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From Bazaar to Street

Investigating the dynamic of Tehran's urban growth in the pre-modern and early modern times

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ABSTRACT

The transformation of the historic city into the modern city in Iran has been defined by one phase in space syntax literature by Karimi (2000). In this process, parts of the old city, including old city centres, were demolished to create new streets in the heart of the Iranian city. Consequently, urban life fell in the old city centre (the bazaar), and the new centre was raised outside the boundaries of the old city. However, this known narrative can be refined by reflecting on the development of Tehran from a historic city to a modern city in the mid-20th century, where the bazaar and the street show different relationships in the structure of the city through this urbanisation process. To understand this model of urban development, the research employs segment analysis and its measurements (choice and integration) to compare the spatial organisation of Tehran in three periods: 1) the historic Tehran in the mid-19th century (1858), 2) Tehran after the first phase of urban development in the late 19th century (1891), and 3) the modern Tehran after the second phase of urban development between the 1930s and 1940s (1948). As a result, the research argues that the role of the bazaar in the structure of Tehran was preserved under the first phase of urban development in the 19th century. However, this role declined following the second phase of urban development based on modern principles.

KEYWORDS

urban development, historic city, modern city, bazaar, street, Tehran

1   INTRODUCTION

Urban development is one of the first topics that Space Syntax explored. In these 50 years, the development of hundreds of cities around the world has been explored by syntactical methodology. This rich background shapes a solid literature about this topic in the field. However, the review of urban development in non-Western contexts shows further potential for enriching the syntactical principles of sustainable urban development. This paper focuses on Tehran, the capital of Tehran since the late 18th century, to contribute to this aim. The transformation of this city is completely different from the other Iranian cities that have been explored in the space syntax community because it faced two phases of urban development, instead of one phase, to transform from a historic city to a modern city. This paper is a tale of this special urban transformation. The paper reviews the works about the development of Tehran between the mid-19th century and the 20th century in the literature review part[1]. Then, the application of syntactical methods and the map selection process is explained. Next, the result is reported and discussed to address the similarities and differences between the development of Tehran and other Iranian cities. In the end, the conclusion of the research summarises the main findings and highlights the study's broader implications.

2   OVERVIEW OF URBAN DEVELOPMENT IN THE IRANIAN CITY FROM THE SAFAVID ERA UNTIL THE MID-20TH CENTURY

The bazaar was the most important urban element in the structure of the Iranian city until the beginning of the 20th century since it distributed economic, social, political, and religious activities in the city. Urban historians like Ardalan & Bakhtiar (1973), Habibi (2011), and Habibi & Ahari (2007) show that the growth of the bazaar shaped the urban development of the city and added new neighbourhoods and urban parts to the structure of the city. They explain that the city centre was a square surrounded by the bazaar and its rastehes (bazaar corridor), the greatest mosque of the city, the king's palace, and the state's building.

During the 17th century, alongside the reign of the Safavid kingdom, the city of Isfahan in Iran witnessed a period of great prosperity. In this era, a series of urban developments redefined the structure of Isfahan and presented a new architectural style. This new style in architecture and urban planning is famously known as the Isfahan School (Habibi & Ahari, 2007). These urban developments were planned to address the king's new request: moving the city's centre from the old square to a new square. This approach contrasts with the common urban development approach in Iranian cities where the existing centre was reconstructed(Habibi, 2011). Based on

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[1] The paper applies a limitation to this part. It only reviews the work of Iranian scholars who lived or are living in Iran. Covering the works of all scholars in this field, including Iranian diaspora scholars and orientalists, is beyond the capacity of an 8000-word paper.

this new modality of urban development, the old centre retained its status as a vibrant social and popular hub, while the new centre became the main host of political, social, and administrative activities. Besides, the bazaar axes served as the link between these two centres and passages provided access to different neighbourhoods.

The next known turning point in urban development and architecture of the Iranian city was marked in the 19th century, under the rule of the Qajar dynasty. Tehran, the capital of the country, was expanded through a series of urban development projects between the late 1860s and the 1870s since there was no further land within the existing walls of Tehran for settling people (Ettehadieh, 1998; Mirza Salor, 1995). This new approach to developing a city and designing new buildings is called "Tehran Style". As Habibi (2011) defined, the urban development based on the principles of this new style created a new centre for Tehran, similar to the Isfahan School, called "Toopkhaneh Square". However, he highlighted that a new urban element, the street, links the old and new parts. Besides, Toopkhaneh Square, unlike the Isfahan School, host the bank, telegraph office, and municipality buildings, which are Western institutions without any background in Iranian society. Thus, this urban development marked a significant shift in the history of the city in Iran. It changed the main driver of the city's developments after more than a thousand years from the bazaar to the western street. Lastly, this urban development is one of the rare attempts to reconcile Iranian urban planning principles with Western practices. In other words, it represents a hybrid identity.
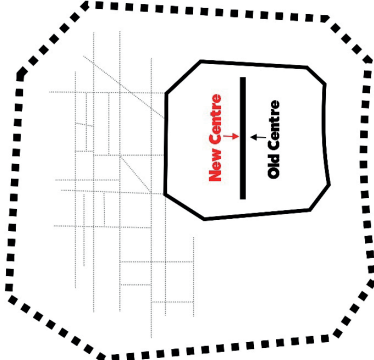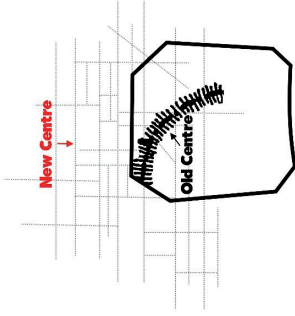
Tehran's last phase of development before the mid-20th century was planned and executed in the 1930s and 1940s. The reasons behind this phase of development were the emergence of vehicular transportation modes, especially cars, in the city (Sultanzadeh, 2011), the poor sanitary conditions (Shahri, 1978), and the decay of the aesthetics and order of urban spaces (Hedayat, 2020). Besides, the new dynasty, the Pahlavi dynasty, imagined a new vision for the Iranian city (Habibi, 2011). The initial attempts for planning this development phase were delivered around 1930 and finalised in 1937 (Habibi, 1990; Safamanesh & Manadizadeh, 2000). There is no explicit information about the progress of this major urban project available. However, Shirazian (2016) works on the historical maps of Tehran indicates that parts of the old city centre (including the bazaar) were demolished to make space for six Modern (Pahlavian) streets in 1944. Besides, that work shows that this phase of Tehran's urban development was completed in 1948.
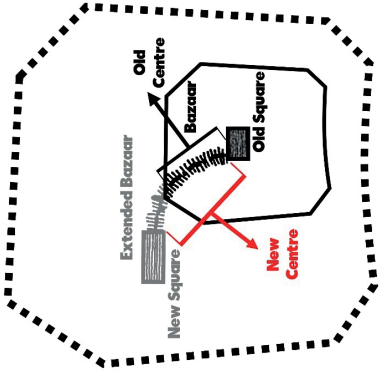
Additionally, this development phase is judged in two different ways through the ages. The political figures, like Hedayat (2020) and Mirza Salor (1995), and historians, like Shahri (1978), who witnessed the development of Tehran in those years, praised this project. In contrast, it has been criticised after the revolution by well-known urban scholars inside Iran, such as Bemanian

(2006), Habibi (1990, 2011), Pakzad (2016), and Sultanzadeh (2011). These scholars witnessed the aftermath of this development for Tehraners in the second half of the 20th century and the beginning of the 21st century. In summary, this new phase of development envisions the future of Tehran based on modern urbanism principles. It means that urban development aims for limitless and continuous urban growth without any constraints or boundaries. This aim contrasts the Isfahan School's principles, which define urban development as limited urban growth with boundaries and centre(s).

On the other hand, space syntax literature has classified three models of urban development in the Western and non-Western contexts (Table 1). In the first model, the old city centre(s) is preserved and adapted to the change after the city's development. This model of urban development has been mainly detected in Western cities in research such as Hanson (1989), Hillier (2007), and Vaughan et al. (2013) on the development of London over various time series, Karimi (2000) and Griffiths (2009) on the urbanisation of English cities between the 18th and 20th centuries, Al Sayed et al. (2009) on the urban growth of Manhattan and Barcelona from past until the mid-2000s, Shpuza (2009) on the evolution of street networks in Adriatic and Ionian coastal cities between 1769 and 2007, and Kostourou (2020) PhD thesis on mapping adaptability in Cité Ouvrière (housing project) through the urban growth of Mulhouse from 1850 to 2015. In the non-Western context, Karimi's (2000) and Karimi and Motamed's (2003) research highlight two other models for developing existing city centres. The first work showed that the application of modern urban planning in five Iranian cities segregates the old centre and shifts the city centre to the new parts of the city. Similarly, Fox (2022) concluded the same result about the urban development of Tel Aviv-Yafo in the 20th and 21st centuries. In the second work, Karimi and his colleague examined the development of Isfahan (Iran) in the 17th century, which sustained the role of the old city in the new urban structure. As a result, the space syntax literature has not examined urban development in either the global north or the global south with a hybrid identity like Tehran's development during the Qajar dynasty.

Table 1. Urban development models in space syntax literature

No.	Urban Development Model	Period	Urban Development Element	Old City Centre	New City Centre	Connecting Urban Elements between Old and New Centres	Destruction of Old City	Consequence of the Urban Development	Schematic Diagram
1	Organic Style (English Cities)	20th Century	(Modern) Street	High Street	High Street (the same)	(Modern) Street	No	preserving the continuity of urban life in old parts (Griffiths, 2009; Hanson, 1989; Hillier, 2007; Karimi, 2000; Kostourou, 2020; Vaughan et al., 2013)	
2	International Style (Modern Planning in non-Western context)	20th Century	(Modern) Street	Bazaar	(Modern) Street	(Modern) Street	Yes, through Modern Street	destruction of the old centre, fall of urban life in old parts (Fox, 2022; Karimi, 2000)	

No.	Urban Development Model	Period	Urban Development Element	Old City Centre	New City Centre	Connecting Urban Elements between Old and New Centres	Destruction of Old City	Consequence of the Urban Development	Schematic Diagram
3	Isfahan School	17th century	Bazaar	Bazaar	Extended Bazaar (including existing Bazaar)	Bazaar	No	preserving the continuity of urban life in old parts (Karimi & Motamed, 2003)	

3   METHODOLOGY

This section provides a detailed explanation of the research methodology employed in the study. It utilises historical maps and space syntax analysis to investigate the research questions in the context of Tehran between the mid-19th century and the mid-20th century. In the first part, a short review of the survey map of Tehran from pre-modern to modern times until 1954 is provided. This review explains the process of selecting maps representing the urban change in the street network of Tehran in each phase of development over these roughly 100 years. Then, the potential and application of space syntax analysis for evaluating urban changes in a non-Western context is highlighted.

3.1 Maps of Tehran between mid-19th century and mid-20th century

The surveying of the city in Iran is something new in comparison with the surveying of the city in Europe which goes back to the early Renaissance era in Europe. The review of sources about survey maps of cities in Iran suggests that the first systemic attempts were delivered in the Naser al-Din Shah Qajar's reign (Shirazian, 2016, p. 2). Before this era, the only meaningful attempt was the Nazkov Map in 1826, which only shows the borders of the city and the boundaries of its neighbourhood (Shirazian, 2017, p. 5). Urban historians consider this map as the oldest map of Tehran. During this period, three maps of Tehran were prepared and published by the order of the king. Two of these maps ("Darol-Khelafe-ye Tehran" (1858) and "Darol-Khelafe-ye Naseri" (1891)) provided detailed information about the city, including urban block and street network. Since then, Iranian engineers have employed surveying methods to produce maps of the city. In the next 60 years, nine maps of Tehran were provided that recorded the urban growth of this city (with various resolutions) from the beginning of the 20th century until post-WWII. Table 2 lists all survey maps of Tehran[2] from the beginning of surveying in Iran in the 19th century until the mid-20th century.

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[2] This table excludes maps that present schematically Tehran and its suburbs, like a schematic map of Tehran and its surroundings by Brigadier General Abdul Razzaq Baghaieri in 1898.

Table 2. Maps of Tehran between the 19th century and the mid-20th century (Habibi & Hourcade, 2005; Shirazian, 2016, 2017)

No.	Title	Date	Surveyor	Scale	(Urban) Information
1	**Nazkov Map**	1826	**Captain Nazkov**	**not accurate**	• The oldest map of Tehran • Wall of Tehran (this wall was built by Tahmasp I, the Safavid king in the 16th century) • Key locations in the city, like the king's palace, Bazaar, and house of well-known people • Outline the suburban of Tehran • The urban block information is not available • The street network information is not available
2	**Brezin Map**	**(start of) Surveying: 1842** **Published: 1859**	**Elias Nikolayovich Brezin**	unknown	• Wall of Tehran (this wall was built by Tahmasp I, the Safavid king, in the 16th century) • Key locations in the city, like the king's palace, Bazaar, mosques • The detailed representation of the urban block is not available • The detailed street network of Tehran is not available (main street/passages are drawn, but alleys are not included)
3	**Map of Tehran's "Dar-ol-Khelafe"** (also known as **Cercich Map**)	**(start of) Surveying: 1848** **Published: 1858**	**Mohammad Taqi Khan Moghadam, Zulfiqarabeig Mahallati under the supervision of August Cercich**	**not accurate**	• The first map of an Iranian city that includes detailed information about urban block and street network • Naser al-Din Shah Qajar (the king) ordered to provide 1200 copies of this map • The urban block information is available • The street network information is available • The bazaar sections are drawn with thick black lines
4	**Map of Darol-Khelafe-ye Naseri** (also known as **Abdolghaffar Map**)	1891	**Abdolghaffar Najmolmolk**	1:4000	• This map was prepared after the development of Tehran in the Naser al-Din Shah Qajar era • The names of 1600 places/buildings are specified • The urban block information is available • The street network information is available • The bazaar sections are drawn by thick black lines
5	**Map of Tehran**	1914	**Karl Pedker (Firm)**	1:34000	• Key locations in the city, like the king's palace, Bazaar, embassies • The detailed representation of the urban block is not available • The detailed street network of Tehran is not available (main street/passages are drawn, but alleys are not included)

No.	Title	Date	Surveyor	Scale	(Urban) information
6	Map of Tehran's Schools	1925	School Inspection Office	1:16000	• This map shows the location of public schools in Tehran between 1920 and 1925 • The detailed representation of the urban block is not available • The detailed street network of Tehran is drawn, but alleys are not included) (main street/passages are drawn, but alleys are not included)
7	Map of the Arrangement of the Streets of Tehran	1929	Unknown	unknown	• The detailed representation of the urban block is not available • The detailed street network of Tehran is not available (main street/passages are drawn, but alleys are not included)
8	New Map of Tehran	1930	François De Romeiser	1:6500	• In this map, 124 places and streets are identified in Tehran • The urban block information is available • The street network information is available
9	Map of Transformation Plan of Tehran	1937	The Ministry of Interior of Iran	unknown	• This map outlines another plan for constructing the new streets in the old Tehran in the Reza Shah era • The detailed representation of the urban block is not available • The detailed street network of Tehran is not available (main street/passages are drawn, but alleys are not included)
10	Guide Map of the City of Tehran	1944	Colonel Mohammad Reza Ghaffari	1:32000	• This map is ordered by the municipality of Tehran and the Ministry of Culture with the permission of the general staff of Iran. • This map shows the final plan for constructing the modern (new) streets in the historic centre of Tehran in the Reza Shah era • Outline the suburban of Tehran • The detailed representation of the urban block is not available • The detailed street network of Tehran is not available (main street/passages are drawn, but alleys are not included)
11	Appendix of Guide Map of Tehran	1947	Engineer Jalaluddin Ashtiani	1:25000	• The detailed representation of the urban block is not available • The detailed street network of Tehran is not available (main street/passages are drawn, but alleys are not included)
12	Guide Map of the City of Tehran (also known as General Staff Map)	1948	Geographical Department of the General Staff of Iran	1:10000	• The urban block information is available • The street network information is available
13	Map of the City of Tehran	1954	Statistical Centre of Iran	1:5000	• The urban block information is available • The street network information is available

Based on Table 2, 13 maps of Tehran have been provided from the early 18th century until the mid-20th century. The research question about the key years in the urban development of Tehran and the space syntax methodology led the research to select three maps of the listed maps above. The first map is the map of Tehran's "Dar-ol-Khelafe" (1858), which represents the urban form and street network of historic Tehran in detail before Tehran's first phase of development in the 1860s and 1870s. The next map is the map of Darol-Khelafe-ye Naseri (1891), which depicts Tehran more than a decade after the first phase of the development. This map provides high-resolution information about the urban form and street network of Tehran at that time. Lastly, the guide map of the City of Tehran (1948) is selected because it is the closest map to the time that the development of Tehran was completed in the mid-1940s, as well as its detailed information about the urban form and street network of Tehran in 1948.

Lastly, the research detects key urban parts of Tehran in these three maps for further exploration. In this process, the literature about the urban development of Tehran in the 19th and 20th centuries is reviewed, three maps (1858, 1898, and 1848) are compared in detail and recent works about the location of Rastehes in contemporary Tehran research, like Karampour (2009, p. 3), are considered. Consequently, the urban elements that are examined in each map are:

- The map of "Darol-Khelafe-ye Tehran" (1858): Key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh)
- The map of "Darol-Khelafe-ye Naseri" (1891): Key Rastehes, Qajarian Streets (Amir Kabir Street, Bab Homayoon Street, Ferdowsi Street, Lalehzar Street Marizkhaneh Street, Naser Khosro Street
- The "Guide map of the city of Tehran" (1948): Key Rastehes, Qajarian Streets, Modern (Pahlavian) Streets[3] (Bouzarjomehri Street (15 Khordad Street), Khayyam Street, Shahreza Street (Enqelab Street), Shush Street 1327, Si Metri Street (Kargar Street), Shahbaz Street (17 Shahrivar))

3.2 Space Syntax Methodology

The space syntax method has contributed to the research on urban development in the global East and global West during the transition from the 19th century to the 20th century. It explores the spatial configuration of the city to understand how people move in the space, behave in it and adapt to changes (Hillier, 1996, 1999, 2007; Hillier et al., 1993; Hillier & Hanson, 1984). Between the emergence of the space syntax theory and the late 2000s, axial analysis has been the only method of this theory for evaluating urban change in the city and its parts (Hillier & Vaughan, 2007; Karimi, 2000). In the beginning, axial analysis was a descriptive tool to study the

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[3] The current names of these streets are in parentheses.

morphology of the city (Hillier & Hanson, 1984), then, it became an analytical tool to explore the urban process by publishing the "Space is the Machine" book in 1996.

In the next phase of space syntax methodology development, three key changes happened in around 10 years. First, the segment analysis was introduced in the mid-2000s by Hillier & Iida (2005) and Turner (2007), then, the problem of normalising the syntactical result was solved in the early 2010s (Hillier et al., 2012), and lastly, "Space Syntax Toolkit" was programmed for QGIS, which uses volunteered geographical information (the OpenStreetMap dataset) for running segment analysis (Gil et al., 2015; Kolovou et al., 2017). The OpenStreetMap dataset brought a special advantage for segment analysis compared to the other spatial/network analysis tools. Since this dataset provides high-resolution street network data of most human settlements in the Western and non-Western contexts, it makes the application of segment analysis accessible everywhere. Therefore, space syntax methodology was not only a solid analytical method for studying urban change but also became a method that could be applied to many cities worldwide at the end of this period. One of the first attempts that used segment analysis and its tools, which are mentioned above, to study urban change over time in a non-Western context is the PhD research of Stella Fox (Fox, 2022) under the supervision of Laura Vaughan between 2018-2022 at the Space Syntax Laboratory in the Bartlett School of Architecture, UCL. Lastly, Griffiths and Vaughan (2020) showed how recent technological advancement helps the researcher in urban history project historical maps in GIS software, extract the historical street network of a city from the existing street network, and apply the space syntax analysis to it.

On the other hand, the research in segment analysis methodology detects radii below 1600m (= 20 minutes-walk) for pedestrian movement (local scale) and above it for vehicular movement (city scale) (Al-Sayed, 2014). In addition, the works of Krenz (2017) and Gil (2017) guide researchers to find radii that can be run for local, city and regional scale analysis in their syntactical model of a city. In addition, the research in this field uses two key measurements to assess the accessibility of the city and its parts (Turner, 2007):

> "Integration" assesses the shallowness of a space in relation to other spaces in a system. It shows a space's potential for to-movement.

- "Choice" assesses how likely it is a space to be passed through on the shortest paths from all spaces to all other spaces in the system. This measure shows a space's possibility for through-movement.

As a result, this research employs segment analysis and its latest advancements for application in a non-Western context to explore the transition of Tehran from a historical city in the mid-19th century to a modern city in the mid-20th century. For this aim, segment analysis applies to:
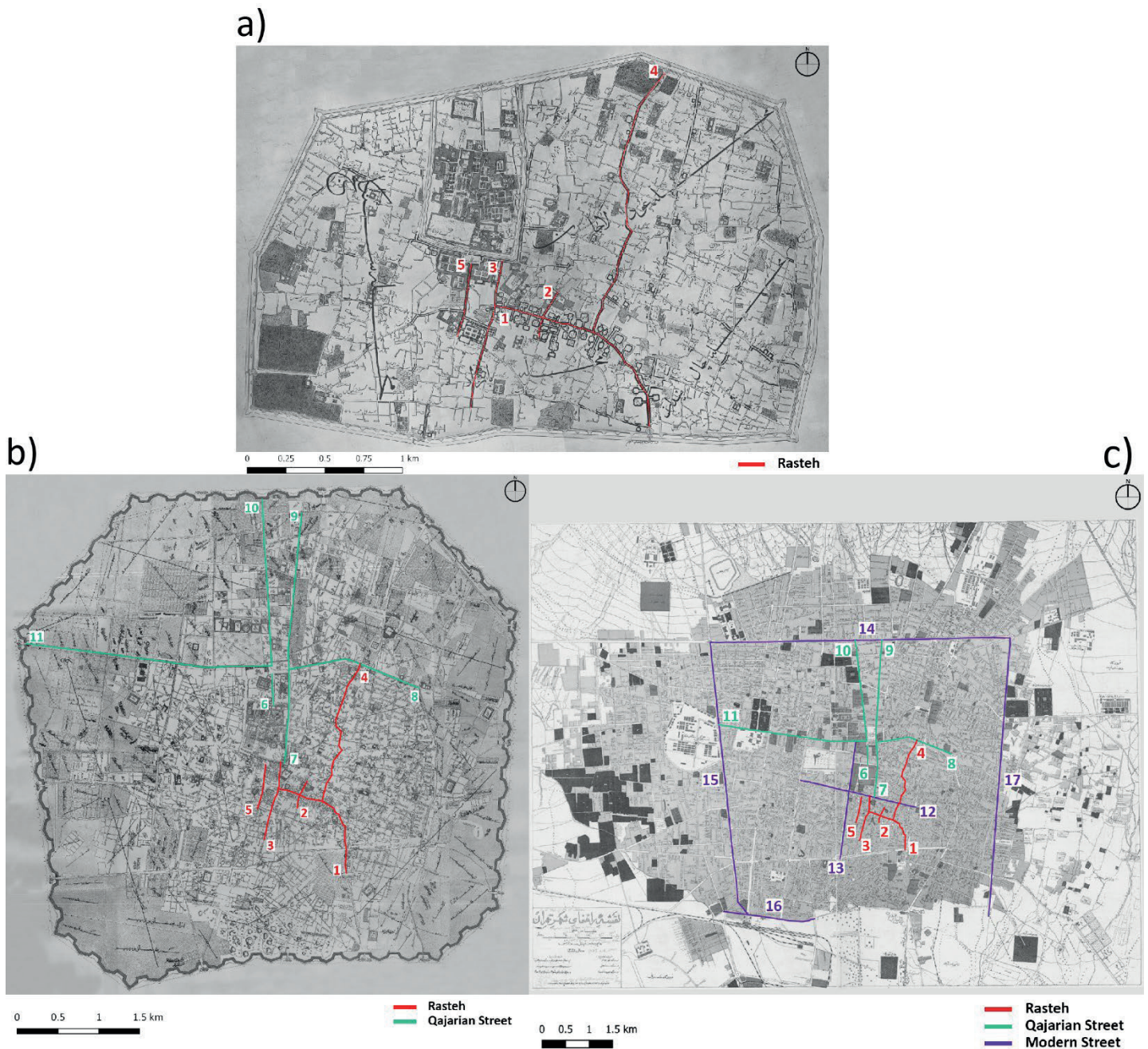
a)

b)

c)

Figure 1. a) The map of "Darol-Khelafe-ye Tehran" (1858) and the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh) | b) The map of "Darol-Khelafe-ye Naseri" (1891), the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh), and the Qajarian streets (Bab Homayoon Street, Naser Khosro Street, Amir Kabir Street, Lalehzar Street, Ferdowsi Street, Marizkhaneh Street) | c) The Guide map of the city of Tehran (1948), the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh), the Qajarian streets (Bab Homayoon Street, Naser Khosro Street, Amir Kabir Street, Lalehzar Street, Ferdowsi Street, Marizkhaneh Street), and the Modern Streets (Bouzarjomehri Street, Khayyam Street. Shahreza Street, Si Metri Street, Shush Street, Shahbaz Street)

- The map of "Darol-Khelafe-ye Tehran" (1858) for radii: 400m, 800m, 1200m, 1600m, 2000m, and n (study of Tehran and five main rastehes of bazaar) (Figure 1)

- The map of "Darol-Khelafe-ye Naseri" (1891) for radii: 400m, 800m, 1200m, 1600m, 2000m, 2400m, 3200m and n (study of Tehran, five main rastehes of bazaar and six Qajarian (new) streets) (Figure 1)
- And the "Guide map of city of Tehran" (1948) for radii: 400m, 800m, 1200m, 1600m, 2000m, 2400m, 3200m, 4000m, 4800m, 5600m, 6400m and n (study of Tehran, five key rastehes of bazaar, six Qajarian streets and six Modern streets) (Figure 1)

The following section will outline the result of the syntactical analysis for these three maps, draw comparisons between their outcome, and culminate in a discussion of the findings.

4   RESULTS

This section examines the geometrical and syntactical values of Tehran and its major urban elements in 1858, 1891 and 1948. In each period, the initial assessment involves evaluating the length value of the city and its selected parts. Then, the research focuses on the choice and integration performance of Tehran and its major urban elements to explore the impact of the first and second urban developments on the structure of this city. This careful examination aims to detect the change and continuity in the role of different urban elements over time. The outcome of this section can help the researchers understand in depth the similarities and differences between the approaches of the first and second developments of Tehran during the transition from the 19th to the 20th century.
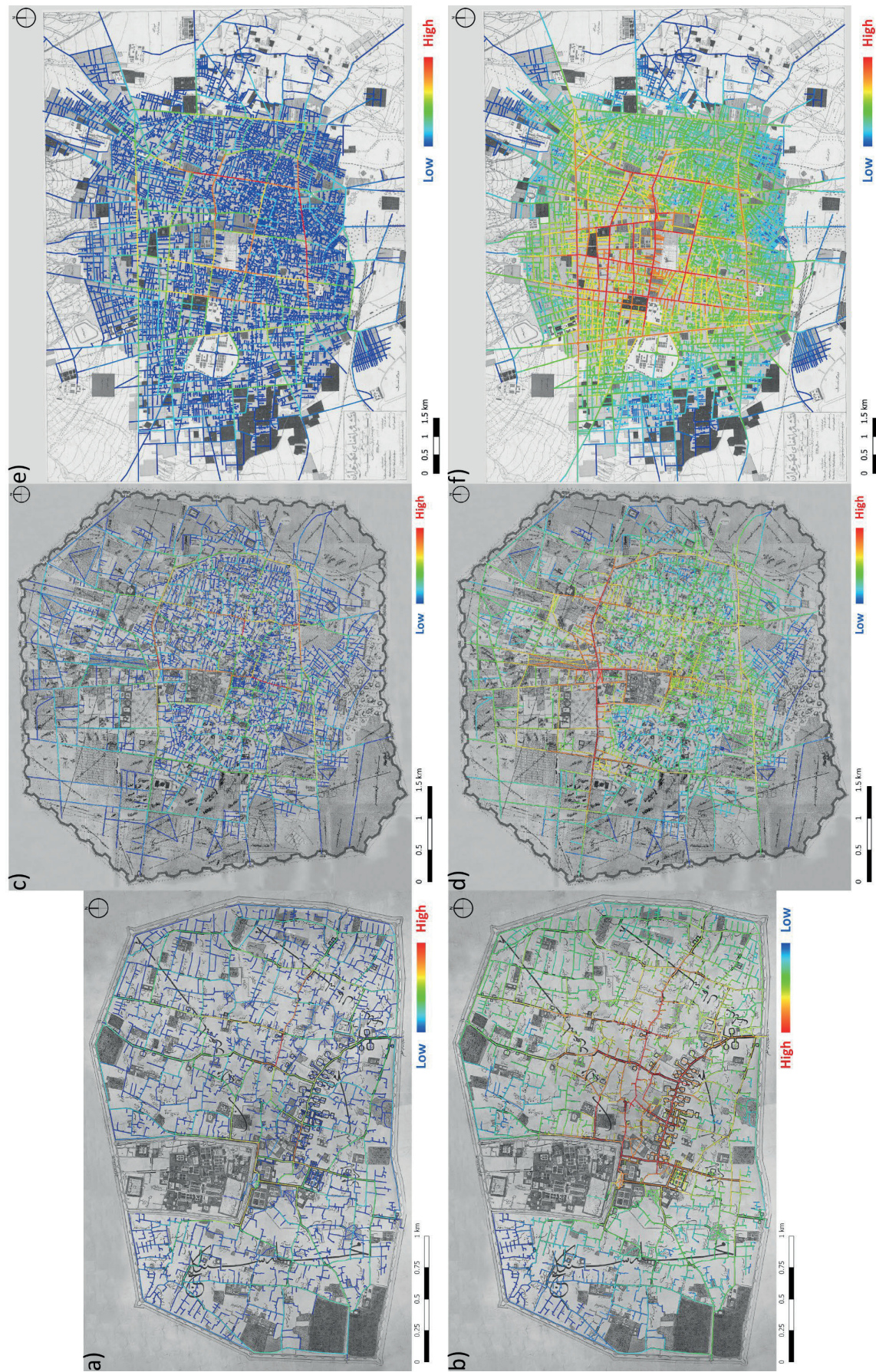
Figure 2. Sample Analysis: a) "Darol-Khelafe-ye Tehran" (1858), Segment Angular Choice for radius= 2000 metres | b) "Darol-Khelafe-ye Tehran" (1858), Segment Angular Integration for radius= 2000 metres | c) "Darol-Khelafe-ye Naseri" (1891), Segment Angular Choice for radius= 3200 metres | d) "Darol-Khelafe-ye Naseri" (1891), Segment Angular Integration for radius= 3200 metre | e) The Guide map of the city of Tehran (1948), Segment Angular Choice for for radius= 6400 metres | f) The Guide map of the city of Tehran (1948), Segment Angular Integration for radius= 6400 metres

From Bazaar to Street

4.1 The Accessibility Dynamic of Tehran in 1858 (before the first development of the city based on "Tehran Style's" principles)

Based on Table 3 , the geometrical analysis of the map of "Darol-Khelafe-ye Tehran" shows that the longest rasteh is the Oudlajan rasteh which is more than 1.8 kilometres. The second one is the Main rasteh which is around 600 meters shorter than the rasteh Oudlajan, though it only has one segment less than this rasteh. Other key rastehes are shorter than one kilometre. Next, the mean length of the rasteh's segments represented that the mean length of the Sabzeh Meydan rasteh is significantly larger than other rastehes, which equal to 77.57 metres. The second one is the mean length of the rasteh Oudlajan, roughly 49 metres. The other three rastehes have similar mean lengths ranging from 33 to 38 meters, which shape a cluster together. Comparing these numbers to Tehran's numbers suggests that the sum of the length of key rastehes is around 3.9% of the total length of the city's street (urban)network. Similarly, the sum of the number of segments of key rastehes is approximately 3.5% of the total segments of the city. Lastly, the mean length of segments of key rasteh is almost seven meters longer than the mean length of the city's segments. In summary, the key rastehes do not show any similarity in their length-based measurements, though they all carry part of the longest segments of Tehran in 1858.

No.	Name of the Rasteh	The number of segments (unit)	Total length of segments (metre)	Mean length of segments (metre)
	Table 3. The number of segments, the total length of segments and the mean length of segments in the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh) and Tehran in 1858			
1	**Main Rasteh**	**39**	**1,295**	**33.21**
2	**Masjid Jama Rasteh**	**9**	**342**	**38.00**
3	**Masjid Shah Rasteh**	**27**	**971**	**35.96**
4	**Oudlajan Rasteh**	**38**	**1,846**	**48.58**
5	**Sabzeh Meydan Rasteh**	**7**	**543**	**77.57**
	Key Rastehes (sum)	**120**	**4,997**	**41.64**
	Tehran (1858)	**3,440**	**120237**	**34.95**

Moving to the syntactical analysis of Tehran in 1858, the review of Tehran's choice values and key rastehes shows their performance for generating the through-movement patterns on the local and global scales (Figure 4). Based on the result, the Masjid Shah rasteh has the highest choice value for all radii among the selected rastehes in all radii, except the 1600m radius, where the choice value of the Main rasteh goes slightly above the choice value of the Masjid Shah rasteh. The Main carries the second-highest choice value in most radii. Its choice value is the third for the 400m radius, and as mentioned previously, it has the highest choice value for the 1600m radius.

The Oudlajan rasteh carries the third highest choice value in most radii apart from the 400m and n radii. The Masjid Jama and Sabzeh Meydan rastehes represent the lowest choice values among the key rastehes. In addition, the choice values of these five rastehes are significantly larger than the average of Tehran in all radii in this year. Also, further calculation indicates that this considerable difference between the average of the choice values of these rastehes and the average of the choice values of the city in all radii is almost the same. Thus, this result suggests that the key rastehes generated strong through-movement patterns in their segments in 1858.

Next, the results of syntactical analysis for integration measurement are presented to understand the performance of Tehran and its key rastehes for generating the to-movement patterns on the local and global scales (Figure 5). The Masjid Shah Rasteh hold the highest integration value for all radii. In contrast, the other four key rastehes do not have a consistent position. In each radius, the order of rasteh from the second to the fifth is changed. However, the Main rasteh becomes the second highest integration value for the radius above 1200m. In addition, the integration values of these five rastehes are larger than the average of Tehran in all radii 1858, though the gap becomes small when the radius increase. Besides, further calculation indicates that this difference between the average of the integration values of these rastehes and the average of the integration values of the city in all radii is declining when there is a rise in the radius of movement except n. Therefore, this outcome suggests that the key rastehes carries high to-movement values in the structure of Tehran in 1858.
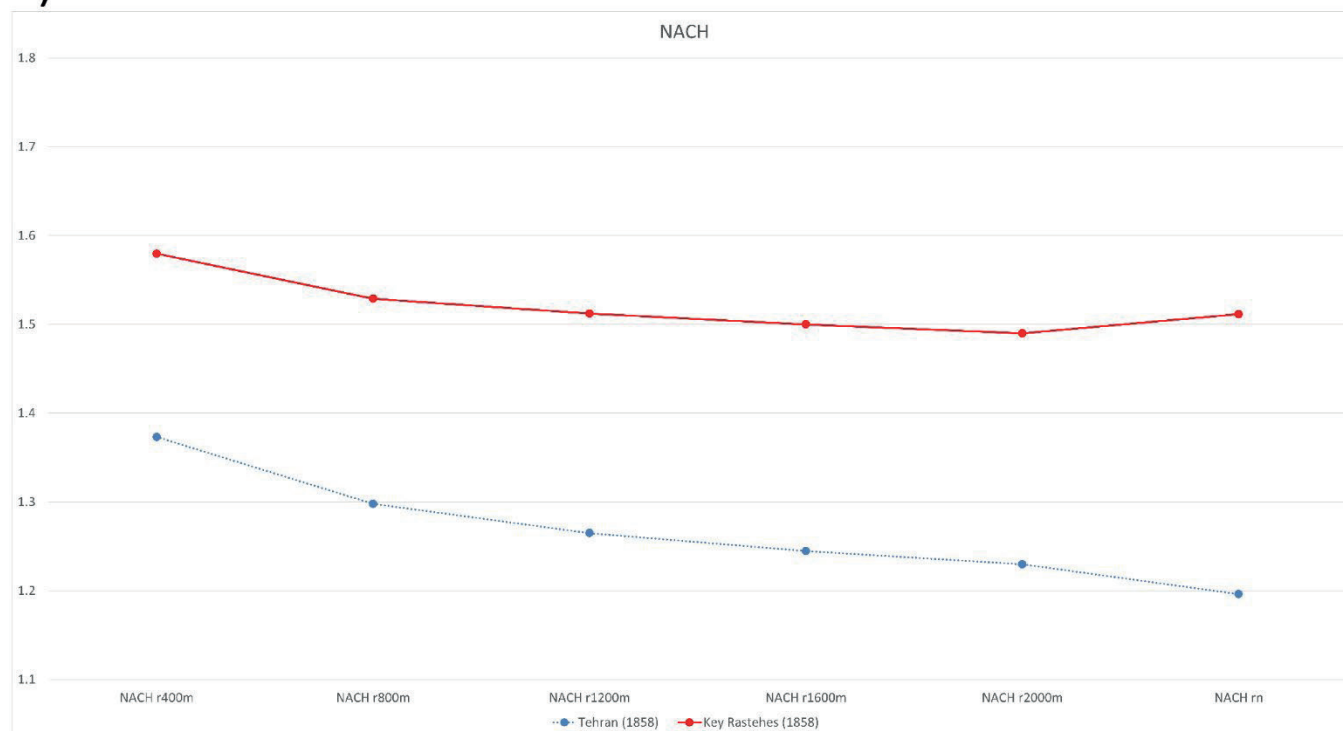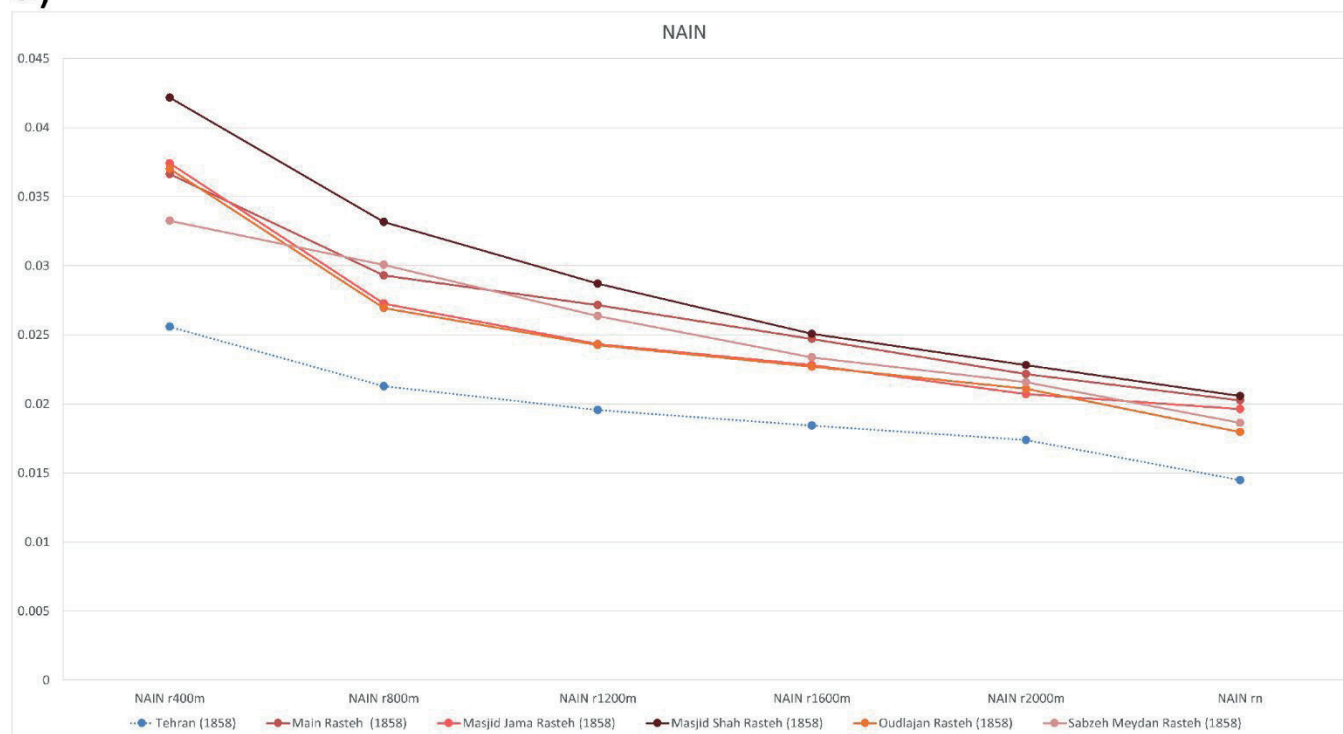
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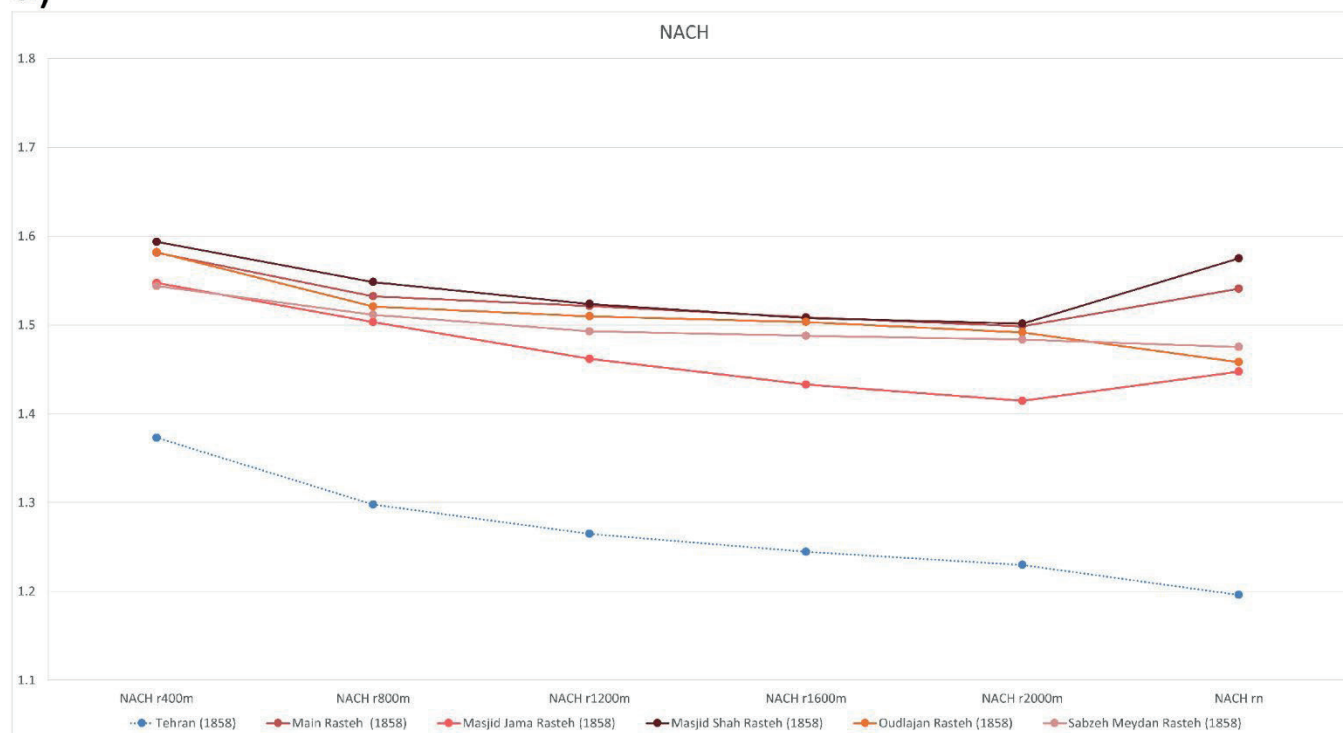
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Figure 3. *a) Comparison between the average of NA choice value of the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh) and Tehran in 1858 | b) Comparison between the average of NA integration value*
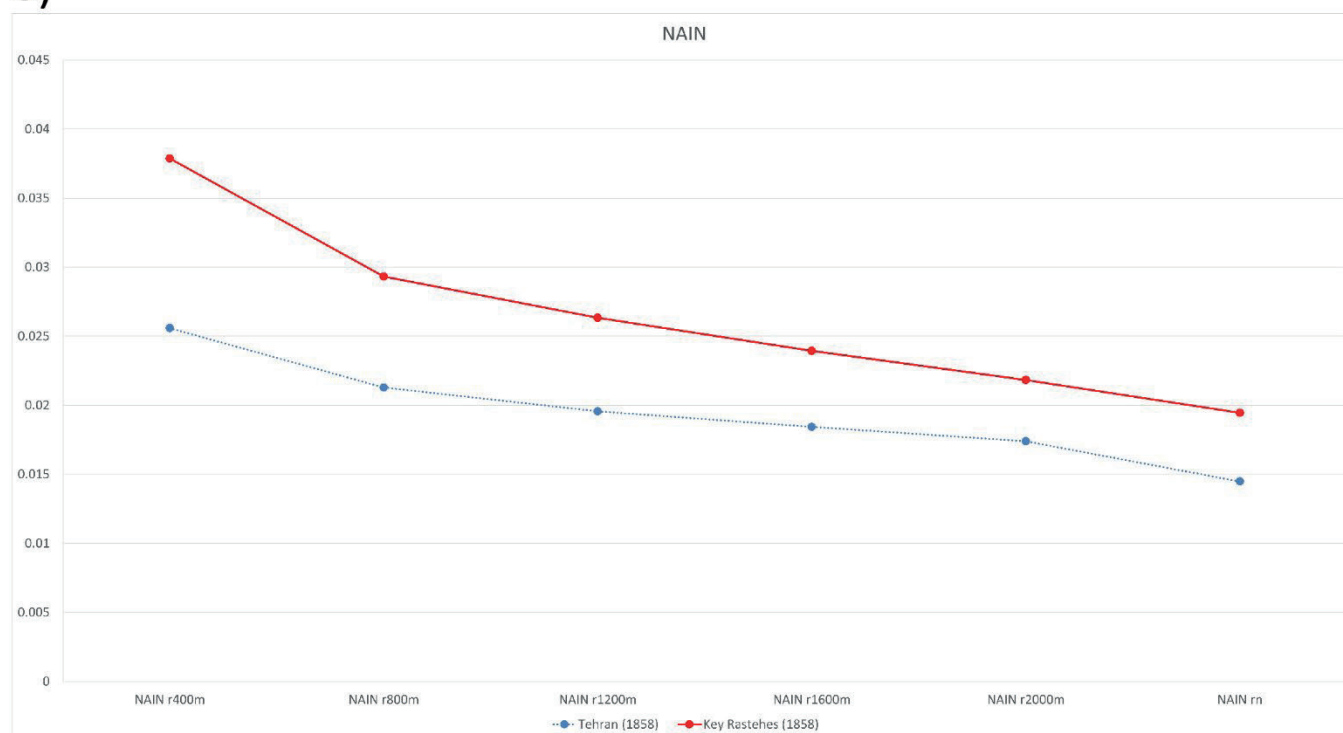
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Figure 4. *a) Comparison between the average of NA integration value of the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh) and Tehran in 1858 | b) Comparison between the average of NA integration value of the key Rastehes and Tehran in 1858*

4.2 The Accessibility Dynamic of Tehran in 1891 (after the first development of the city based on "Tehran Style's" principles)

Table 4 displays the geometrical analysis of the map of "Darol-Khelafe-ye Naseri". Based on the result, the Oudlajan rasteh is the longest rasteh which has the same length of 1858. The Main rasteh is the second one, though it is lengthened to approximately 1.6 kilometeres. The length of other rastehes remain the same: the Masjid Shah rasteh is 971 meters, the Sabzeh Meydan rasteh is 543 metres, and the Masjid Jama rasteh is 342 meters. Next, the mean length of the key rasteh's segments is reviewed. This column shows a noticeable difference with the same column for Tehran (1858) since these rastehes' number of segments changed. Mean length of segments of three rastehes falls: Masjid Shah rasteh, Oudlajan rasteh, and Sabzeh Meydan rasteh, though the mean length of segments of the other two increases: Main rasteh and Masjid Jama rasteh. The increase in the first one goes back to increase in the length of this rasteh. For the Masjid Jama rasteh, the decline in the number segments causes the increase in the rasteh's mean length of segments. Lastly, the mean length of segments on the key rastehes is around one meter shorter than the mean length of the segments in Tehran (1858) boundaries. It means there is no clear difference between the length of a segment on a key rastehes and its surroundings. This change contrasts with the findings of 1858, where there is a clear distinction between the mean length of segments on the key rastehes and the same value for the city.

On the other hand, the longest Qajarian steet in 1891 is Marizkhaneh Street. Ferdowsi Street and Lalehzar Street are the second and third longest streets which also longer than the longest rasteh (Oudlajan rasteh) of bazaar at this time. For the rest: Amir Kabir Street is only shorter than the Oudlajan rasteh, Naser Khosro Street is shorter than the Oudlajan rasteh and the Main Rasteh, and Bab Homayoon Street is only 30 meters longer than the shortest rasteh (Masjid Jama Rasteh). Then, the Qajarian street's mean length of the segments is explored. Amir Kabir Street has the longest value, and Lalehzar Street has the smallest one. However, the mean length of the segments of all the Qajarian streets' is above the mean length of the segments of the key rasteh. Besides, a segment on the Qajarian streets is almost three times longer than a segment on the key rastehes. In the same way, the mean length of the segments of the city is 17 meters longer than the mean length of the segments of the key rasteh. The key rastehes carry 2.5% of the city's segments and 1.7% of the city's street (urban) network, though the Qajarian streets hold almost 1.6% of the city's segments and 3.3% of the city's street (urban) network. Lastly, the Tehran (1858) boundaries cover approximately 70% of the city's segments, though their total length is below 50% of the length of the city's street network in 1891. In other words, the new areas that are

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added to the structure of the city during the development of Tehran in the Naser al-Din Shah Qajar's reign contain fewer segments but longer segments than the old city.

Table 4. *The number of segments, the total length of segments and the mean length of segments in the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh), and the Qajarian streets (Bab Homayoon Street, Naser Khosro Street, Amir Kabir Street, Lalehzar Street, Ferdowsi Street, Marizkhaneh Street), the Tehran (1858) boundaries, and Tehran in 1891*

No.	Name of the Rasteh	The number of segments (unit)	Total length of segments (metre)	Mean length of segments (metre)
1	**Main Rasteh**	**41**	**1574**	**38.39**
2	**Masjid Jama Rasteh**	**7**	**342**	**48.86**
3	**Masjid Shah Rasteh**	**29**	**971**	**33.48**
4	**Oudlajan Rasteh**	**47**	**1846**	**39.28**
5	**Sabzeh Meydan Rasteh**	**10**	**543**	**54.30**
	Key Rastehes (sum)	**134**	**5276**	**39.37**
6	**Bab Homayoon Street**	**4**	**3,99**	**99.75**
7	**Naser Khosro Street**	**14**	**1,165**	**83.21**
8	**Amir Kabir Street**	**21**	**1,664**	**79.24**
9	**Lalehzar Street**	**10**	**1,912**	**191.20**
10	**Ferdowsi Street**	**15**	**2,029**	**135.27**
11	**Marizkhaneh Street**	**21**	**3,048**	**145.14**
	Qajarian Streets (sum)	**85**	**10,217**	**120.20**
	Tehran (1858) boundaries	**3667**	**147,438**	**40.21**
	Tehran (1891)	**5332**	**308,641**	**57.88**

The syntactical analysis of Tehran (1891) for the choice measurement assesses the performance of Tehran, the key rastehes, the Qajarian streets, and the Tehran (1858) boundaries for carrying through-movement patterns on various scales (Figure 7). For the key rastehes, the Masjid Shah rasteh carries the highest choice values among rastehes for all radii except 400m. Similarly, the Main Rasteh has the second highest choice values in all radii. Generally, the other rastehes follow this order: the Oudlajan rasteh is the third, the Sabzeh Meydan Rasteh is the fourth, and the Masjid Jama rasteh has the least choice values in all radii. On the other hand, none of the Qajarian Streets are dominant in various radii. The highest choice values for these streets change between Amir Kabir Street, Ferdowsi Street, and Marizkhaneh Street. In contrast, Bab Homayoon Street represented the lowest choice values for all radii apart from 400m and 800m. Furthermore, the comparison between the key rastehes and Qajarian Streets shows that the average of the rasteh is smaller than the average of the streets for all radii. However, it is important to note that the key rastehes have choice values above the average of the city's choice value. In contrast, the Tehran (1858) boundaries' choice value is smaller than the city's average choice value. Therefore,

the result suggests that the development of Tehran based on the Tehran Style's principles weakened the through-movement power of the key rastehes and the Tehran (1858) boundaries.

Then, the result of syntactical analysis for the integration measurement is presented to understand the closeness centrality of the key rastehes, and the Qajarian streets in the structure of Tehran (1891) on the local and global scales (Figure 8). For the key rastehes, the Masjid Shah Rasteh has the highest integration values for all radii expect 2000m and 2400m. The next one is the Main rasteh, which generally carries the second-highest integration values. The other rastehes do not hold a consistent order. On the other side, the Qajarian streets represent the least consistency since the order from highest to lowest integration value changes in each radius. However, Amir Kabir Street has a partially consistent pattern. It has the second-highest integration value for the local radii (between 400m and 1600m) and the highest integration value for the global radii (above 1600m). Next, the average of key rastehes, and the Qajarian streets is compared. This comparison shows that the key rastehes' value is above the Qajarian streets' value for all local radii, their value is almost the same for 2000m, and the Qajarian streets' value becomes the larger one for radii above 2000m. Besides, the key rastehes' value is above the average of the city in all radii, though the Qajarian streets' value is below the average of the city for 400m. Lastly, the average of the integration value of the Tehran (1858) boundaries is larger than the average of the integration value of Tehran (1891) for all radii below 3200m. As a result, the development of Tehran based on the Tehran Style's principles preserves the to-movement potential of the rastehes up to 2000m radii, though this development reduces this potential for rastehes for the radii above 2000m. Besides, this urban development added Qajarian streets to the city's structure, generating higher to-movement potential on the global scale radii (above 2000m).
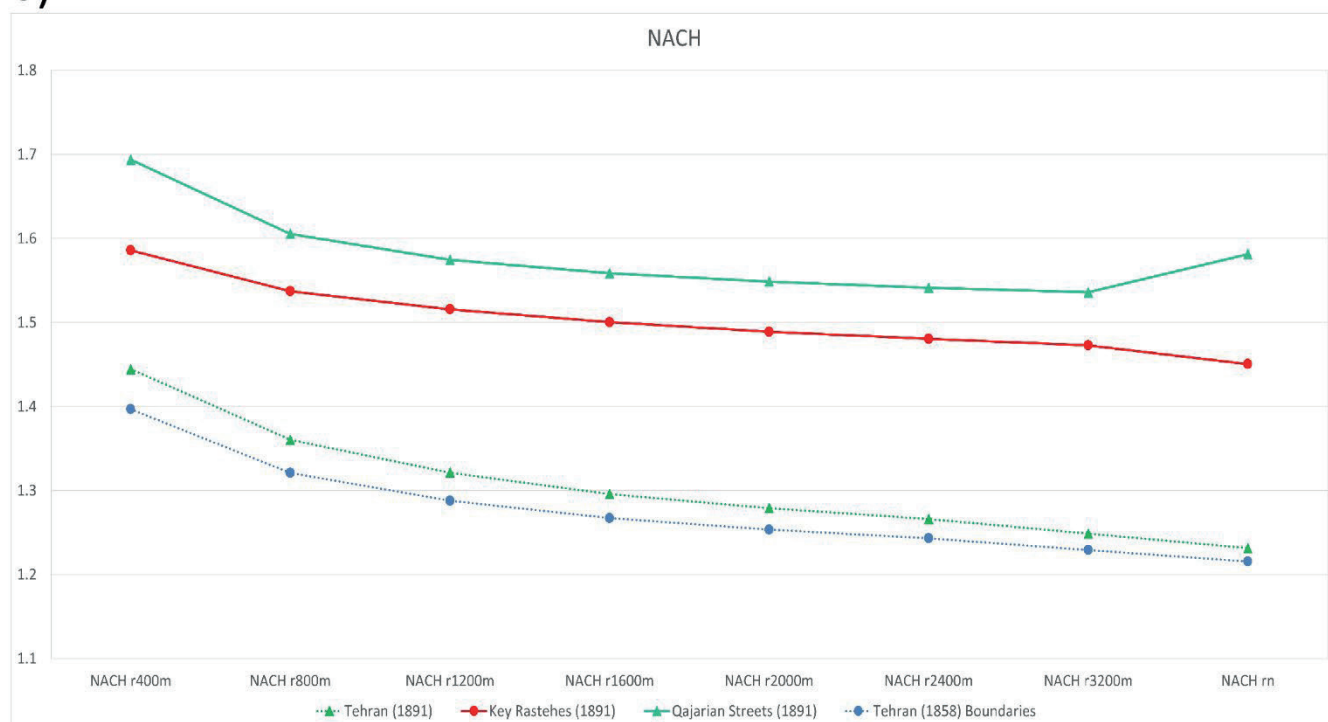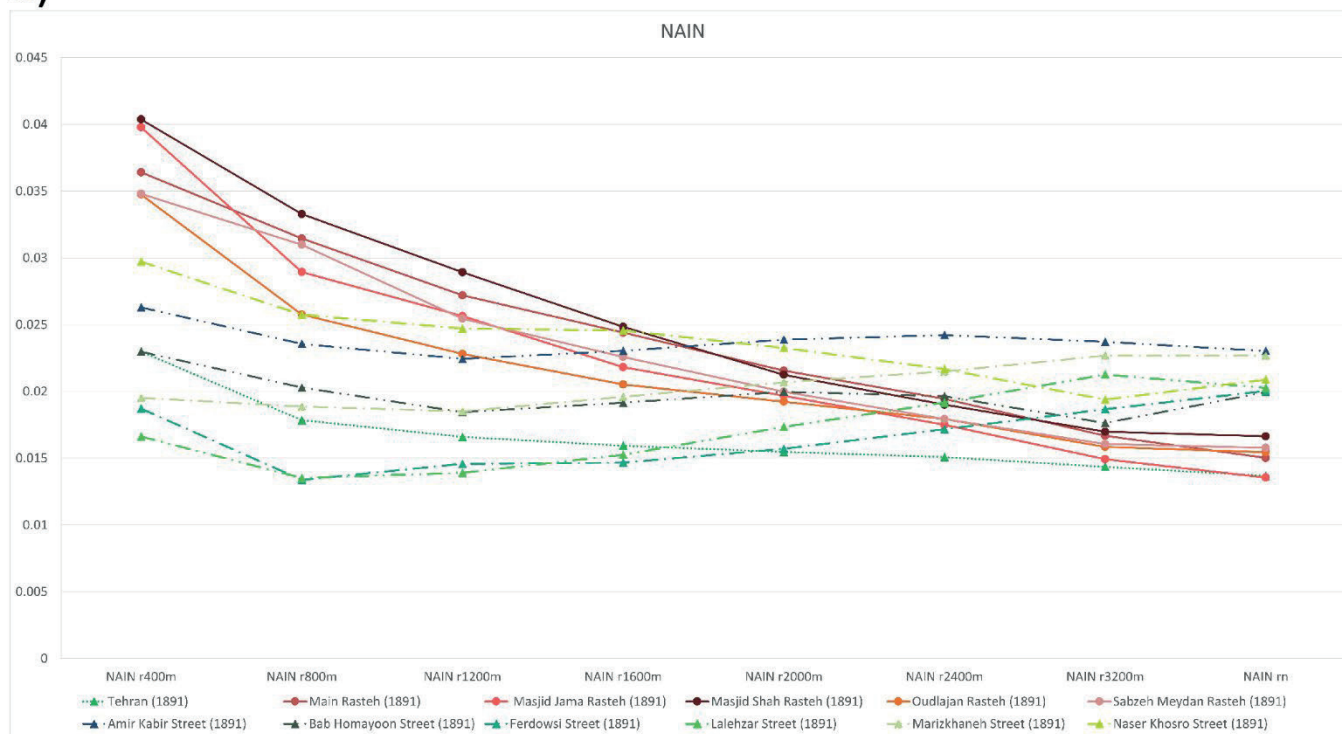
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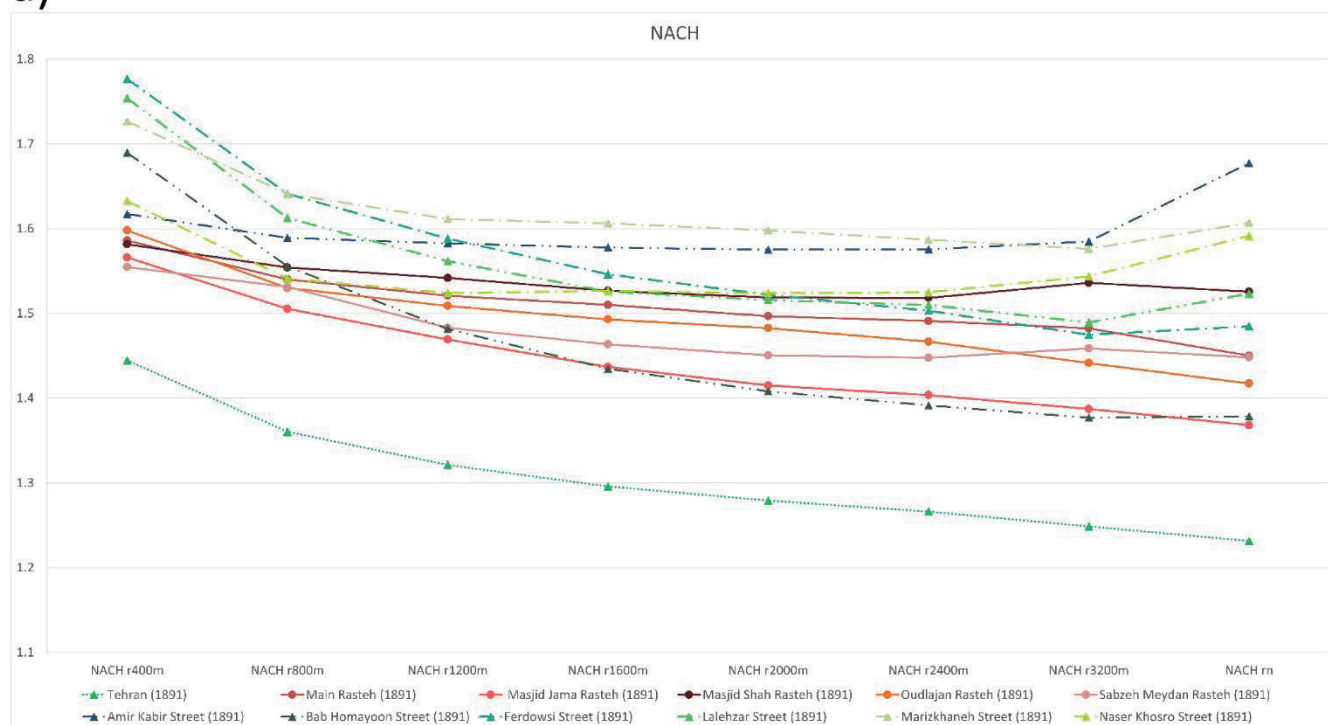
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Figure 5. a) *Comparison between the average of NA integration value of the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh), and the Qajarian streets (Bab Homayoon Street, Naser Khosro Street, Amir Kabir Street, Lalehzar Street, Ferdowsi Street, Marizkhaneh Street), the Tehran (1858) boundaries, and Tehran in 1891 |b) Comparison between the average of NA choice value of the key Rastehes, the Qajarian streets, the Tehran (1858) boundaries, and Tehran in 1891*
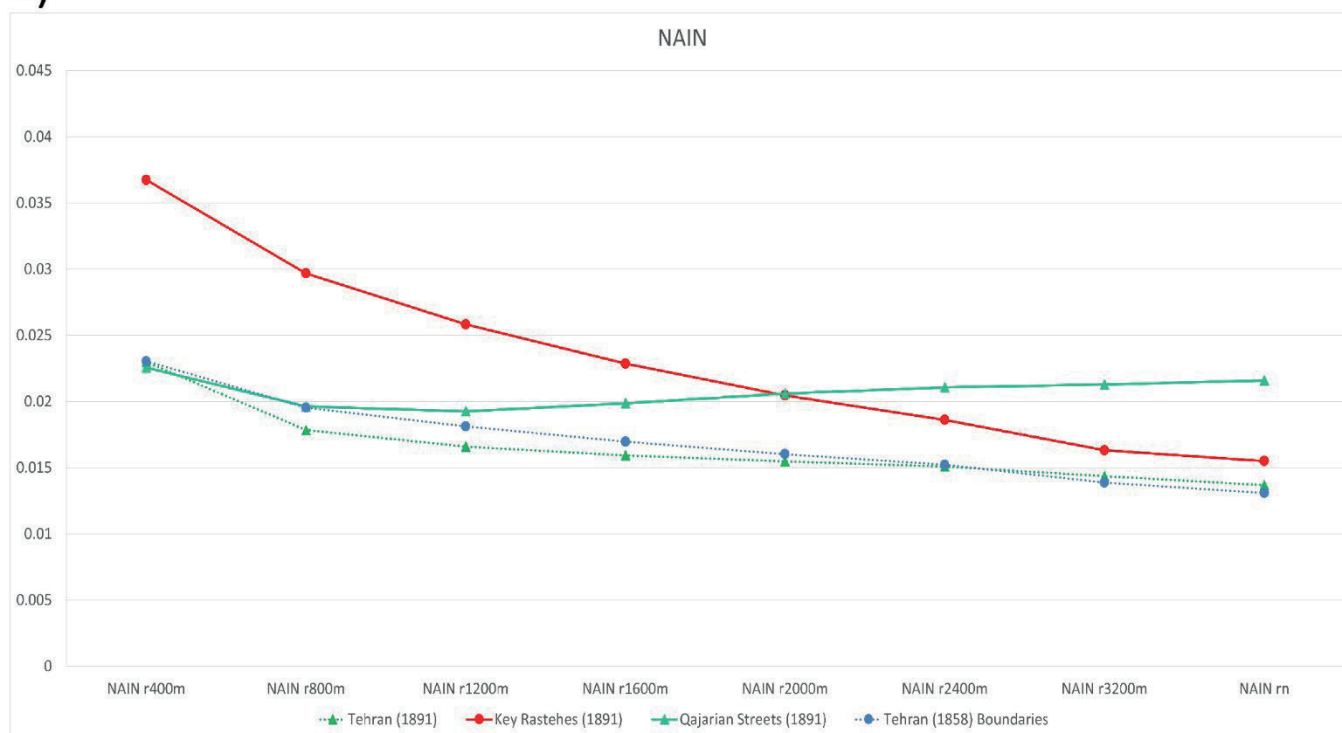
a)

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Figure 6. *a) Comparison between the average of NA integration value of the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh), and the Qajarian streets (Bab Homayoon Street, Naser Khosro Street, Amir Kabir Street, Lalehzar Street, Ferdowsi Street, Marizkhaneh Street), the Tehran (1858) boundaries, and Tehran in 1891 | b) Comparison between the average of NA integration value of Tehran, the key Rastehes, the Qajarian streets, the Tehran (1858) boundaries, and Tehran in 1891*

4.3 The Accessibility Dynamic of Tehran in 1948 (after the second development of the city based on the modern principles)

Firstly, the changes in the length of the key rastehes, the Qajarian streets, the Modern Streets are reviewd. The Table 5 shows that the length of all rastehes is the same as 1891 except the Main rateh. This rasteh loses around 300 meters of its southern side and becomes close to its length in 1858. Besides, it is important to note that the length of the Oudlajan rasteh remains unchanged, even though a section of it is demolished to make way for constructing a modern street (Bouzarjomehri Street). In this context, the ranking of rastehes from the longest to the shortest remains the same as in 1891. Conversely, the mean length of all the studied rasteh is changed apart from the Masjid Jama rasteh. In other words, three rastehes (Masjid Shah Rasteh, Oudlajan Rasteh, and Sabzeh Meydan Rasteh) face changes in the number of intersections with their surroundings. Lastly, the mean length of segments on the key rastehes is around one meter longer than the mean length of the segments in Tehran (1858) boundaries. However, this change signs that there is no clear difference between the length of a segment on a key rastehes and its surroundings, same as findings in 1891.

For the Qajarian streets, three streets have the same length of 1891: Bab Homayoon Street, Naser Khosro Street, and Amir Kabir Street, and the other three streets that have become longer: Lalehzar Street (252 meters) Ferdowsi Street (111 meters), and Marizkhaneh Street (113 meters). Besides, Lalehzar Street ranks as the second longest Qajarian Street since it becomes longer than Ferdowsi Street in 1948. The mean length of the segments of these streets decreases apart from Amir Kabir Street, which shows a four-meter increase in this parameter. This change suggests that the other five Qajarian streets now have additional intersections within their surroundings. In addition, the mean length of a segment on the Qajarian street is 28 meters longer than a segment in Tehran (1891) boundaries, which means that these segments are clearly recognisable in their surroundings. Finally, the number for the Modern streets indicates that the longest one is Shahreza Street, with more than 6.3 kilometres in length. The remaining Modern streets are ordered from the longest to the shortest are Shahbaz Street (5.87 km), Si Metri Street (5.85 km), Khayyam Street (2.5 km), Bouzarjomehri Street (2.49 km), and Shush Street (1.94 km). These numbers show that the Modern streets, except Bouzarjomehri Street, Khayyam Street, and Shush Street, are longer than both the key rastehes and the Qajarian Streets. In addition, the mean length of the segments on these streets is similar to the number of the Qajarian Streets, except Shush Street, which is close to 130 meters. Besides, this parameter suggests that the mean length of a segment on the Modern street is two meters shorter than the mean length of a segment on the Qajarian street. In summary, there is not a distinct difference between a segment of the Modern and the Qajarian streets; nevertheless, both remain distinguishable within the structure

of Tehran in 1948. In contrast, a segment of the key rasteh is much shorter than both the Qajarian and Modern Streets, but they are not distinguishable within the structure of the city in this era.

Table 5. *The number of segments, the total length of segments and the mean length of segments in the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh), the Qajarian streets (Bab Homayoon Street, Naser Khosro Street, Amir Kabir Street, Lalehzar Street, Ferdowsi Street, Marizkhaneh Street), and the Modern streets (Bouzarjomehri Street, Khayyam Street. Shahreza Street, Si Metri Street, Shush Street, Shahbaz Street), the Tehran (1858) boundaries, the Tehran (1891) boundaries and Tehran in 1948*

No.	Name of the Rasteh	The number of segments (unit)	Total length of segments (metre)	Mean length of segments (metre)
1	**Main Rasteh**	**33**	**1,296**	**39.27**
2	**Masjid Jama Rasteh**	**7**	**342**	**48.86**
3	**Masjid Shah Rasteh**	**26**	**971**	**37.35**
4	**Oudlajan Rasteh**	**41**	**1,846**	**45.02**
5	**Sabzeh Meydan Rasteh**	**13**	**543**	**41.77**
	Key Rastehes (sum)	**120**	**4,998**	**41.65**
6	**Bab Homayoon Street**	**4**	**399**	**99.75**
7	**Naser Khosro Street**	**18**	**1,165**	**64.72**
8	**Amir Kabir Street**	**20**	**1,664**	**83.20**
9	**Lalehzar Street**	**24**	**2,164**	**90.17**
10	**Ferdowsi Street**	**23**	**2,140**	**93.04**
11	**Marizkhaneh Street**	**39**	**3,161**	**81.05**
	Qajarian Streets (sum)	**128**	**10,693**	**83.54**
12	**Bouzarjomehri Street**	**42**	**2,496**	**59.43**
13	**Khayyam Street**	**31**	**2,500**	**80.65**
14	**Shahreza Street**	**65**	**6,351**	**97.71**
15	**Si Metri Street**	**89**	**5,856**	**65.80**
16	**Shush Street**	**15**	**1,941**	**129.40**
17	**Shahbaz Street**	**65**	**5,869**	**90.29**
	Modern Streets (sum)	**307**	**25,013**	**81.48**
	Tehran (1858) boundaries	**3,139**	**128,318**	**40.88**
	Tehran (1891) boundaries	**10,052**	**559,878**	**55.70**
	Tehran (1948)	**1,5473**	**1,050,348**	**67.88**

Next, the syntactical analysis of Tehran (1948) for the choice measurement is reviewed (Figure 11). The performance of the key rastehes for this parameter varies in each radius. However, the Masjid Shah rasteh has the highest choice value for all radii above 1600m except n. Besides, the Masjid Jama Rasteh represents the lowest choice value for all radii. For the Qajarian street, there is the same condition, varied performance for each radius. But Amir Kabir Street carries the highest choice value for all radii larger than 2400m. Besides, Bab Homayoon Street holds the

highest choice value for all radii larger than 1200m. The Modern streets provide partial ordering for the performance of its members. Shahreza Street represents the highest choice value for about all radii. Khayyam Street and Bouzarjomehri Street carry the lowest choice value for all radii above 800m. In addition, the comparison between the key rastehes, Qajarian streets and Modern streets shows that the average choice value of the key rasteh is smaller than the average of the choice value of Qajarian streets and Modern streets. Besides, the average choice value of the Qajarian streets is larger than the average of the choice value of the Modern streets for the smallest radii (400m and 800m). Besides, the value of all three averages is above the city's average, though the average of the choice value of the key rasteh tends to approach the average of the city when the radius is increasing. Lastly, the average of the choice value of the Tehran (1858) and Tehran (1891) boundaries is below Tehran's average. Therefore, this outcome suggests that the development of Tehran based on the modern principles creates higher through-movement potentials for the Modern and Qajarian streets, not the key rasteh.

This part outlines the outcome of syntactical analysis for the integration measurement for the key rastehes, the Qajarian streets, and the Modern streets in Tehran (1948) (Figure 10).For the key rasteh, their performance for each radius varies. However, the Sabzeh Meydan and Masjid Shah rasteh carry the highest and second-highest integration values, respectively, for all radii beyond 800m. The Qajarian streets' order varies, too. Their figures show that Naser Khosro Street hold the highest integration value for all radii up to 3200m, and then Marizkhaneh Street becomes the most integrated street in this category. The Modern streets are the most varied ones. The partially consistent patterns are for Bouzarjomehri Street, which has the highest choice value for all radii below 2400m, and Shahbaz Street, which has the lowest choice value for all radii between 1200m and 6400m. In addition, the comparison between the key rastehes, Qajarian streets and Modern streets shows that the average of the integration value of the key rastehes is only larger than the Qajarian streets and Modern streets' values for radii between 400m and 1200m. Besides, the average of the integration value of Qajarian streets is smaller than Modern streets' value in all radii, except radii between 3200m and 5600m. The value of all three averages is above the city's average, though the average of the integration value of the key rastehes significantly approaches the average of the city when the radius is increasing. Also, the average of the integration value of the Tehran (1858) and Tehran (1891) boundaries is around Tehran's average. The Tehran (1858) boundaries' value goes below the average of the city when the radius passes 4000m. Thus, the findings of this part suggest that the second development of Tehran leads to the strengthening to-movement power of Modern and Qajarian streets over the key rasteh.

To conclude, the spatial-morphological studies of Tehran's urban development between the mid-19th century and the 20th century highlighted the constant change in the key urban elements of

this city. Before the first development, the bazaar and its key rastehes are the most accessible parts of the city. The first development of Tehran (between the late 1860s and the 1870s), which followed the "Tehran Style" principles, changes the accessibility dynamic of the city. The key rastehes are the most integrated places in the city for the local radii and partial global radii (up to 2000m), though the Qajarian streets substitute its role. Besides, the new Qajarin streets hold larger choice values than the key rastehes for all radii. The second development of Tehran (between the 1930s and the 1940s) applies another change to the accessibility dynamic of the city. The key rastehes only have the highest integration value for radii below 1200m. The Qajarian and Modern streets carry the highest integration value for other radii. In other words, the key rastehes not only lose their global role in the structure of Tehran in 1948, but also lose their local role. Also, the choice value of the key rastehes is smaller than the choice value of the Qajarian and Modern streets in all radii. In addition, the geometrical assessment shows that the length of a segment on the key rasethes (bazaar) is roughly half the length of the Qajarian or Modern streets' segment. Lastly, this part reveals how different urban development approaches affect the role of old urban elements (key rastehes/bazaar) and embed new urban elements (Qajairan/Modern streets) in the structure of a city in a non-western context over a century.
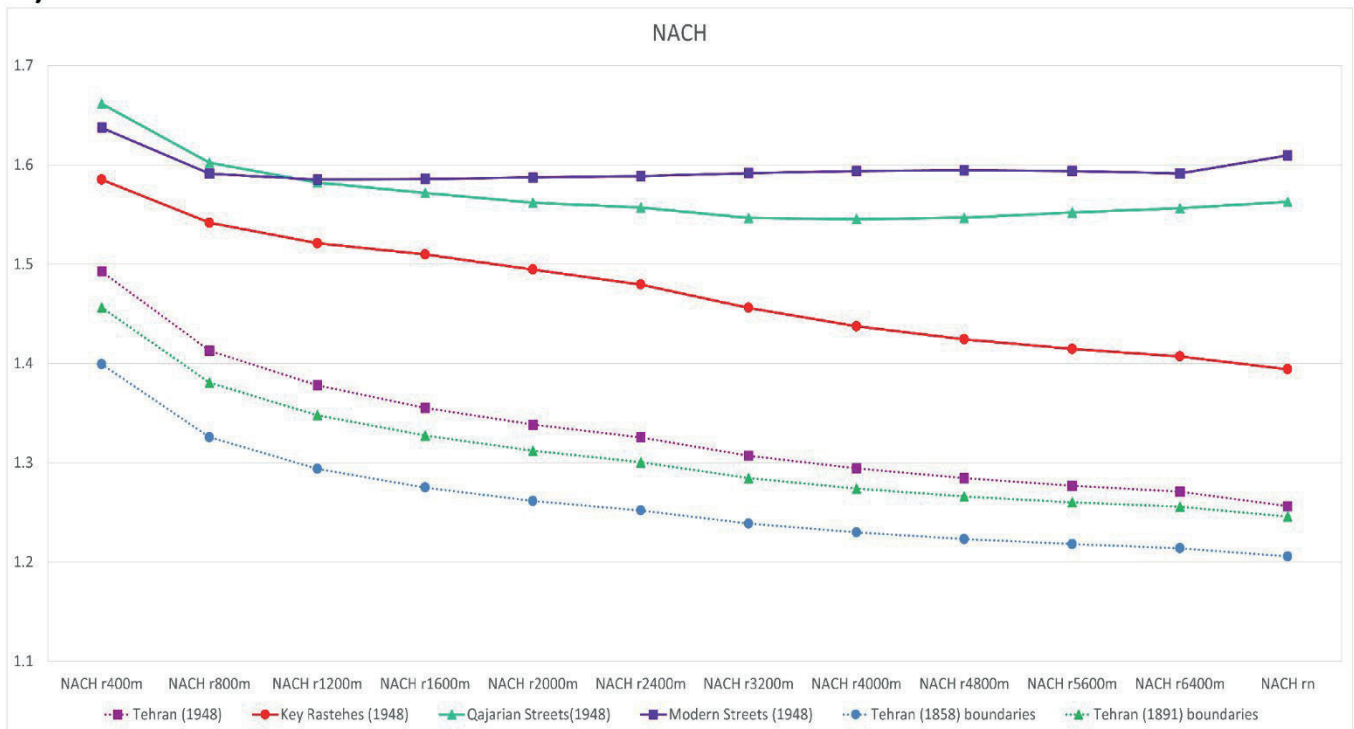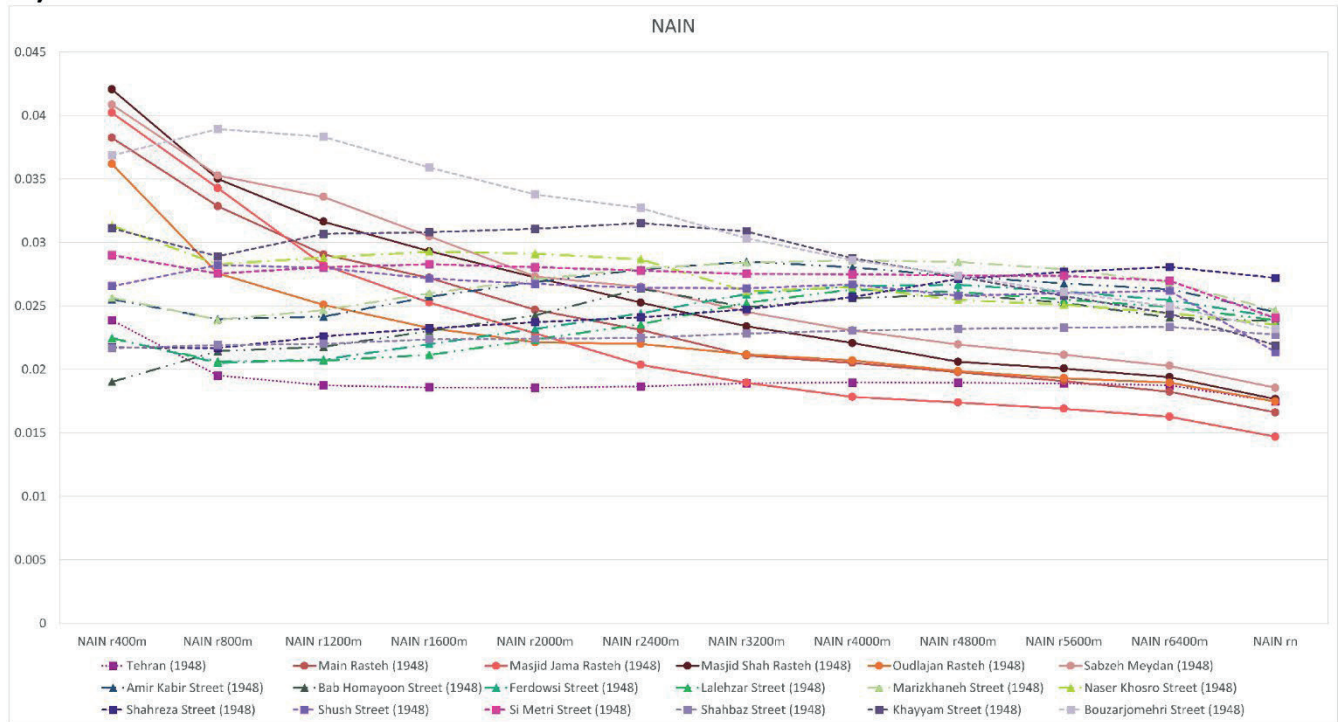
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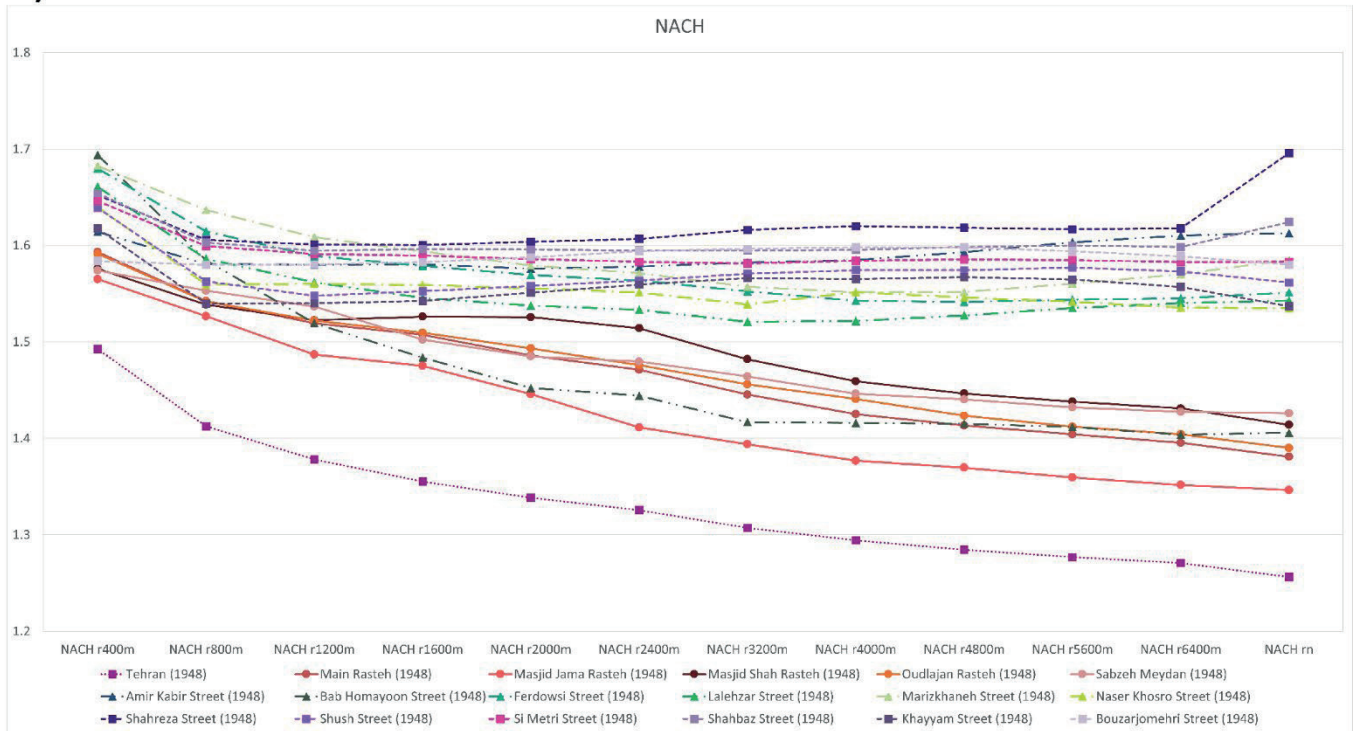
b)

Figure 7. *a) Comparison between the average of NA choice value of the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh), the Qajarian streets (Bab Homayoon Street, Naser Khosro Street, Amir Kabir Street, Lalehzar Street, Ferdowsi Street, Marizkhaneh Street), and the Modern streets (Bouzarjomehri Street, Khayyam Street. Shahreza Street, Si Metri Street, Shush Street, Shahbaz Street), the Tehran (1858) boundaries, the Tehran (1891) boundaries and Tehran in 1948 | b) Comparison between the average of NA choice value of the key Rastehes, the Qajarian streets, the Modern streets, the Tehran (1858) boundaries, the Tehran (1891) boundaries, and Tehran in 1948*
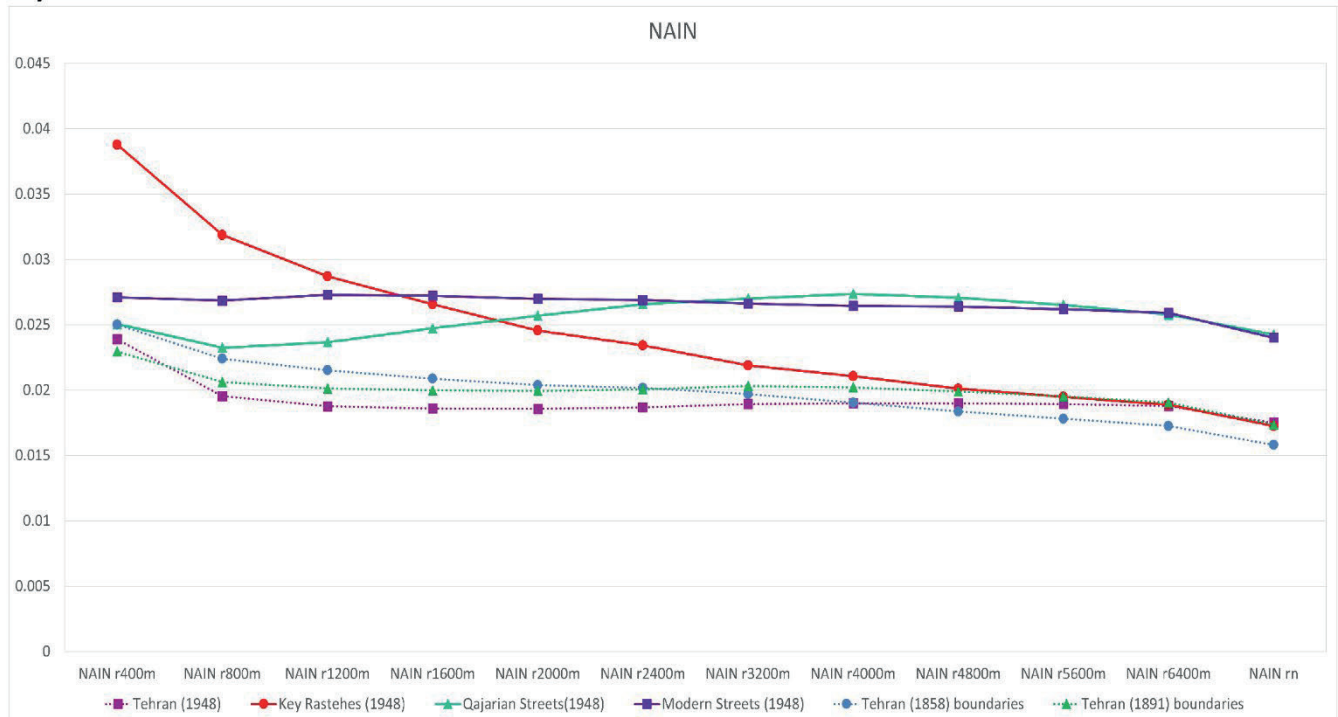
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Figure 8. Comparison between the average of NA integration value of the key Rastehes (Main Rasteh, Masjid Jama Rasteh, Masjid Shah Rasteh, Oudlajan Rasteh, Sabzeh Meydan Rasteh), the Qajarian streets (Bab Homayoon Street, Naser Khosro Street, Amir Kabir Street, Lalehzar Street, Ferdowsi Street, Marizkhaneh Street), and the Modern streets (Bouzarjomehri Street, Khayyam Street. Shahreza Street, Si Metri Street, Shush Street, Shahbaz Street), the Tehran (1858) boundaries, the Tehran (1891) boundaries and Tehran in 1948 | b) Comparison between the average of NA integration value of the key Rastehes, the Qajarian streets, the Modern streets, the Tehran (1858) boundaries, the Tehran (1891) boundaries, and Tehran

5   CONCLUSION: ANOTHER PARADIGM IN URBAN DEVELOPMENT IN A NON-WESTERN CONTEXT

In conclusion, this research shows that the existing space syntax literature about urban development in the non-Western context still needs to be completed. The Tehran Style created a hybrid identity for the urban development of Tehran in the 19th century. This approach employs a street, the western urban element, to imitate the approach of Isfahan School for developing the city. This initiative shaped different consequences for the old and new parts of the city under this special urban development. Based on the result, the key rastehes preserved their role as the most accessible part of the city for the local and some global radii. The new part, including Qajarian Streets, became the most accessible part of the city for the majority of the global radii. In other words, there is a change in the role of the old parts in the city's structure, though this change does not equal decline and decay. In contrast, this change means a planned redefinition of the old parts in the developed structure of the city. In closing, it is important to note that this paper only provides a general overview of the transformation of Tehran and its key parts over a century. However, the consequences of these urban developments for each key element's social and spatial characteristics are unexplored. Future studies should address this issue to enrich the space syntax literature on urban change in non-Western contexts, like Iran, through the ages.
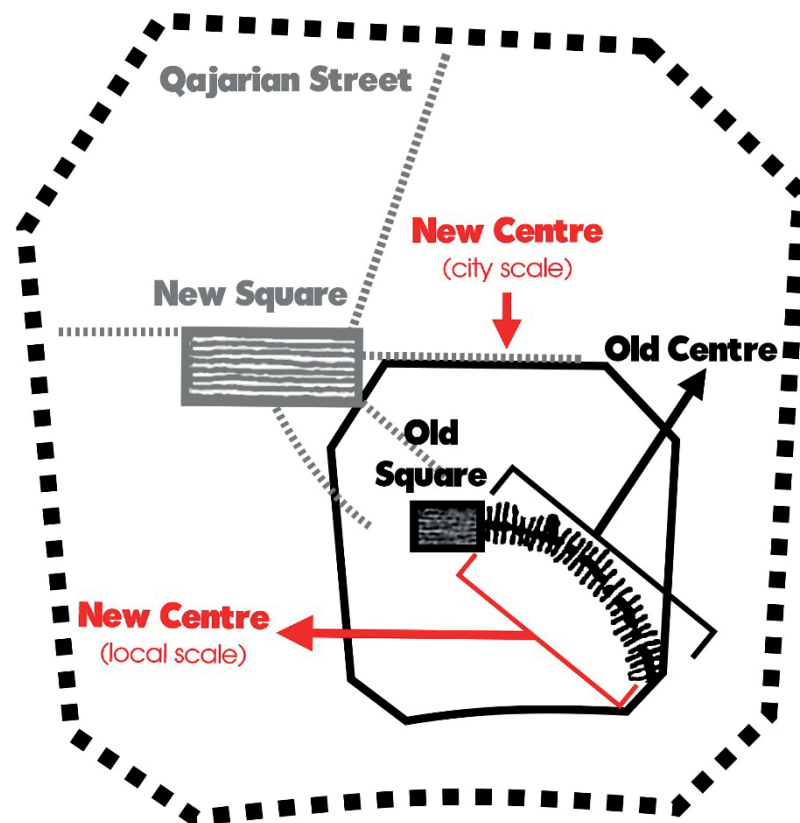

Figure 9. Schematic diagram of Tehran Style's urban development

Table 6. Tehran Style's urban development model based on space syntax literature

No.	Urban Development Model	Period	Urban Development Element	Old City Centre	New City Centre	Connecting Urban Elements between Old and New Centres	Destruction of Old City	Consequence of the Urban Development
1	**Tehran Style**	**19th century**	**Qajarian Street**	**Bazaar**	**Bazaar (local scale) + Qajarian Street (city scale)**	**Qajarian Street**	**No**	**preserving the role of old parts on the local scale, redefining their role on the city scale**

ACKNOWLEDGMENT

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