The Morphology of Qom; The Study on Spatial Configuration Changes of the City (1956-2021)

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Abstract

The present study attempts to investigate the relationship between spatial configuration changes of Qom and the central core in the last half century. The main objective of this study is to review the Spatial form of Qom, and analyze the effect of changes in Urban configuration on the central core of the city and the main axes of urban activities during 1946 to 2011 and ultimately, Forecast the future status of the city based on the extensive changes being conducted on the configuration of this religious metropolis in the time horizon of 2021. The findings of this study on the alignment of decisions made with regard to the Qom structure and the Holy Shrine of Fatima Masumeh (AS) as the Central core of the city in the last half century have identified two time periods. The first, Decisions adopted on developmental changes during 1946 to 2011, which weakened the Qom spatial Configuration Values. Second, Future developmental changes during 2011 to 2021 that are expected to lead to improvements in Spatial Configuration Values.
Based on Qom morphological analysis in the last half century, this study concludes if the Qom roadmap foreseen for the time horizon of 2021, including construction of ceremonial axis of Prophet (PBUH) boulevard, inner ring roads and completion of urban ring roads happens, then the improvement of global integration, synergy, intelligibility and Choice values in the Central core and other parts of the city are expected.

Keywords: Urban Form, Space Syntax, Spatial Configuration, Central Core of the City of Qom**.**

1. Introduction

Urban planners' decisions and interventions in cities that are often performed in the form of urban plans do not just focus on the physical aspects of city and have profound effect on social and economic structures in space (Hillier & Hanson, 1984; Cuthbert, 2006; Harvey, 1973; Soja, 2010). The scientific methods assessing the spatial structure are applied tools that enable urban planners to gain knowledge of the evolution of past events and their impact on the urban fabric so as to forecast and quantify the effects of decision-makings regarding future urban plans and prevent some of the mistakes that impose long-term effects on the urban fabric (Hillier & Pen, 2004).
Accordingly, the present study investigated the evolution of Qom configuration resulted from the physical extension and changes taking place in the city during 1946 to 2021 and attempted to use space syntax analysis to judge the interventions made to date and forecast the results of the roadmap explained for the city in the time horizon of 2021, which is prepared as one of the city's development guidance documents.
The study goes on to describe the research methodology and the main indices of the analysis used. Then, the city of Qom as one of the major Iranian cities examined as a case study is introduced. Finally, Qom Spatial Configuration Values in five sections of 1946, 1965, 1996, 2011 and 2021 are analyzed.
Quantitative values are related to elements and statistical and graphical comparisons are possible within the system. Finally, its computations provide values that allow

2. Methodology

The spatial configuration of the city of Qom and its changes over time is investigated through space syntax method as a means of monitoring. The aim of the use of this technique is expression of various aspects of the relationship between morphological structure of built environment and the social and spatial structure of events in the city (Steadman, 2004; Mohareb & Kronenburg, 2012; Kubat, 1999). The theory of space syntax was proposed by Bill Hillier et al. in the 70s at the Bartlett School. The theory is a technique for exploring the relationship between space and society. The most important discussion in this theory is an emphasis on the fact that the pattern of a settlement is rooted in the collective life of its users (Hanson, 1989; Hillier, et al., 1983; Peponis, et al., 1989; Hillier, 1997). It is in a way that some social norms of communities can be achieved by analyzing patterns of settlements (Hillier, 2015).
The analysis is done based on converting maps to linear graphs and quantifying the spatial qualities of the nodes through the use of mathematical formulae. This method provides a simple operational process to explain, compare and translate settlement patterns. Some of the features of this method have made it a robust research tool. First, the space syntax method provides a real, simple and analyzable spatial model. Second, analysis of the elements is done in the form of an integrated system. Third, the systems of different sizes to be compared (Kubat, 1999). Integration (R) is the basic concept that is under discussion in the space syntax analysis, while this method

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provides secondary analysis parameters such as intelligibility, connectivity, choice and synergy.

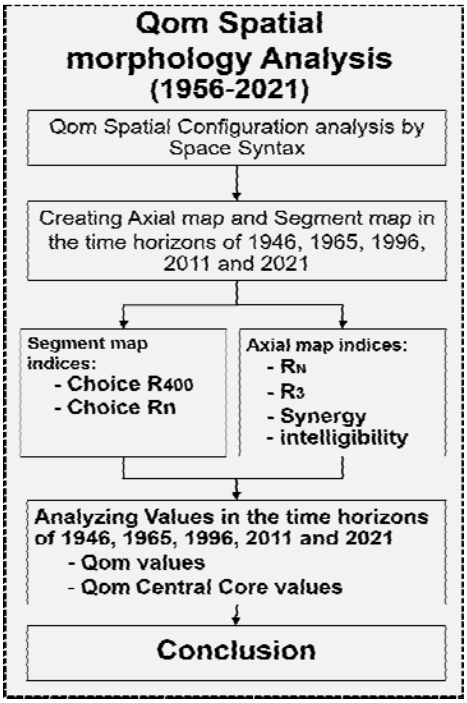

Fig. 1. Research Process

- **Analysis indices**

The Space Syntax method is used in this study. For this purpose, the axial and segment map of the city of the Qom in the time horizons of 1946, 1975, 1996, 2011 and 2021 was prepared using available documents, including aerial images and maps of the city. Then, some of the main measures of space syntax method including global integration (R_n), local integration (R_3), mean depth, synergy and intelligibility indices were investigated in the axial map and the "choice" index was investigated in the segment map of the city of Qom on the mentioned time horizons using DepthMap software. It is noteworthy that the segment length index was used as a weighting factor in the analysis of "choice" index in Qom segment map. (figure 1.).

In order to better understanding of potential options of movement in space, Turner proposes the use of different metric radius of movement in the analyses of the choice index (Turner, 2007). This provides a flexible analytical tool regardless of the type, size, and location of urban fabric. Smaller metric radius of movement is used proportionate to pedestrian movement and bigger radius of movement is used to analyze potential options of cycling and driving paths. In this study, a movement radius of 400 meter is used to analyze potential paths of pedestrian movement in a fabric and an infinite radius (n) is used to analyze selection of potential paths of driving in the city.

3. Case study

Due to the location of the shrine of Fatima Masumeh (AS) and having specific pilgrimage characteristics, the city of Qom is the second largest pilgrimage center in Iran after Mashhad. The growing population of residents and tourists causes great changes in the structure of city of Qom in the modern era.

The presence of leading Shi'ite authorities and development of religious schools in Qom has made it one of the most important religious education centers in addition to its pilgrimage function in the Shiite world (figure 2 and 3).

Fig. 2. The view of shrine (Bird vision)
Source: Qom Municipality Photo Archive

Fig. 3. The view to Qomroud in central Qom
Source: Qom Municipality Photo Archive

3.1. Geographical position

The city of Qom is the capital of Qom city and province in longitude of 50 degrees and 53 minutes and 15 seconds and latitude of 34 degrees and 38 minutes and 30 seconds, and is located 125 kilometers south of Tehran (Figure 4).

The city with about 7850 hectares and a population of 1,083,698 people in 2011 is considered as the eighth most populous city of Iran (Census of Islamic Republic of Iran, 2011).

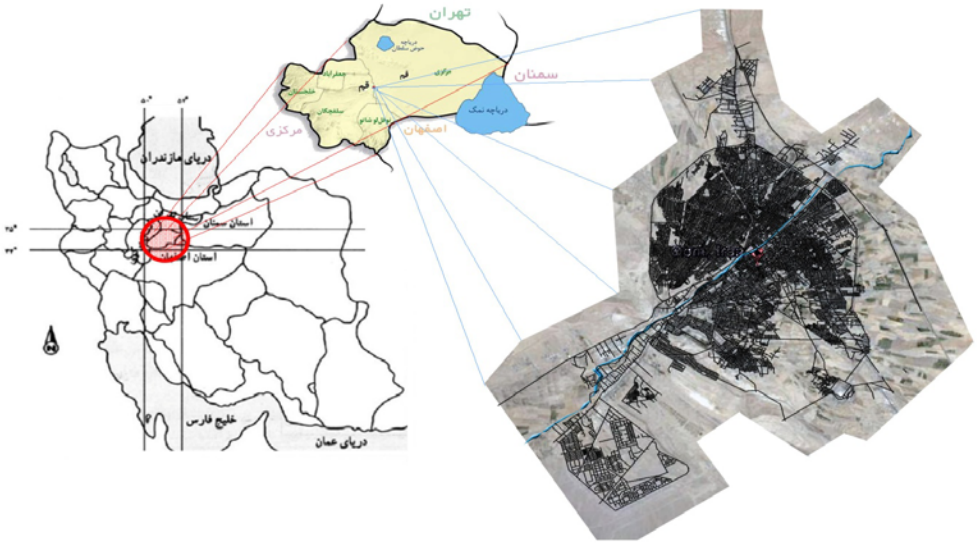

Fig. 4. The location of Qom in Iran (source: Census of Islamic Republic of Iran)

3.2. Physical development process

Foundation of the city of Qom goes back to five thousand years B.C. In this period, Qom was created five kilometers southeast of the current center of the city. The growth of the city was continued up to 727 AD (617 AH) until the city was completely destroyed by the Mongols.
Then, the people started to build the new Qom at the margin Qomroud and in the vicinity of the shrine Fatima Masumeh (AS) (Sa'adat, 1977). Today the ruins of the ancient city of Qom (the old Qom) are around the ancient hill of Darvish near the northern margin of *Jamkaran* (Figure 5).

The first organized intervention in the body of the city of Qom was done during the years of 1921 in the period of first Pahlavi. In this period the Haussmann urban planning spread in Europe, and it was imitated in Iran with the aim of facilitating access to the central cores of cities. In this time, cross-shaped road-building was put on the Iranian government's agenda, and the city of Qom was no exception. The main axes built in this period are Imam Khomeini (Haramnama) Street, the axis of access to railway station, Arak Street in the north of Qomroud, Azar Street, Eram and Bajak Streets in the south of the river. Transcontinental railroad line crossing the western edge of the city is one of the other major changes seen in this period (figure 6).

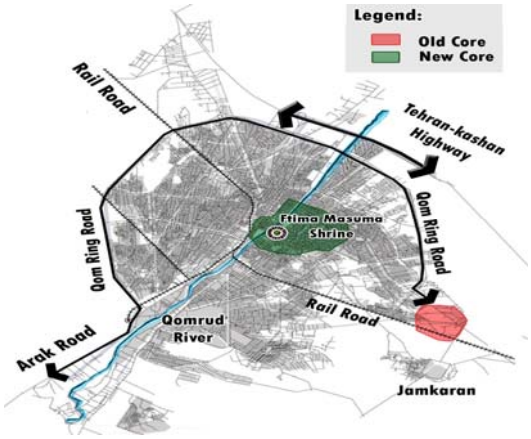

Fig. 5. The old and new core of Qom

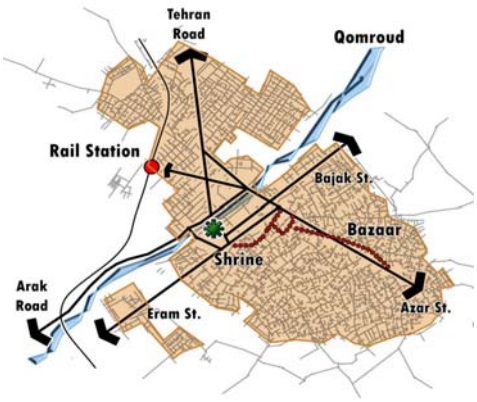

Fig. 6. Old streets in Qom during 1921 – 1956

The most important changes in Qom were made between 1921 and 2011, and decisions adopted to be performed in the time horizon of 2021 are shown on Figure 7 and 8.

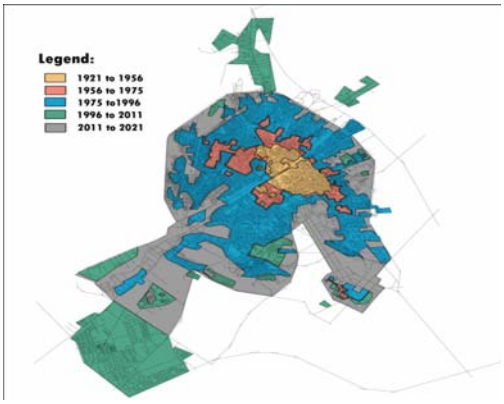

Fig. 7. The Qom expansion during 1921-2021

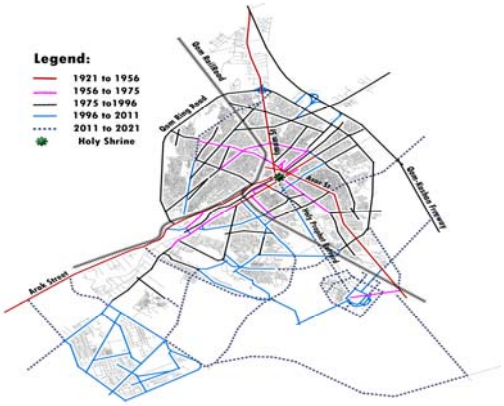

Fig. 8. The streets constructed in Qom during 1921-2021

4. Spatial analysis of the city of Qom

4.1. Integration index

Integration can be applied to any space in any configuration: the less depth from the complex as a whole, the more integrating the space, and vice versa (Hillier, 2007; Penn, 2003; Raford & Ragland, 2004). In this study, integration has been investigated on two scales of global integration (R_n) and local integration (R_3) in order to understand the main structural elements and investigate synergy (relation between part and whole) in the city of Qom. Comparison of the global integration index (R_n) during 1956 to 2021 shows a steady increase in the difference between the minimum and maximum value of this index. This means that the changes made in the city of Qom in the past decades have increased the homogeneity of different urban fabrics and some parts of the urban fabric of the city of the Qom have been more integrated and some parts have been more segregated as compared to the structure of this metropolitan. Paths with the highest integration have been in accordance with the main constructed streets during 1921 to 1956, including Tehran, Eram, Azar and Arak Streets, and have preserved their role as the main structural exes of the city (figure 9).

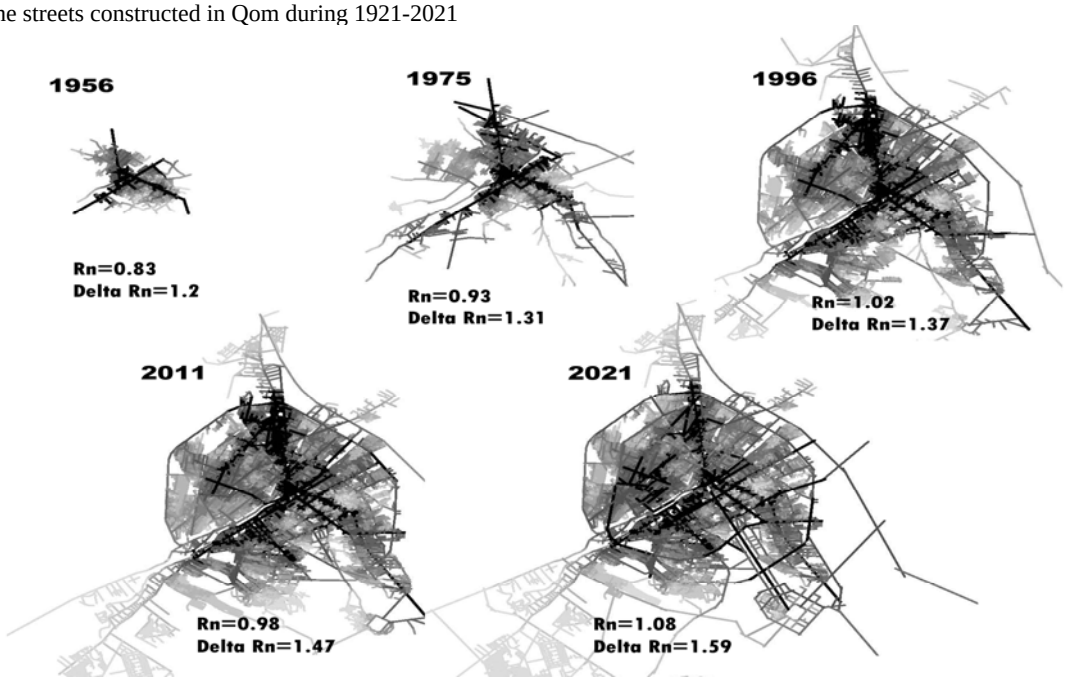

Fig. 9. Axial map of Qom in five sections of 1946, 1965, 1996, 2011 (the most integrated streets are shown in bold black lines)

4.2. Synergy ($R^{\wedge 2}\ R_3/\ R_n$)

Synergy (relation between part and whole) is the homogeneity or heterogeneity of a local structure and macro-structure of the urban fabric (Hillier, 2007). Synergy value of city of Qom during 1921 to 2021 shows that physical interventions carried out until 2011 have increased differentiation between macro-structure and local structure of the city. It is expected to observe an increase in the correlation between global integration and local integration by operationalizing the road map envisaged for the city of Qom in the time Horizon of 2021.

Another comparison made regarding the synergy is comparison between the synergy value in the whole city with the synergy value of the city's central core. This could explain whether the Qom central core is more integrated to or segregated from Qom Spatial Configuration. (Figure 10 to 14).

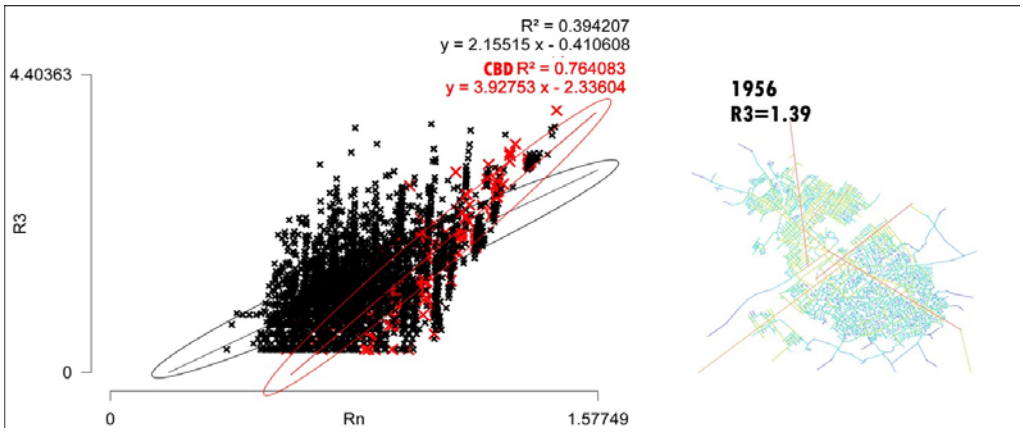

Fig. 10. Comparing synergy scattergram of city of Qom and its central core in 1956

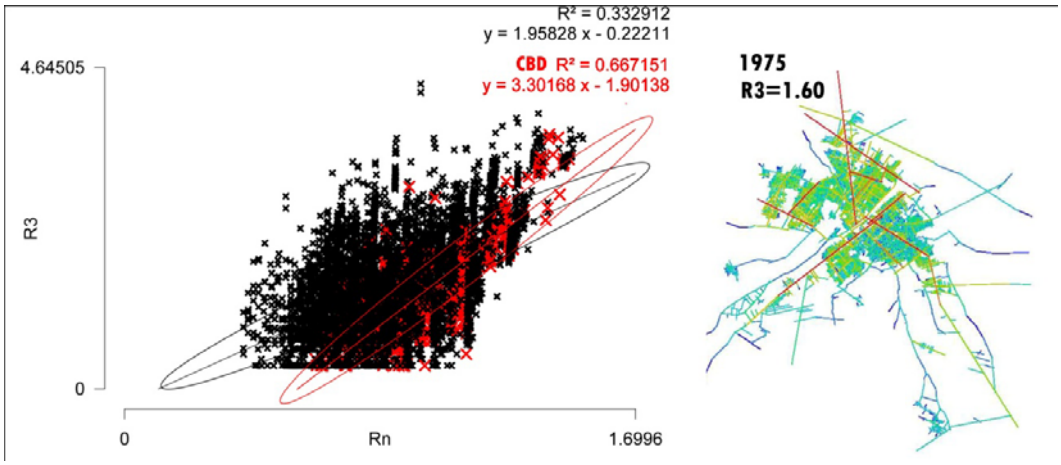

Fig. 11. Comparing synergy scattergram of city of Qom and its central core in 1975

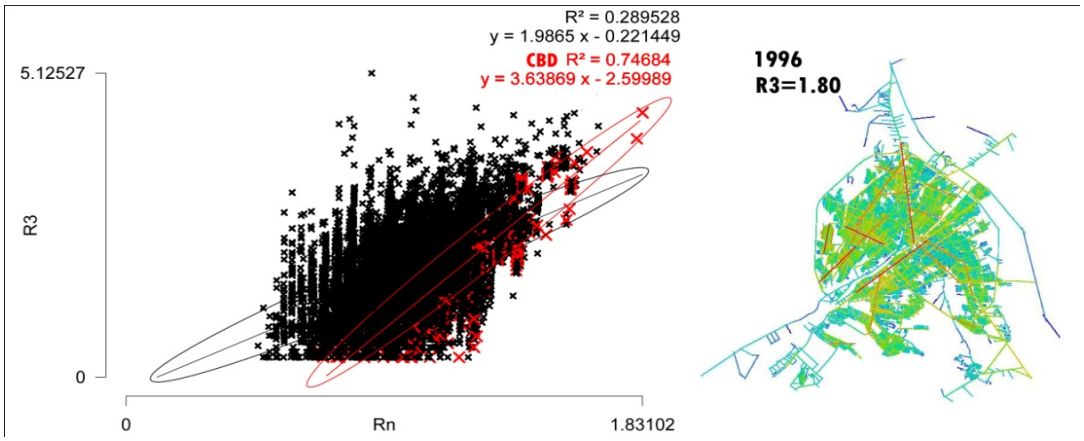

Fig. 12. Comparing synergy value of city of Qom and its central core in 1996

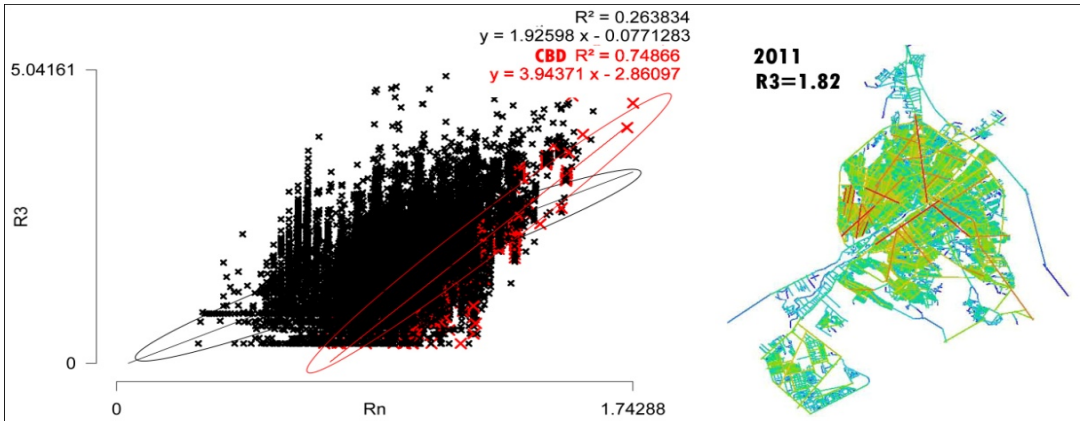

Fig. 13. Comparing synergy scattergram of city of Qom and its central core in 2011

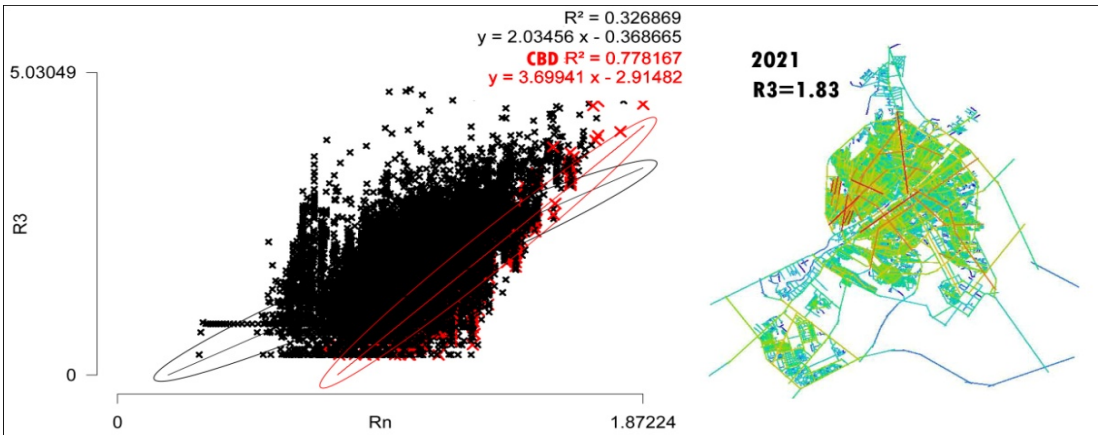

Fig. 14. Comparing synergy scattergram of city of Qom and its central core in 2021

Analyses show that contrary to the synergy value of Qom that has been declining to date, but the synergy value of the central core has just declined during 1956 to 1975 and then it has had a rising growth. On the other hand, because of the major focus of the measures regarding locating and construction of main access streets in central fabric of Qom and the failure to achieve anticipated road-building projects in other parts of the city, the difference between the synergy value of the city of Qom and the synergy of the Qom central core is increasing (Table 1).

Table 1
Qom Synergy values during 1956-2021

Indices	1956	1975	1996	2011	2021
Synergy of city of Qom ($R^{\wedge 2}$ R_3/Rn)	0.39	0.32	0.29	0.26	0.32
Synergy of Qom central core ($R^{\wedge 2}$ R_3/Rn)	0.76	0.66	0.74	0.75	0.78
Difference between Synergy of Qom and Qom central core	0.37	0.34	0.45	0.49	0.46

4.3. The intelligibility

The intelligibility is defined as the degree of correlation between Connectivity and Global integration values of the axial lines in spatial configuration analysis (Hillier, et al., 1983). Hillier states The property of 'intelligibility' in a deformed grid means the degree to which what we can see from the spaces that make up the system - that is, how many other spaces are connected to - is a good guide to what we cannot see, that is, the integration of each space into the system as a whole (Zhang, Chiradia & Zhuang, 2013).

Intelligibility is different from the legibility and perception, and greater intelligibility of a fabric does not necessarily mean that the fabric is legible. Factors such as the presence of people due to certain events in space and Baroque axes, in addition to increasing the legibility of a fabric, play a major role in consolidating the intelligibility properties.

Evaluation the index of different parts of the city of Qom and its central core makes it clear that the intelligibility of the city of Qom have been constantly undermined as a result of physical intervention of urban planners over the past years (Figure 15).

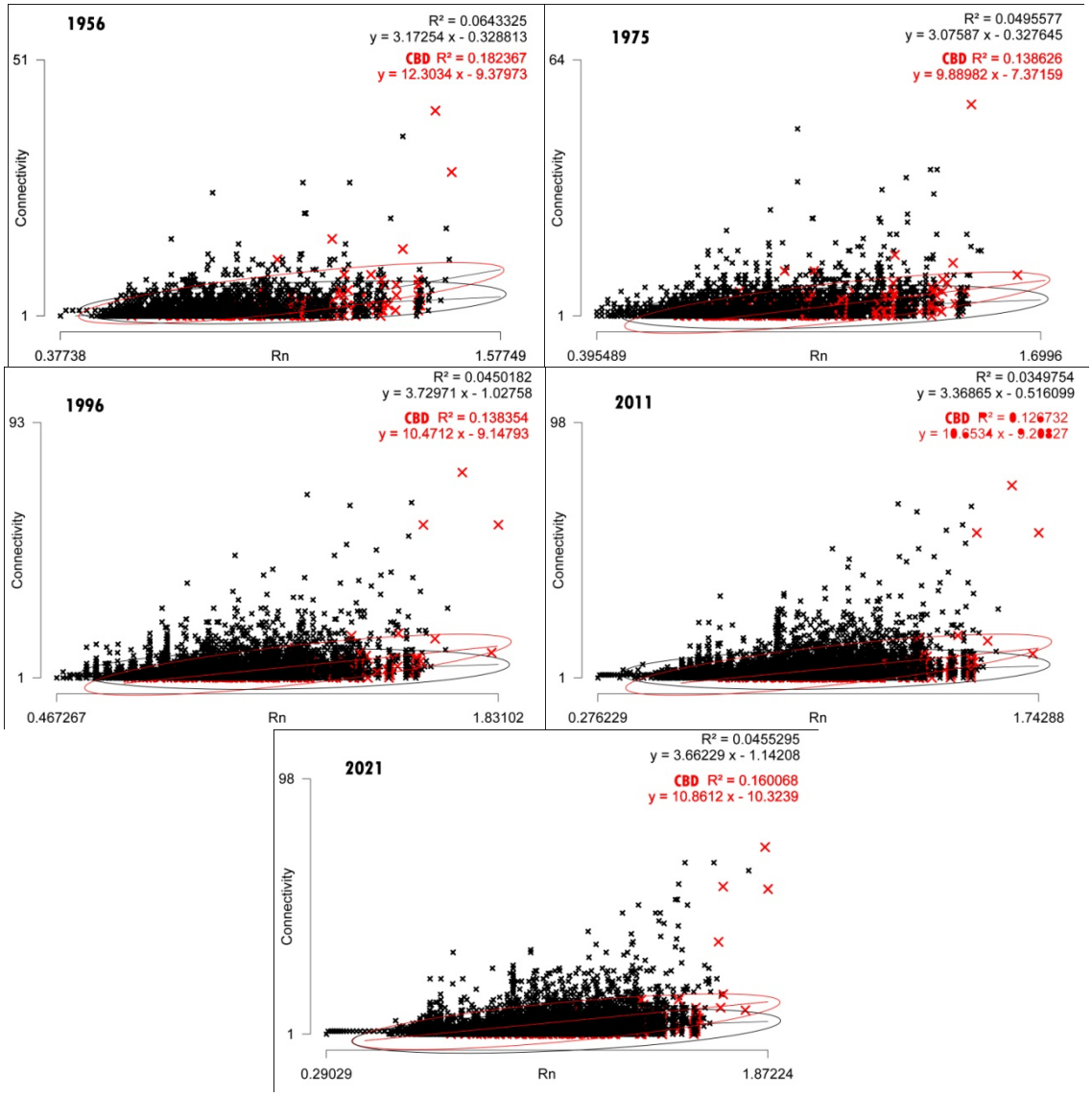

Fig. 15. Qom intelligibility scattergram during 1956-2021

Data show that the planned measures foreseen in the time horizon of 2021 such as the construction of Prophet (PBUH) Boulevard, continuing the ring roads of Ferdowsi and Karimi, along with completion of the southwest access of the city to Qom-Kashan highway will help improved intelligibility value. However, some of the measures carried out during this period may also distort the legibility of the city and have a negative impact on the intelligibility value. Such measures include the construction of the monorail along the Qomroud that may be followed by a blocked vision to Fatima Masumeh (AS) shrine from the surrounding fabric and Imam Street (Haramnama), which has had the greatest intelligibility since its construction. It is expected that the Imam, Eram, Bajak, Azar, Chaharmardan, and Jomhouri Streets have the highest intelligibility in the fabric of the city of Qom in the time horizon of 2021 (Figure 16).

Fig. 16. Paths having highest intelligibility index in Qom in the time horizon of 2021

4.4. The choice value

The choice value indicates the degree of choice that a space provides or it refers to the choices a space provides to pass from an area to another. Choice, in short, is also called the potential power of movement in a fabric (Hillier & Iida, 2005).

Evaluation of the comprehensive choice (Rn) and the index of a radius of 400 (R400m) in Qom shows that in the years 1956 and 1975, the passages that provide the greatest level of choice for driving across the city are largely overlapped with the passages that provide access of pedestrians within a radius of 400 meters in the residential fabrics. The overlapping of the passages causes problems such as interactions between the natural movement of pedestrians and roadways. This, in the years from 1996 so far, has been improved with the construction of ring roads for cars moving around the city and shows a change of tendency of cars from local roads to main streets and ring roads (Figure 17). Ongoing interventions in the roads and crossovers along with the management of the cross sections of paths can be the determining factor in the development of comprehensive choice index.

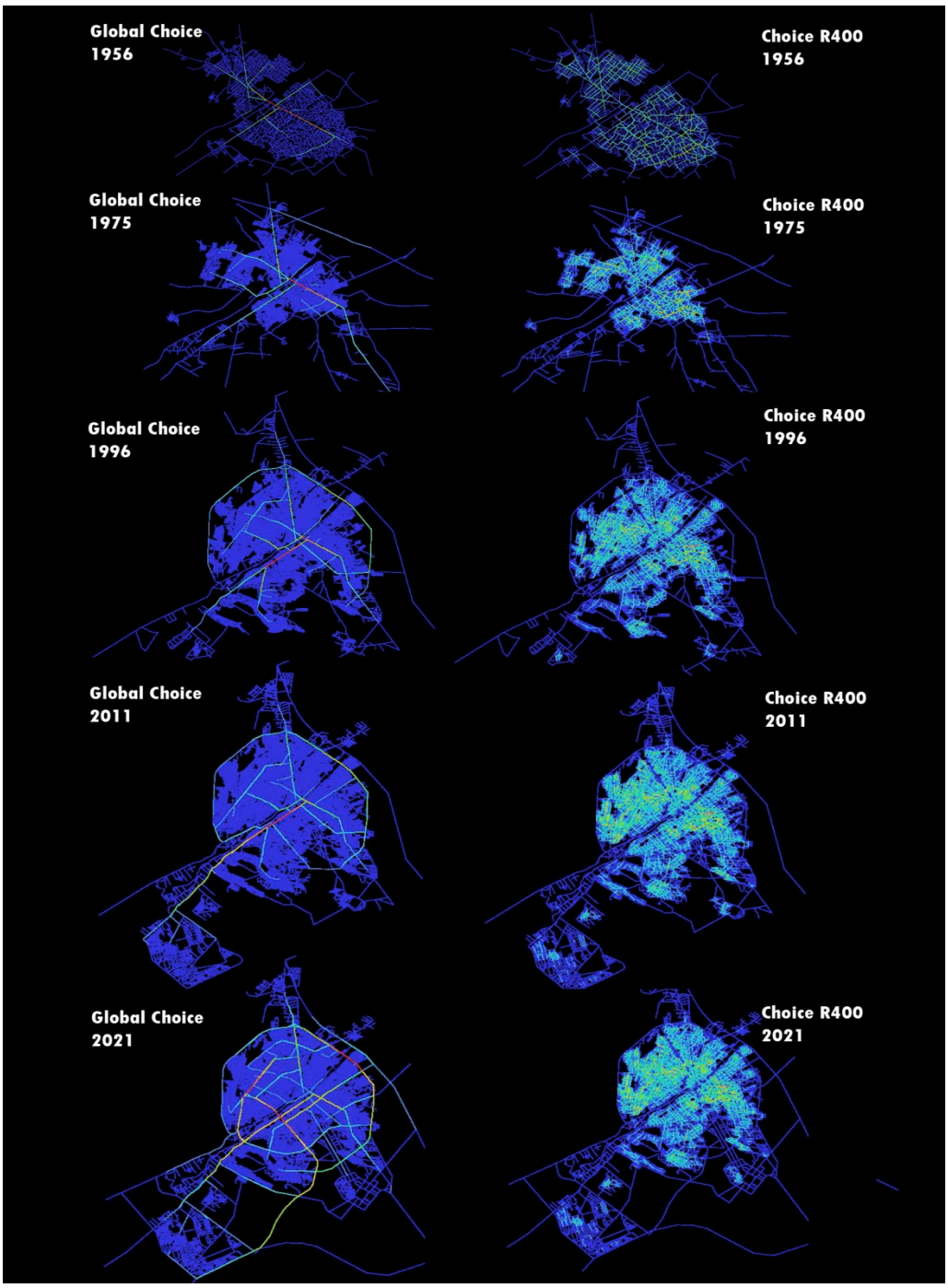

Fig. 17. The Global Choice and Choice R400 of Qom during 1956-2021

5. Conclusion

Spatial configuration growth and changes are always associated with competition, influencing and being influenced among fabrics and new and old centers of cities. General trend of changes in historical cities are towards the low boom of downtown core of cities and creation of booming urban fabrics. Studies on quantitative indices of spatial configuration of the city of Qom during 1956 to 2021 show that despite the growth and expansion of this city, the focus of much urban projects including physical development plans and the creation of a new road network with a functional role on the downtown of the city of Qom has prevented marginalization of the downtown. Due to the lower degree of realization of proposals for central and suburban parts of the city, a decrease in the indices of integration, intelligibility and the correlation between the global integration and local integration is observed. Based on the quantitative analysis, it is expected to see an improvement of Local and global integration, synergy and intelligibility values in the Central core and other parts of the city with the realization of proposed projects regarding the changes in spatial configuration of the city of Qom in the time horizon of 2021 (Table 2 and figure 18).

Table 2
Qom Axial map indices during 1956-2021

index/year	1956	1975	1996	2011	2021
Mean R_n	**0.83**	**0.93** ↑	**1.02** ↑	**0.98** ↓	**1.08** ↑
Mean R_3	**1.39**	**1.60** ↓	**1.80** ↑	**1.82** ↑	**1.83** ↑
Synergy	**0.39**	**0.32** ↓	**0.29** ↓	**0.25** ↓	**0.32** ↑
Intelligibility	**0.064**	**0.049**↓	**0.045**↓	**0.034**↓	**0.046** ↑

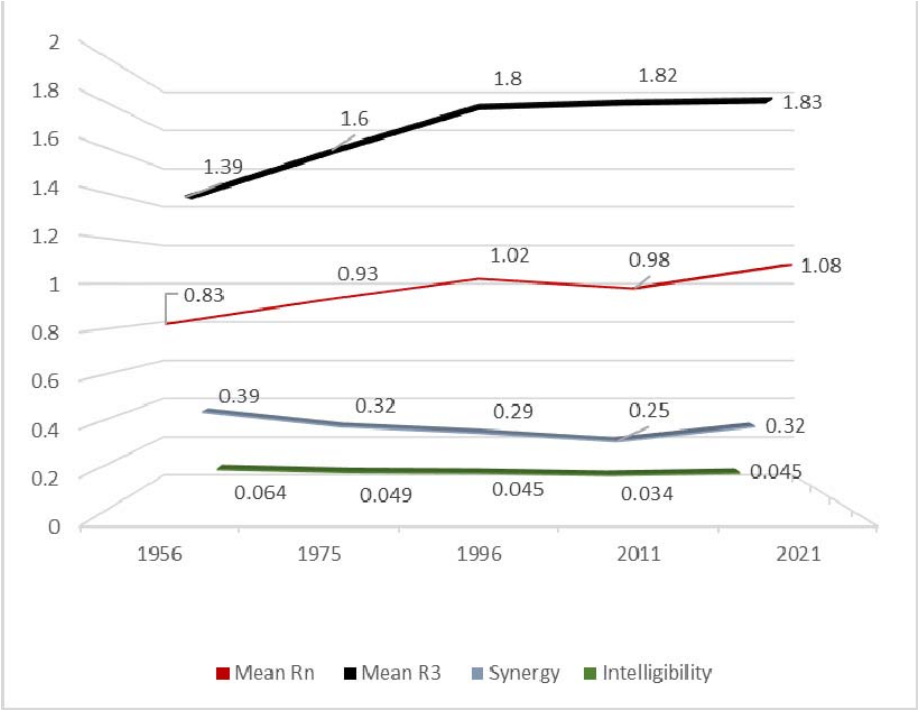

Fig. 18. Comparison of Qom Axial map indices during 1956-2021

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