modern intersections have entered historical human-scale contexts. We can document the destruction of urban spaces, squares, bazaars, and the Hosseiniyahs in this period. In other words, modernism destroyed these public spaces to connect the Pahlavi streets directly.	
Contemporary	Takaya and Hosseinehs, as the most critical parts of squares, tried to get inspired by the former patterns, decorations, and architectural styles. However, closed spaces were built without addressing square architecture's spatial patterns.	

[2] As a sacred location in Iran during the Islamic period, Hosseinieh's architecture adheres to Islamic teachings and values. The Hosseinieh structures are among the most prominent examples of this sort of public space, whose purpose is connected to one of the most influential religious collective festivals, namely the mourning for the Third Shi'a Imam. Our findings demonstrated that establishing a "relationship between behavioral patterns of communal rituals and the spaces in a Hosseinieh" contributed to making collective memories — mourning for the Third Shi'a Imam for three months each year — a sense of belonging to space through social interactions, which leads to interactions between memorial space and people for the duration of the year (RAJABI, M., NOQSAN MOHAMMADI, M.-R. & MONTAZER AL-HODJJAH, M. 2022. Functional Patterns in the Spaces of Hosseiniehs of Taft. *Journal of Iranian Architecture Studies,* 8, 181-203.).

Table 4 Spatial aspects of the square. *Source* authors

Measuring tool	Aspects	Component	Dimension	Concept	Sample
Observation/ photography/ interview/ field surveys	Length Width Shape Orientation and elongation Enclosure degree Height Number of stories	Pattern	spatial	Space	Social square

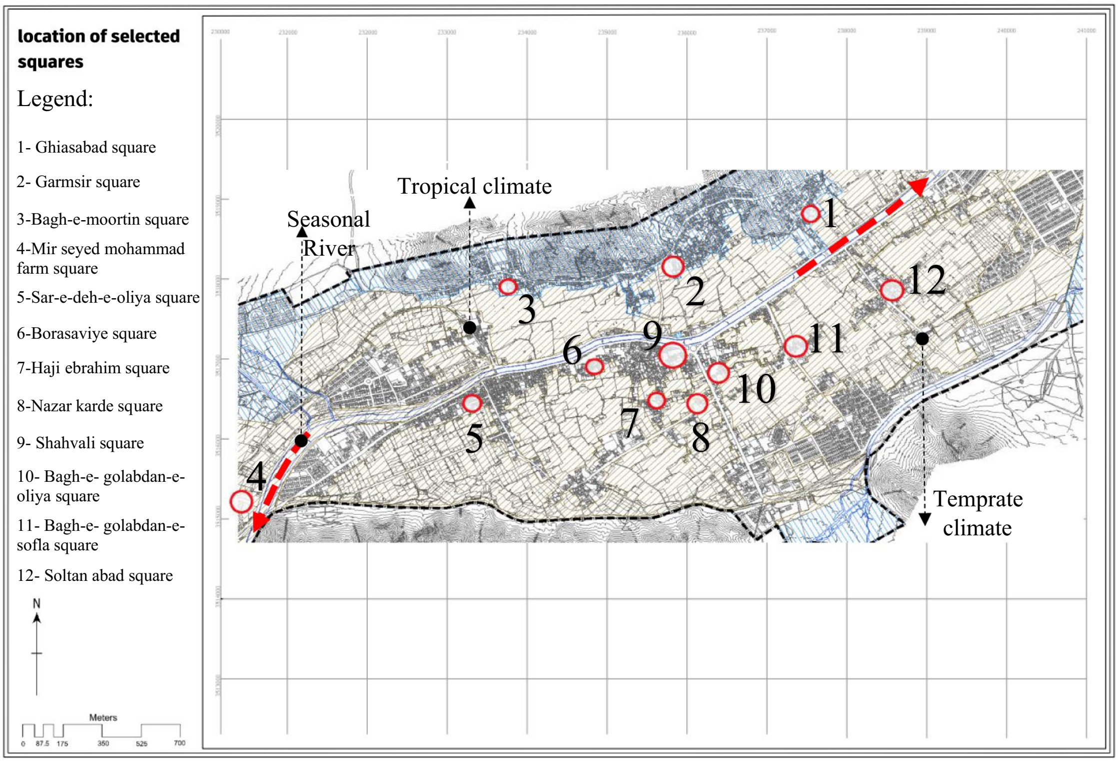


Fig. 3 The location of selected squares as samples of study in Taft city. *Source* authors

Table 5 Examples of edges and nodes in a square. *Source* authors

Length/ width/ height	●——●	edge	Taken from graph theory
Nakhl/ Takaya/ mosque/ Aza khaneh / junction of the main paths	●	node	

Materials

Case studies

Taft City is 10 km away from Yazd City, Iran, and has a temperate climate with annual changes in various parameters such as temperature, rainfall, and humidity, making it a city full of gardens and farmland (agricultural lands) in the centre of the desert.[3] Moreover, Taft is an old city with historical characteristics and several neighbourhoods. Each block has at least one public bath, a mosque, a Hosseiniyah, and a water reservoir surrounding a square (Mirmoghtadaee 2009). According to the criterion of "being open spaces", we selected 12 squares (Fig. 3).

Data collection

The pattern of the space body in the case studies

A graph portrays a spatial pattern and a configuration of spatial elements. Accordingly, each node is an element, and each edge represents its relationship (A graph has different edges and nodes at different positions and levels based on the hierarchy principle). These graphs show how they relate to each other and, as a pattern graph, how users can experience any space (Table 5). In making these arguments, the overlaps and differences between these data analytics enable us to achieve the final pattern of the square. The field survey findings of case studies are in Tables 6 and 7 (Figs. 4, 5).

By examining Tables 6 and 7, we found that the square space in Taft City had a length of 20, a width of 15, and a ratio of 4 to

[3] Kerias Bana engineering, (2014). Taft City Development Plan, Ministry of Roads and Urban Development of Yazd.

Table 6 The characteristics of case studies (node). *Source* authors

Samples Node	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
Nakhl	1	1	–	–	1	–	–	–	1	1	–	1
Takaya	1	1	–	1	1	1	–	–	1	–	1	1
mosque	1	1	1	1	1	1	1	1	1	1	1	1
Aza khaneh	1	1	1	1	1	1	1	1	1	–	1	1
Period[a]	Qajar	Qajar	Qajar	Pahlavi	Safavid	Qajar	Qajar	Pahlavi	Qajar	Pahlavi	Qajar	Qajar

[a]The period in which the square was built

3 (length to width).[4] Furthermore, this space had three intersections with the dominant passage. One of the square walls played Takaya's role, and the average height of the other walls (except the Takaya) was 4 m, providing a semi-enclosed space for users. Due to the neighbourhood population, the floor may vary between 1 and 2 in some neighbourhoods. In addition, each building was located in a spatial discipline[5] and surrounded the square in each neighbourhood. Northwest-southeast (with relatively longitudinal or relatively transverse elongation) was the best orientation on the basis of the climatic conditions with respect to thermal comfort resulting from building types and orientations in a social space (Fig. 5).

A square was bounded by six square faces, facets, or sides with overlapped edges (length, width, and height) and different nodes at different positions. Hence, we calculated the weight of each level by considering the hierarchy principle and system theory (Chart 1), i.e. the weight of directed graphs. Accordingly, square space included the A1, A2, A3, A4, and A5 sides in the first position (inner level).

Each level has various weights calculated from different physical details. For instance, on side A1, the weight is achieved through details, elements, and the intersection of the main paths. Weight is transmitted by the wall and its components to the plan[6] as a visual methodology. As a result, graph theory is valid for all other levels and side A1.

We pursued fuzzy logic to calculate the quantitative of the weight number, referring to a numerical value with the numbers “0” and “1”. Fuzzy logic enables us to study complex problems and then simplify them so that the human mind can perceive them because fuzzy logic is easy to understand from a conceptual point of view. Fuzzy systems are viable for non-linear modelling functions of any complexity (Rajabi and Shrifian 2022).

Thus, we obtained the spatial pattern of each square by the A1 level of each sample, their graph weight, fuzzy logic, and their overlaps and presented them as follows in Tables 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19:

According to the above tables and field survey from the case studies, most samples had two floors, or Takaya, whose height was two or more floors, which had two advantages. The first was to provide ample space to do religious or ritual ceremonies at a particular time of year. The second one was to do social activities offered by shading quality. According to Fig. 6, when the sun moved from east to west, the shadows in the space moved from 1 point to 4; number 1 refers to the dawn shadow. The number 4 shows the shading of sunset, which is a significant aspect of designing a square in a new neighbourhood.

We studied how grid block, plot, and square sizes affect pedestrian accessibility. The top local squares' highest pedestrian accessibility was computed using plot sizes and square measurements. These indications were used to generate the appropriate spatial square pattern for the ambient and regular grids. In the sections that follow, we will talk about how different spatial pattern variables affect a pedestrian's ability to “walk” and give an example of a good spatial pattern for pedestrian-friendly subdivisions in modern urban planning.

Discussion

Analysis has shown that the weighted directed graph of the square has edges and parallel vertices with the same weight. In addition, the more detailed the components of the square space, the greater the weight of the pattern. Accordingly, we need significant indicators such as ’Vertex Degree”, “Edge Degree”, and “Graph Weight” to pattern the body square. In this regard, we need the detailed data as follows. Therefore, in the following graph, the “Edge Degree” is equal to (E (G/, 10, and the Vertex Degree is (V (G/, 14 (Fig. 7).

Urban blocks with the smallest typological length and width should produce a multidirectional horizontal pattern of urban areas. These blocks should create as many sidewalks and squares as possible within this framework (Krier 1984). Every constructed environment has a spatial order that defines the closeness of buildings, public areas,

[4] These statistics vary based on the population and requirements of each neighbourhood.

[5] The spatial distribution or arrangement of the physical building types.

[6] www.ihoosh.ir.

Table 7 The characteristics of case studies (edge). *Source* authors

Samples Edge[a]	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
Length (m)	20	100	26	34	19	18	23	18	84	12	14	40
Width (m)	15	20	17	25	18	16	15	10	35	10	12	16
Elongation	Relatively transverse	Longitudinal	Longitudinal	Relatively transverse	Relatively transverse	Relatively transverse	Relatively longitudinal	Relatively longitudinal	Relatively transverse	Relatively longitudinal	Relatively longitudinal	Relatively longitudinal
Orientation	Southwest/Northeast	North/South	North/South	Northwest/Southeast	Northwest/Southeast	Southwest/Northeast	Northwest/Southeast	Northwest/Southeast	Southwest/Northeast	Northwest/Southeast	Northwest/Southeast	Southwest/Northeast
Number of stories	2	2	2	1	2	1	1	1	1	1	1	2
Height (m)	6	10	8	4	8	4	4–5	4	5	3–5	4	7
Junction of the main paths	3	4	3	3	2	2	4	4	4	3	3	2
Enclosure degree	Semi-enclosed	Semi-enclosed	Semi-enclosed	Opened	Semi-enclosed	Semi-enclosed	Semi-enclosed	Semi-enclosed	Opened	Enclosed	Enclosed	Semi-enclosed
Proportions[b]	4/3	20/4	5/3	7/5	4/4	4/3	5/3	4/2	17/7	2/2	3/2	8/3
Period	Qajar	Qajar	Qajar	Pahlavi	Safavid	Qajar	Qajar	Pahlavi	Qajar	Pahlavi	Qajar	Qajar

[a]Aspects and influential factors in achieving the square pattern

[b]Module: 5 m (ratio: length to width)

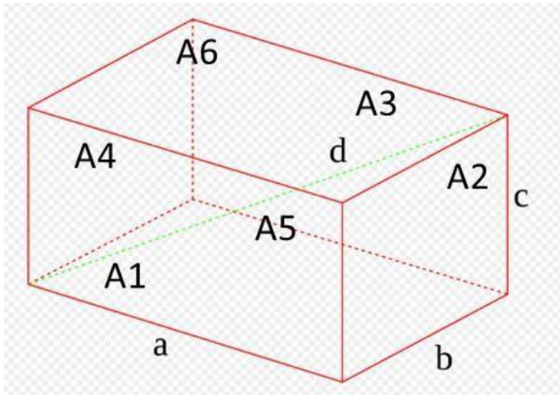


Fig. 4 Left: faces in square space. *Source* authors

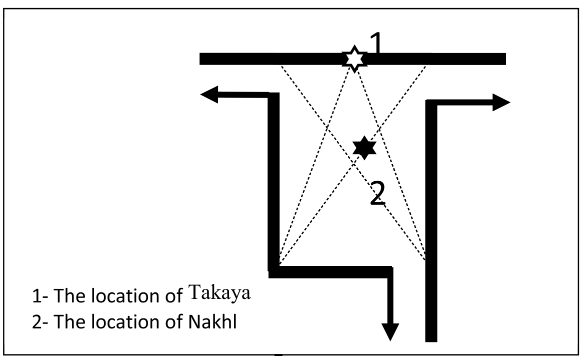


Fig. 5 Right: square at (A1) face in Taft city. *Source* authors

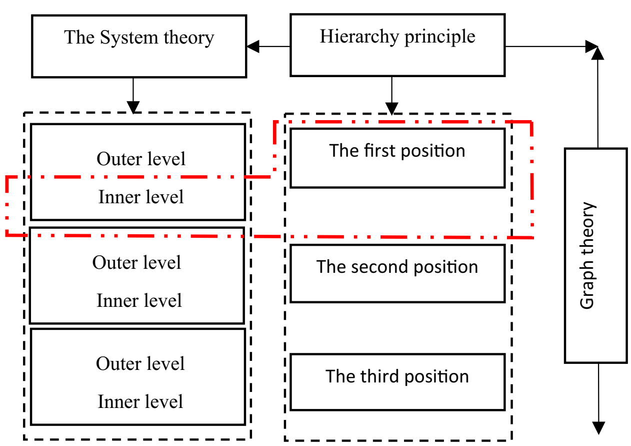


Chart 1 Research position and level based on systems theory. *Source* authors

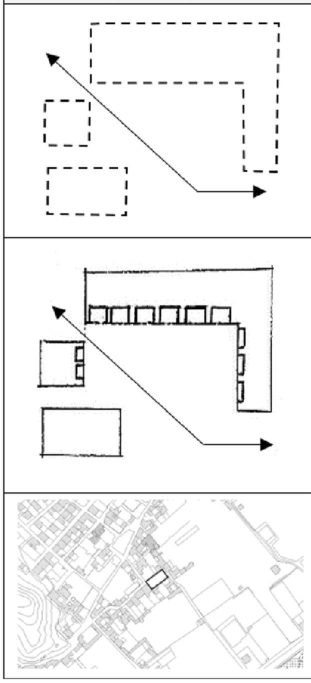
and transportation. These linkages affect how circulation routes are used, how visible or linked public areas are, and how buildings are positioned. These spatial patterns dictate whether sites are better or worse for various land uses in terms of pedestrian accessibility, i.e. which public spaces building renters experience. We generated a network representation of the built environment to capture and operationalise urban form interactions. Two-dimensional plans offer spatial information to experts across disciplines. Plans might be misconstrued, and their substance and purpose can be missed. Real urban areas may need concurrent processing of a large number of spatial interactions. We employed network-based built environment models to describe and evaluate the complicated spatial interactions as a type of subdivision for pedestrian accessibility. Network-based representations of urban space incorporate the clear interactions between network components, such as how nodes are linked, how long travel times are between nodes, squares, or buildings, or how many people commute between them. Linkage information is stored in two ways. First, it may be stored in a detailed origin–destination matrix (Sevtsuk et al. 2016), where every element of a plan is presented next to every destination, and a single column indicates the needed linkage information about each relationship. Second, the examination of accessibility was based on the graph theory accessibility index. This allowed us to examine pedestrian accessibility as well as the proximity of the grids to the theoretical maximums of pedestrian accessibility when taking into account plot sizes and square aspects. The results illustrated how aspects of spatial patterns influence pedestrian accessibility in gridiron urban contexts. In this article, we demonstrated some archetypal square sizes that enhance pedestrian accessibility and may be acceptable for pedestrian-friendly subdivisions in proposed urban planning.

Studies have pointed to one particular environmental aspect as the most important component of walkability. The likelihood of people going on walking excursions decreases with increasing distance because, all other factors being equal, individuals are more inclined to go on a short walk than a long walk (Handy and Niemeier 1997). In most cases, the usefulness, comfort, and safety of walking paths are also key categories of qualities that contribute to walkability (Speck 2015). We showed that there are nine essential parameters that govern the aspects of two-entry or tree-entry rectangular grids: plot length, width, shape orientation, enclosure degree, height, the number of stories, proportions, and the junction of the main paths, which are largely intuitive.

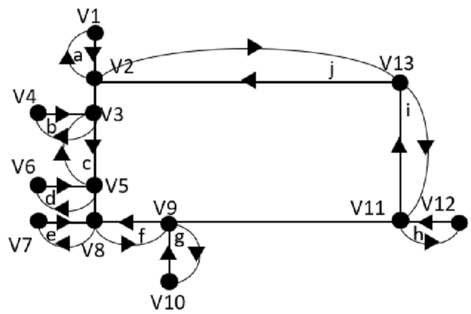
The amount of walking activity in urban areas is influenced by various metrics measuring pedestrian accessibility that have received a lot of attention (Ewing and Cervero 2010; Gehl 1987, 2010; Ozbil et al. 2011; Garbrecht 1978; Guy and Wrigley 1987; Forsyth et al. 2008; Guo 2009; Frank and Pivo 1994; Li and Tsukaguchi 2005; Zacharias 2001; Thoroughfares 2010; Takeuchi 1977; Pushkarev and Zupan 1975). This study investigated how block aspects in orthogonal urban grids affect pedestrian access. In analysing

Table 8 Ghiasabad square specification. *Source* authors

Depictive plan

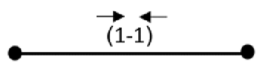


Graph 1



$0<q<(13/2)$
$P=13$
$q=10$
$0<x<1$
X= weight of each vertex and edge

legend 2



Shape

Sample 1

Ghiasabad square

Legend 1

Face A1

edge	Edge degree	Vertex (node)	Vertex degree
a	(0-1)	V1	0
b	(0-1)	V2	1
c	(1-1)	V3	1
d	(0-1)	V4	0
e	(0-1)	V5	1
f	(0-0)	V6	0
g	(0-0)	V7	0
h	(0-1)	V8	0
i	(1-1)	V9	0
j	(1-1)	V10	0
-	-	V11	1
-	-	V12	0
-	-	V13	1

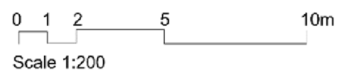
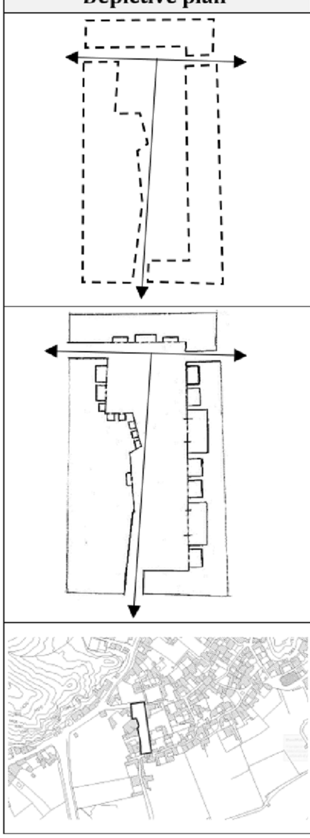
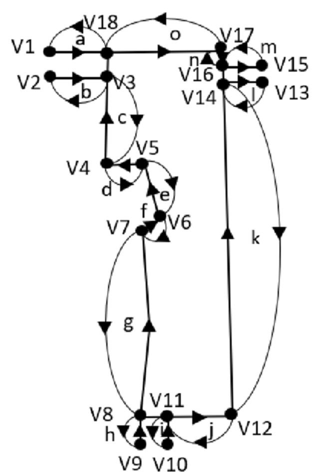


Table 9 Garmsir square specification. *Source* authors

Depictive plan

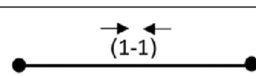


Graph 2



$0<q<(18/2)$
$P=18$
$q=15$
$0<x<1$
X= weight of each vertex and edge

legend 2



Shape

Sample 2

Garmsir square

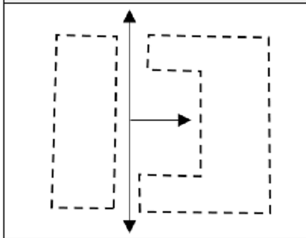
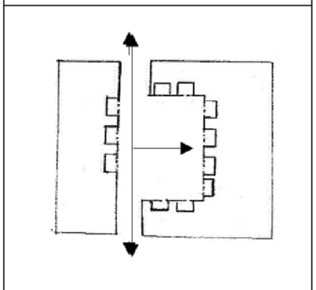
Legend 1

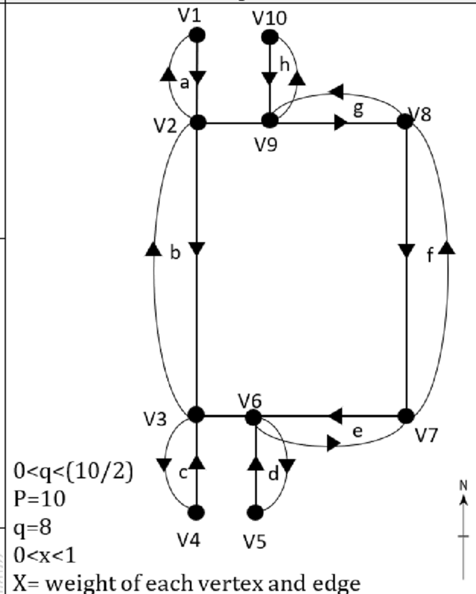
Face A1

edge	Edge degree	Vertex (node)	Vertex degree
a	(0-1)	V1	0
b	(0-1)	V2	0
c	(1-1)	V3	1
d	(1-1)	V4	1
e	(1-1)	V5	1
f	(0-0)	V6	0
g	(0-1)	V7	0
h	(0-0)	V8	1
i	(0-1)	V9	0
j	(1-0)	V10	0
k	(0-1)	V11	1
l	(0-1)	V12	0
m	(0-1)	V13	0
n	(1-1)	V14	1
o	(1-1)	V15	0
-	-	V16	1
-	-	V17	1
-	-	V18	1

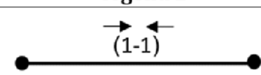
Table 10 Bagh-e-Moortin square specification. *Source* authors

Depictive plan	Graph 3	Shape	Sample 3

legend 2



Bagh-e-Moortin square

Legend 1

Face A1

edge	Edge degree	Vertex (node)	Vertex degree
a	(0-1)	V1	0
b	(1-1)	V2	1
c	(1-0)	V3	1
d	(0-1)	V4	0
e	(1-1)	V5	0
f	(1-1)	V6	1
g	(1-1)	V7	1
h	(1-0)	V8	1
-	-	V9	1
-	-	V10	0

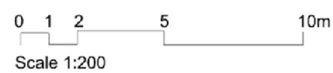
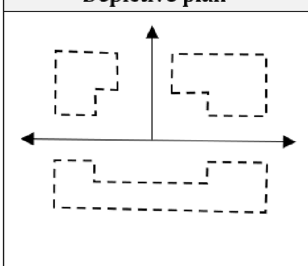
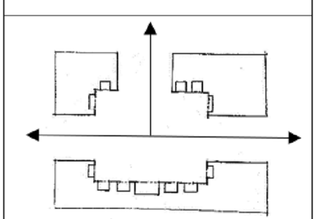
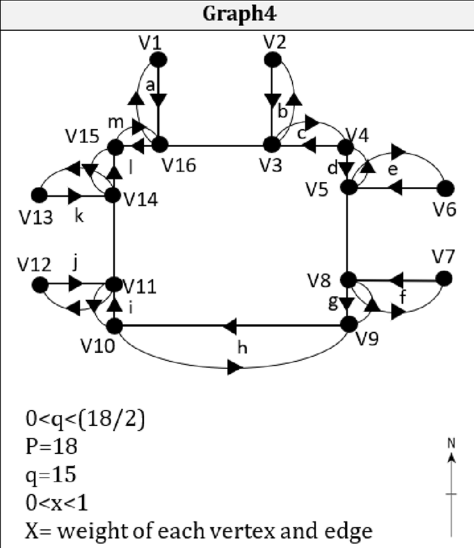


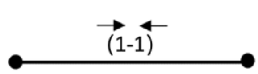
Table 11 Mir Seyed Mohammad farm square specification. *Source* authors

Depictive plan	Graph4	Shape	Sample 4



legend 2



Mir seyed Mohammad farm square

Legend 1

Face A1

edge	Edge degree	Vertex (node)	Vertex degree
a	(0-1)	V1	0
b	(0-1)	V2	0
c	(1-1)	V3	1
d	(1-1)	V4	1
e	(1-0)	V5	1
f	(0-1)	V6	0
g	(1-1)	V7	0
h	(1-1)	V8	1
i	(1-1)	V9	1
j	(1-0)	V10	1
k	(0-1)	V11	1
l	(1-1)	V12	0
m	(1-1)	V13	0
-	-	V14	1
-	-	V15	1
-	-	V16	1

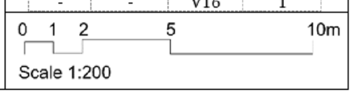
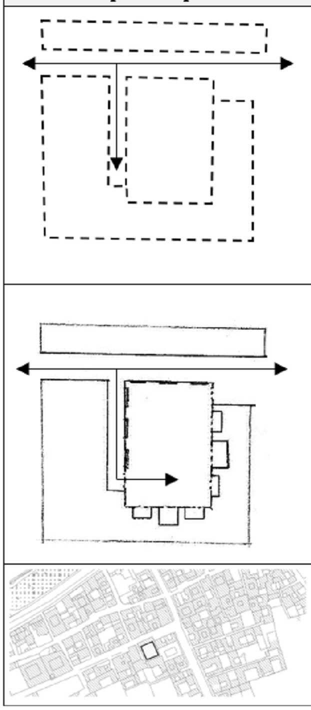
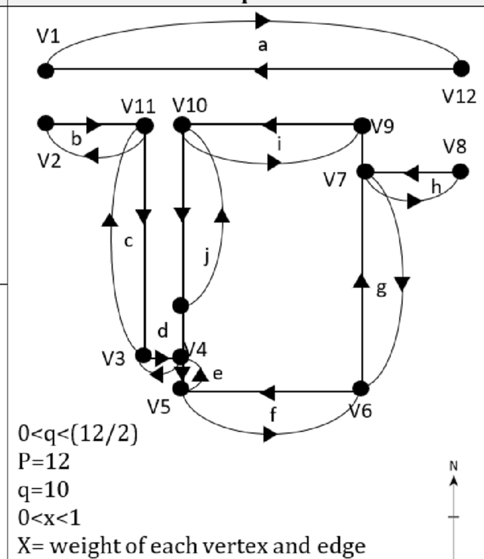


Table 12 Sar-e-Deh-e-Oliya square specification. *Source* authors

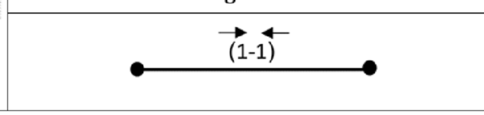
Depictive plan



Graph 5



legend 2



Shape

Sample 5

Sar-e-Deh-e-Oliya square

Legend 1

Face A1

edge	Edge degree	Vertex (node)	Vertex degree
a	(0-0)	V1	0
b	(0-1)	V2	0
c	(1-1)	V3	1
d	(1-1)	V4	1
e	(1-1)	V5	1
f	(1-1)	V6	1
g	(1-1)	V7	1
h	(1-0)	V8	0
i	(1-1)	V9	1
j	(1-1)	V10	1
-	-	V11	1
-	-	V12	0

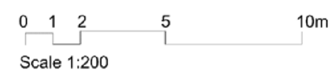
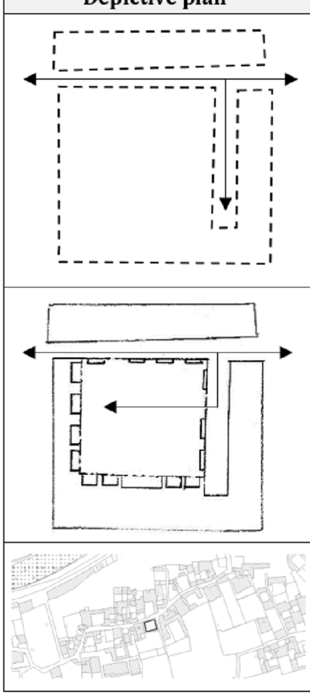
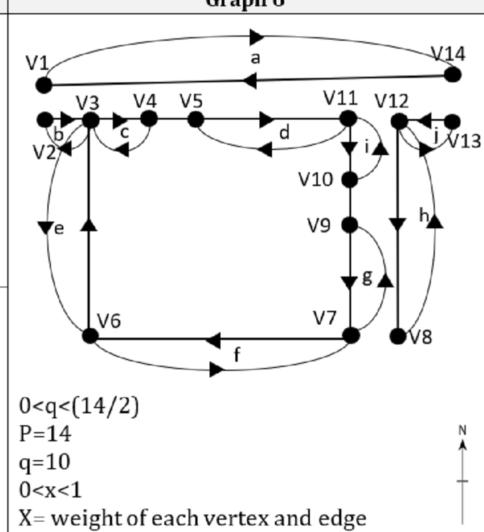


Table 13 Borasaviye square specification. *Source* authors

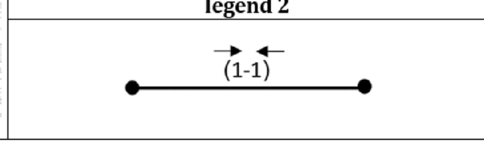
Depictive plan



Graph 6



legend 2



Shape

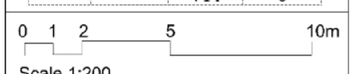
Sample 6

Borasaviye square

Legend 1

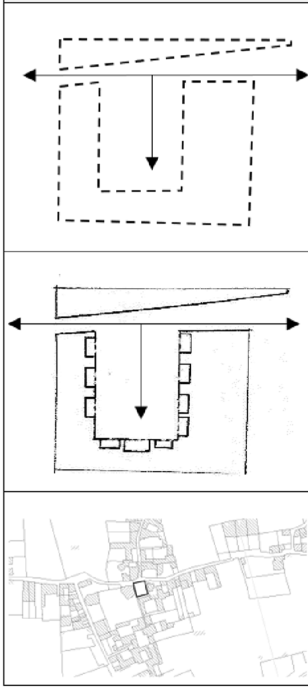
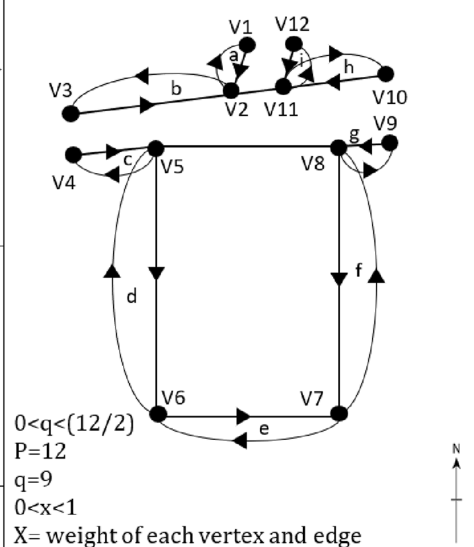
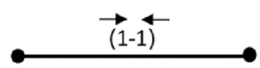
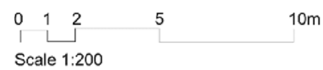
Face A1

edge	Edge degree	Vertex (node)	Vertex degree
a	(0-0)	V1	0
b	(0-1)	V2	0
c	(1-1)	V3	1
d	(1-1)	V4	1
e	(1-1)	V5	1
f	(1-1)	V6	1
g	(1-1)	V7	1
h	(0-1)	V8	0
i	(1-1)	V9	1
j	(1-0)	V10	1
-	-	V11	1
-	-	V12	1
-	-	V13	0
-	-	V14	0



pedestrian accessibility, we did not monitor actual pedestrian activity in Taft City but instead focussed on the potential of grids to produce pedestrian activity. Research has shown that the geometric visual model has a spatial system consistent with the urban construction system, while describing various issues related to collective space. Since the nature

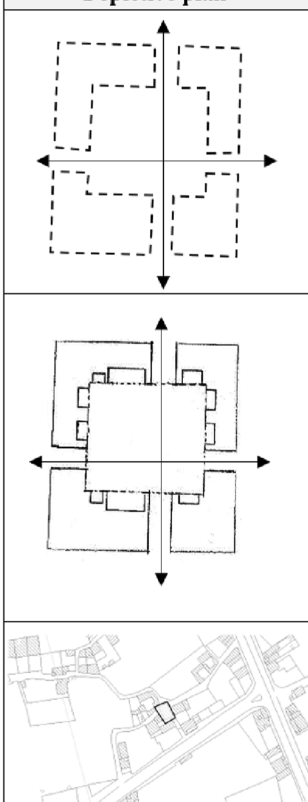
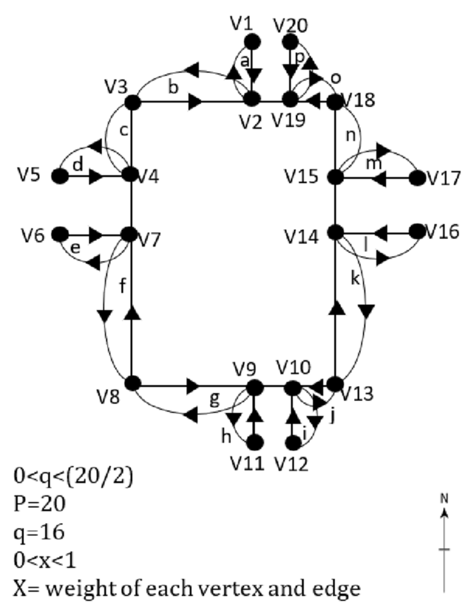
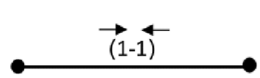
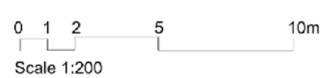
Table 14 Haji Ebrahim square specification. *Source* authors

Depictive plan	Graph 7	Shape	Sample 7
			**Haji Ebrahim square**
	legend 2	Legend 1	
			

Legend 1 — Face A1

edge	Edge degree	Vertex (node)	Vertex degree
a	(0-1)	V1	0
b	(1-0)	V2	1
c	(0-1)	V3	0
d	(1-1)	V4	0
e	(1-1)	V5	1
f	(1-1)	V6	1
g	(1-0)	V7	1
h	(0-1)	V8	1
i	(1-0)	V9	0
-	-	V10	0
-	-	V11	1
-	-	V12	0

Table 15 Nazar karde square specification. *Source* authors

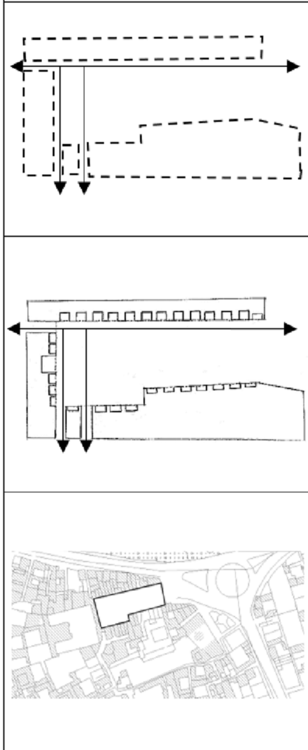
Depictive plan	Graph 8	Shape	Sample 8
			**Nazar karde square**
	legend 2	Legend 1	
			

Legend 1 — Face A1

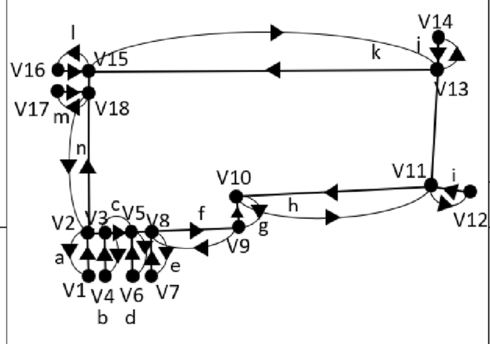
edge	Edge degree	Vertex (node)	Vertex degree
a	(0-1)	V1	0
b	(1-1)	V2	1
c	(1-1)	V3	1
d	(1-0)	V4	1
e	(0-1)	V5	0
f	(1-1)	V6	0
g	(1-1)	V7	1
h	(0-1)	V8	1
i	(1-0)	V9	1
j	(1-1)	V10	1
k	(1-1)	V11	0
l	(1-0)	V12	0
m	(1-0)	V13	1
n	(1-1)	V14	1
o	(1-1)	V15	1
p	(1-0)	V16	0
-	-	V17	0
-	-	V18	1
-	-	V19	1
-	-	V20	0

Table 16 ShahVali square specification. *Source* authors

Depictive plan

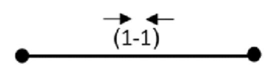


Graph 9

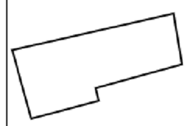


0<q<(18/2)
P=18
q=14
0<x<1
X= weight of each vertex and edge

legend 2



Shape



Sample 9

ShahVali square

Legend 1

Face A1			
edge	Edge degree	Vertex (node)	Vertex degree
a	(0-1)	V1	0
b	(1-0)	V2	1
c	(1-1)	V3	1
d	(1-0)	V4	0
e	(0-1)	V5	1
f	(1-1)	V6	0
g	(1-1)	V7	0
h	(1-1)	V8	1
i	(1-0)	V9	1
j	(1-0)	V10	1
k	(1-1)	V11	1
l	(1-0)	V12	0
m	(0-1)	V13	1
n	(1-1)	V14	0
-	-	V15	1
-	-	V16	0
-	-	V17	0
-	-	V18	1

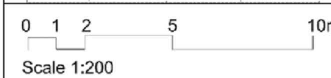
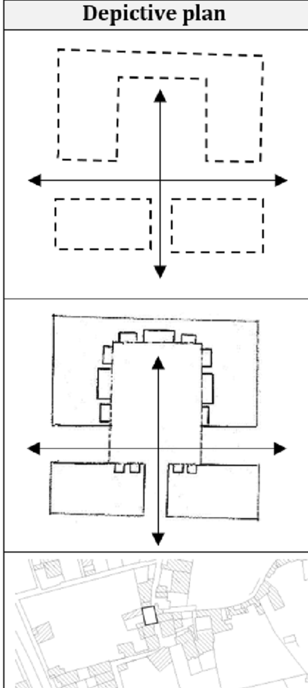
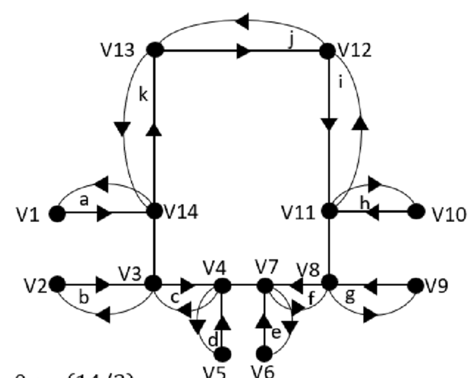


Table 17 Bagh-*e- Golabdan-e- Oliya square specification, source: authors*

Depictive plan

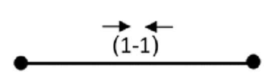


Graph 10



0<q<(14/2)
P=14
q=11
0<x<1
X= weight of each vertex and edge

legend 2



Shape

Sample 10

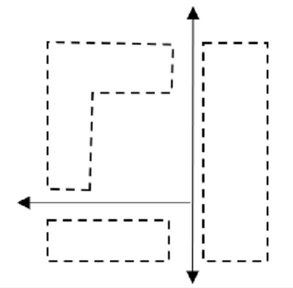
Bagh-e- Golabdan-e- Oliya square

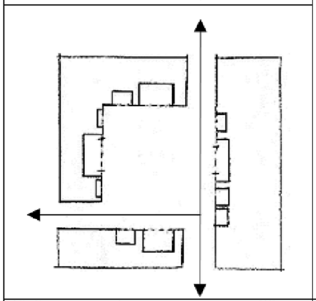
Legend 1

Face A1			
edge	Edge degree	Vertex (node)	Vertex degree
a	(0-1)	V1	0
b	(0-1)	V2	0
c	(1-1)	V3	1
d	(1-0)	V4	1
e	(0-1)	V5	0
f	(1-1)	V6	0
g	(1-0)	V7	1
h	(0-1)	V8	1
i	(1-1)	V9	0
j	(1-1)	V10	0
k	(1-1)	V11	1
-	-	V12	1
-	-	V13	1
-	-	V14	1

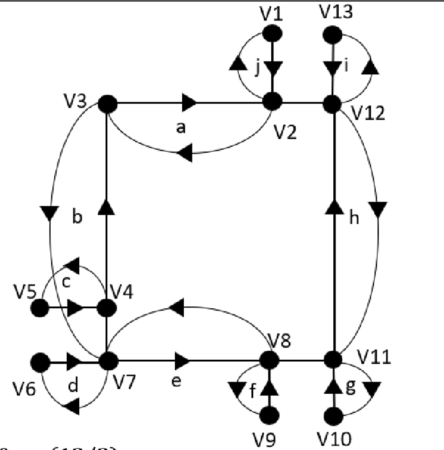
Table 18 Bagh-e- Golabdan-e-Sofla square specification. *Source* authors

Depictive plan



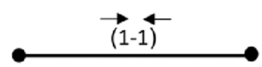


Graph 11



0<q<(13/2)
P=13
q=10
0<x<1
X= weight of each vertex and edge

legend 2



Shape

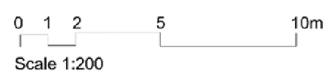
Sample 11

Bagh-e- Golabdan-e-Sofla square

Legend 1

Face A1

edge	Edge degree	Vertex (node)	Vertex degree
a	(1-1)	V1	0
b	(1-1)	V2	1
c	(1-0)	V3	1
d	(0-1)	V4	1
e	(1-1)	V5	0
f	(1-0)	V6	0
g	(0-1)	V7	1
h	(1-1)	V8	1
i	(1-0)	V9	0
j	(0-1)	V10	0
-	-	V11	1
-	-	V12	1
-	-	V13	0



of this model shows how a practical and creative solution can be found for this flexible human-based space, politicians can use the representation of this pattern in other urban areas, especially memorial territories, which are rare in Iran because of its complex policies.

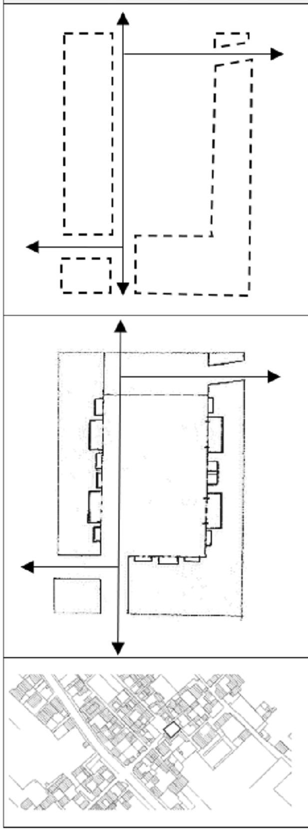
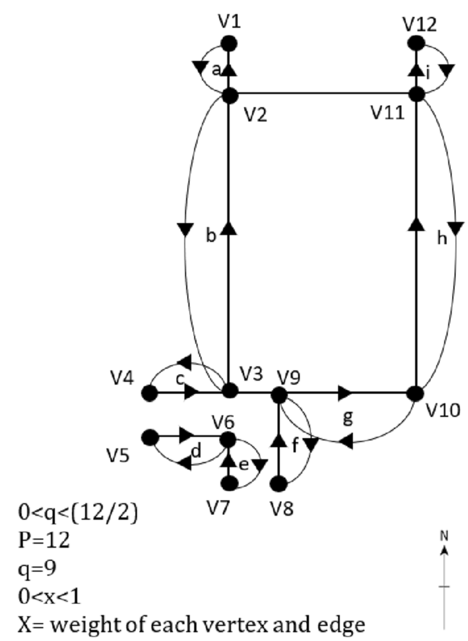
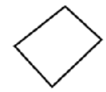
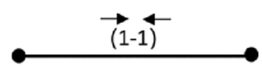
Table 20 identifies a set of configurational comparisons between squares through graph theory that can be used in the proposed neighbourhood development.

Conclusion

We examined a sample of historical city grids with the goal of determining how significant the potential benefits would have been if the block aspects had been optimised. To do so, we measured the spatial pattern aspects of historical squares, an alternative that we define as the block length with the greatest walkability for Taft neighbourhoods' plot and square aspects. We looked at the grid as a common typology of urban layouts and examined how spatial aspects of regular, two-entry, or tree-entry rectangular grids affect pedestrian access to surroundings for a neighbourhood as a typical block. The past has shown that plot sizes are also the most malleable of the factors, and they have a tendency to shift over time in response to ownership changes, land value, land use, and the types of buildings that are constructed (Siksna 1998; Moudon 1986; Moudon 1986). We showed that the spatial model has the maximum walking accessibility level and enhances local liveability in the city's neighbourhoods, but that the effect varies by city and venue type. Indeed, our findings demonstrate that grid block, plot, and square sizes have the most significant influence on pedestrian "accessibility" in urban gridiron situations. Knowing this optimum can help planners foster walkability by adjusting the spatial dimensions of individual block aspects. Block lengths, despite the fact that they are not the most significant aspect, may, at times, be the sole lever available for altering urban subdivisions to improve pedestrian accessibility. On the basis of a purely geometrical examination of grids, many have speculated about the implications that grid subdivisions have on the accessibility of pedestrian areas. The findings were not acquired from any actual measures of pedestrian activity; rather, they were produced via the use of a computer model. A future study will focus on the empirical validation of the indicated impacts of walking behaviour on grids.

This implies that a certain configuration of grid aspects will be associated with an increase in pedestrian walkability, even after controlling for such explanatory variables as location attractiveness, the safety and comfort of walking routes, the climate, the time of day, socioeconomic indicators of the neighbourhood's users, location within the larger

Table 19 Soltan Abad square specification. *Source* authors

Depictive plan	Graph 12	Shape	Sample 12
			Soltan Abad square
	legend 2 	Legend 1	

Face A1

edge	Edge degree	Vertex (node)	Vertex degree
a	(0-1)	V1	0
b	(1-1)	V2	1
c	(1-0)	V3	1
d	(0-1)	V4	0
e	(1-0)	V5	0
f	(0-1)	V6	1
g	(1-1)	V7	0
h	(1-1)	V8	0
i	(0-1)	V9	1
-	-	V10	1
-	-	V11	1
		V12	0

Table 20 The square's physical pattern specification in Taft city. *Source* authors

A square (a social space)		
Pattern aspects	Square body pattern	Equivalent components
Length	20 m	Accessible
Width	15 m	Interactive
Shape	Rectangle	Usefulness
Orientation	Northwest-Southeast	Comfort
Enclosure degree	Semi-enclosed	Safety
Height	4 m	
Number of stories	2	
Proportions	3/4	
Junction of the main paths	3	

urban context, and the availability of alternative modes of transportation to walking. In reality, the accessibility consequences that result only from urban grids' two-dimensional layout aspects may be changed through land use and built form changes that define a grid. In addition to the effects of the ground layout, imbalanced lot ratios, household sizes, and employment density may have an impact on pedestrian accessibility.

Utilising the increasing availability of spatial pattern data for urban studies, we evaluated the spatiotemporal influence of the patterns on the walkability of local users by analysing their changes and characteristics. The results indicate that the supplied layout and square dimensions in two-entry or tree-entry rectangular grids have a substantial influence on the maximum walking accessibility level, but that the effect varies by city and venue type. Existing vernacular and historical urban grids are in close proximity to the highest achievable local pedestrian accessibility levels with present block sizes. It is also evident that existing historical spatial grids benefit much more from the optimal proportions for new gridiron subdivisions in order to maximise pedestrian accessibility. It attests to the neighbourhood's enhanced walkability and facilitates a vast array of activities for local residents. Our multifunctionality assessment of a spatial pattern may capture an essential feature that may resemble Jane Jacobs' concept of urban vitality and a variety of lifestyle activities (Jacobs 1961a). As a result, it could play a significant role in improving local liveability. We hope that it may be used and evaluated in other research. As anticipated, our findings demonstrate that grid block, plot, and square sizes

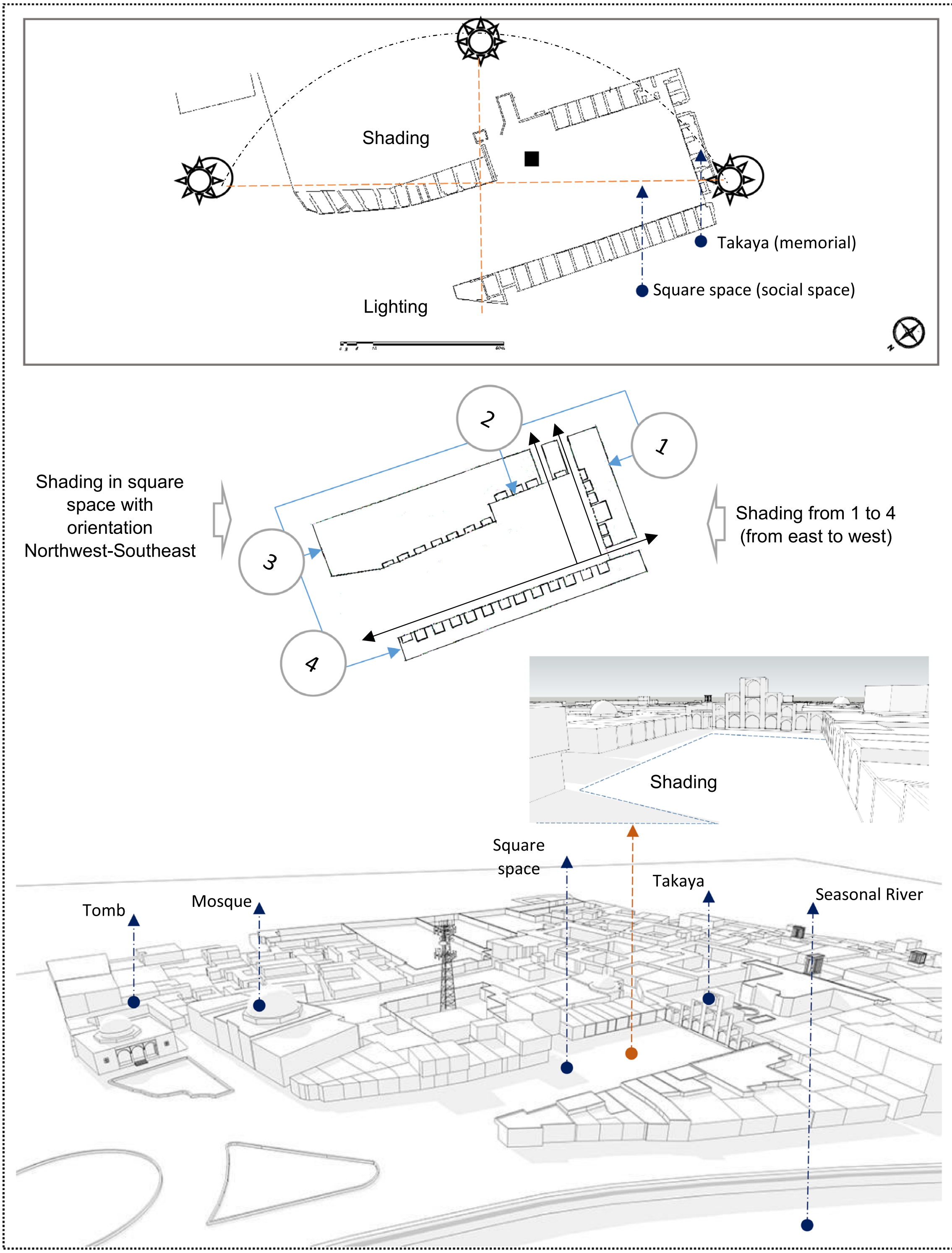


Fig. 6 The relationship between aspects, such as orientation and number of stories with shading the criterion in Shah vali square-sample 9. *Source* authors

have the most significant influence on pedestrian "accessibility" in gridiron urban situations. Future research should concentrate on improved tools and data to pattern and analyse historical square typologies and their components based on advances in local life and liveability, a goal that is beyond the scope of the present study. Obviously, this research has additional limitations. Although the spatial pattern data have several benefits, we were unable to obtain prior square

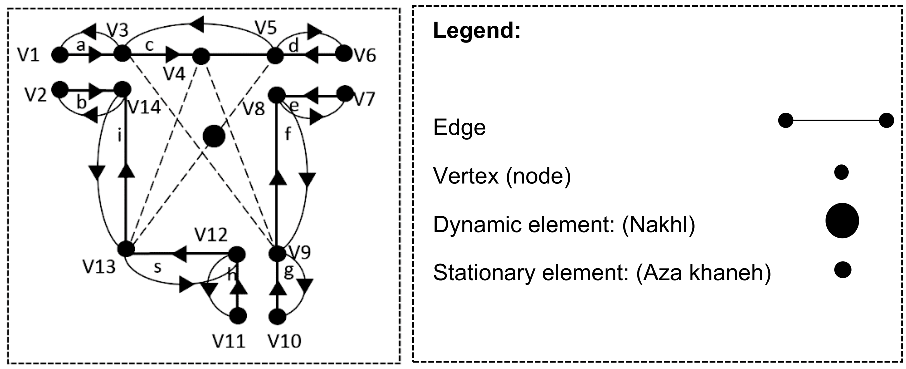


Fig. 7 Square Graph—spatial pattern specification—in Taft city. *Source* authors

patterns due to their destruction. In addition, we have not examined the evident network impact that a single spatial square has on the whole city. Due to the limited scope of the study and the lack of data, we were forced to ignore a few factors that may have helped to explain why the influence of local spatial squares differs in other pattern characteristics across cities. For example, the culture of spatial patterns is different in various cities, and the amount of use may have an effect on the pattern and its features.

Limitation

Obviously, this research has additional limitations. Although the spatial pattern data have several benefits, we were unable to obtain prior square patterns due to their destruction. In addition, we have not examined the evident network impact that a single spatial square has on the whole city. Due to the limited scope of the study and the lack of data, we were forced to ignore a few factors that may have helped to explain why the influence of local spatial squares differs in other pattern characteristics across cities. For example, the culture of spatial patterns is different in various cities, and the amount of use may have an effect on the pattern and its features. The size of the grids in various cities varies significantly. Our analysis is restricted to standard orthogonal grids in a single historical neighbourhood with rectangular blocks and two-entry or tree-entry rectangular grids. This restriction narrows our emphasis away from certain widely recognised grids in which plots face in four directions, but it also enables us to reduce the complexity of the simulation framework utilised to produce alternative synthetic grids. In addition, simulations are utilised to demonstrate how a judicious choice of aspects of the spatial pattern might increase pedestrian accessibility in freshly developed urban layouts. The distance decay function can look different depending on how people travel (walking, driving, etc.) and how they measure distance (in metres, miles, or minutes), which can change based on culture, geography, and weather.

The graph theory indices employed for this study would conveniently allow the introduction of weights for each area surrounded by various buildings to represent their differences in size or intensity, leading future research to empirically specify such variances. However, it may be difficult to simultaneously parameterise two-dimensional and three-dimensional urban shapes. Grid layouts, block sizes, and lot sizes may also alter over time, creating a complex sequence of cyclical causalities in which constructed form and land spatial patterns adapt to one another over time. To unravel these linkages, a further interdisciplinary study involving urban morphology, urban economics, and planning rules is necessary. Another limitation of our study is that we have just focussed on pedestrian accessibility and not automotive, public transportation, or cycling accessibility. A future study might further expand the analysis to include partly gridded or non-gridded urban subdivisions; however, a regular subdivision pattern would be required to evaluate parameter modifications. The regular grids that were looked at in this study could also be used as a standard to compare the outcomes of other irregular patterns of subdivision.

Geolocation information

See Fig. 8

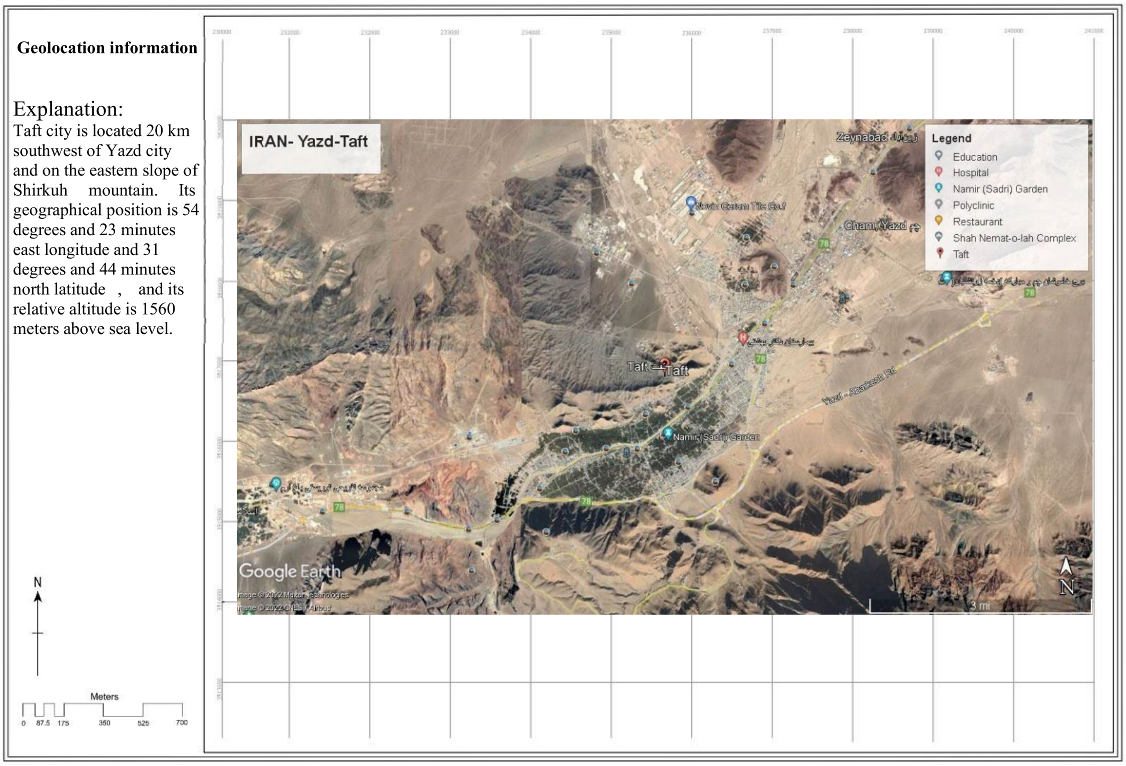


Fig. 8 Taft city's location. *Source* Google earth

Glossary[7]

A Hosseiniyeh — is a congregational hall for commemoration ceremonies, particularly those related to the Mourning of Muharram and other Shia commemoration rituals. A Hosseiniyeh is different from a mosque.

A Takaya — It is the place of mourning, performing ceremonies, and gathering travellers or passengers.

A Bazaar — A bazaar is a permanently enclosed marketplace or street where goods and services are exchanged or sold. The term "bazaar" originates from the Persian word "bāzār". The term "bazaar" is sometimes also used to refer to the "network of merchants, bankers, and artisans" working in the area.

A Reservoir — A pond is a covered pond or pool, usually built in the basement to store water. The reservoir is filled with rainwater or seasonal streams in low-water and desert areas.

A Nakhl — In Islam, a Nakhl symbolises a coffin decorated with special tools such as cloth, wood, and mirrors. Their scale is such that they serve as a dynamic memorial in the Islamic urban space. This coffin needs a big group of people and is usually moved during a ceremony on a certain day.

An Aza khaneh — is a house where rituals, religious ceremonies, and mourning ceremonies are held**.**

[7] https://en.wikipedia.org/

Data availability The authors confirm that the data supporting the findings of this study are available within the article.

Declarations

Conflict of interest No potential conflict of interest was reported by the authors.

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