

Transformations of Systems of City Centers: The Case of Baghdad, Iraq

Wed Abdulmohsin Abdullah & Dheah Hameed Basee

Architecture Department

Al-Nahrian University, College of engineering

Baghdad, Iraq

wed.architect95@gmail.com

dr.dheah.h.basee@nahrainuniv.edu.iq

Abstract

Since its inception, the urban systems of city centers have been exposed to a set of morphological transformations and changes in their urban structure as a result of development processes. They impose on the continuous growth and transformation of the city center both in the short and long terms. This is considered a natural phenomenon that incurs changes: that is, the thing changes from itself, or gradual changes that change in how it is while maintaining its qualitative image. These are caused by many factors such as urban development, which causes transformations at the level of the urban fabric, changing the shape of the city, or due to social development associated with the social structure that affects the composition of the society and its activities. Other factors such as the politics and its their role in making decisions related to the urban sectors and their changes can also contribute. This is an issue related to the city centers and their physical processes, and very little is known about the systems and their transformations.

The study adopted an analysis using (DepthMapX), a program developed specifically for space synthesis theory. According to this program, the quality of urban life can be assessed by measuring the different values of different indicators, according to the transformation and change due to the development. The study examined an area in the Rusafa side of Baghdad over two different time periods, the historical phase (1958) and the current phase (2023).

Research found that urban systems have high flexibility in their structural structures, which appear in the nature of their constituent structure. Any process of change at the part level is ineffective and the system adapts to it without any defect. This appears in traditional organic cities more than networked cities. The nature and composition of society imposes is the main factor in the formation of the urban systems of cities, which appeared clearly within the types of formation of city centers and their different origins and at different periods of time.

Keywords: city centers, formal urban systems, morphological transformations, urban change, grid systems, organic systems.

Introduction

Cities are socio-spatial phenomena resulting from the interactions of people with the built environment. They represent a broad qualitative social phenomenon that occurs within a specific physical geographic space. Ancient and traditional cities in particular have undergone

many changes that have changed the nature of these cities, in terms of urban planning, land use and socio-economic structures. Since their inception, city centers have suffered from a series of urban problems, including physical and functional problems, legal and administrative problems, and social and cultural problems that affect the urban morphology of a city center (plan, urban fabric, land uses), especially in areas where old and new meet and coexist. The fragmentation of the urban fabric after the forced development of the construction of modern streets affect the interdependence of the old fabric and the change of land uses in line with the reality of the new situation, as the traditional parts have become physically and structurally old. These factors then affect the overall urban system of the city.

The old city center of Baghdad is known for its traditional character and architectural values. As a result of the fragmentation of the urban fabric after the era of modernization, it has led to cutting new main streets through the traditional urban fabric, which has imposed new streets and spaces (Abbas and Al-Dujaili, 2013). These modern planning practices have caused significant morphological changes that have led to the restructuring of the city and the emergence of straight grid systems and highways, eventually causing significant changes in land use, changes in the type and volume of trade and production, the expansion of commercial activities and modern functions such as administrative buildings. There are also changes in the patterns of land use in most areas of the center. (Al-Obaidi and Rashid, 2017)

Research Objectives

In this context, the research has the following objectives.

- 1- Reveal the relationship between the formal urban systems of cities and their efficiency to solve the problems of city centers resulting from the processes of transformations and morphological changes of the city.
- 2- Detect effective urban systems that are adaptable to the transformations that occur as a result of the urban development processes.

1. Theoretical Basis

Transformations of the built environments occur as a result of constant interactions between physical parts and people. These transformations are either a change at the level of the urban context of the existing environment, or have come into being in order to achieve different social, economic or political goals, by changing the physical and urban features of the structure through the introduction of new and urban structural relationships (Salman, 2018). It is therefore necessary to understand morphological transformations and urban changes as well as the most important problems faced by the transformations of cities.

1.1 City Center

Although there have been many debates about the origin of cities, such as hydraulic and economic theories (Lynch, 1960), the indisputable fact is that cities have emerged as an outcome of a series of social, economic and environmental factors, producing interactions over a long period of time. The patterns of construction and composition of a city determine the location of the center, and the spatiality of it. The relationship of the center with the changes that take place in the city is direct and positive in terms of the speed of impact, which requires quick responses. The most important factors affecting the construction of urban centers are as in Fig. (1)

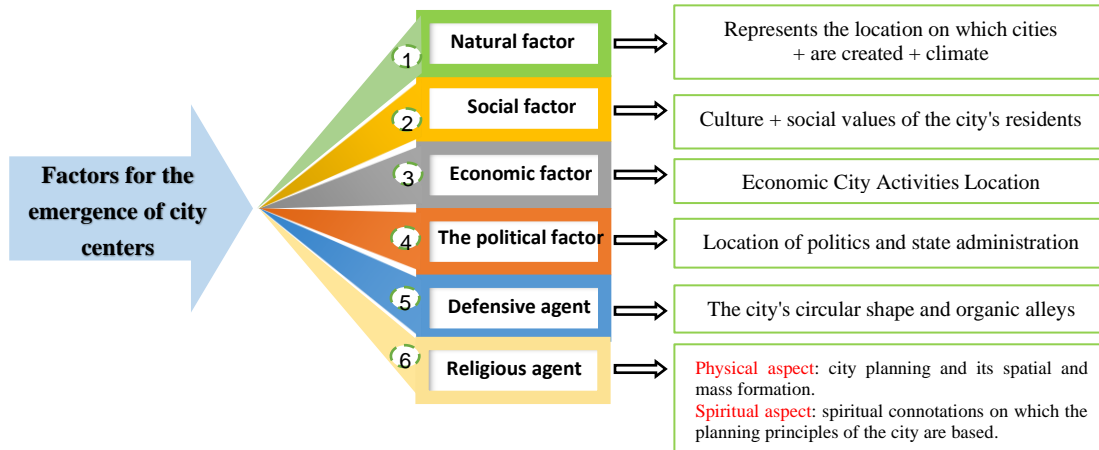
According to Shakibamanesh (2011), the centers of cities are considered a measure of their superiority and a center for the aspirations and desires of society. They have always been and still are the beating heart and lifeline for them, as they are the center of economic, political and social activities. They are considered the centers of finance and businesses, in addition to being the center of demographic, economic and environmental challenges, which ultimately constitute the size, shape, structure and function of the region and its future growth.

Throughout history, city centers have had a major role in city planning. Since ancient times, the cities were a compact urban gathering that contained a group of centers specific to different activities such as worship, shopping or social interactions among the members of the

city community. At the beginning of the twentieth century was an area with retail trade, and in the middle of the century it became commercial complexes occupied by the offices. However, today it has become tourist and sports centers in large cities, while small cities still have retail trade. The signs of development indicate that the center areas will become a commercial, cultural and entertainment area in the future. (Abu Sobha, 2003:24)

Fig. 1: Factors affecting the locations and distribution of city centers.

Source: Author



1.2 Morphological urban transformations

Many cities have suffered huge transformations due to many reasons such as the rapid developments, and the development of technology and globalization (Deppisch, 2017). Ancient and traditional cities in particular have undergone many changes that have changed the nature of these cities, whether in terms of urban planning, land use or socio-economic structures. Most of the time, modern and traditional urban plans coexist side by side, which can consequently cause a massive shift in their urban morphology. These modernizations of cityscapes can cause distortions in the traditional urban form of a city (Barau and others, 2015)

According to Al-Zubaidi and Al-Delfi (2017), the transformations appear in two models: the first is negative, showing defects in the fabric and spatial planning being an integral part of the consequences of obsolete spatial continuity. They do not take into account the future growth of the city center, such as sometimes bad modern interventions that integrate with the current city structure, leaving behind neglected spaces that have lost their social identity and dead spots. The second model describes it as positive because it stands out by investing the good energies possessed by the place and provide opportunities for good development based on innovation and renewal of events within the city center (Al-Zubaidi and Al-Delfi, 2017)

1.3 Urban change

According to Jawad (2011), an urban structure relies in its composition on the bonds between its parts that interact through accumulated experience and adaptability that leads to continuous development and growth. Therefore, an urban structure is in a state of change and transformation as long as the relations between its parts are in a state of change and transformation. As Jawad (2011) points out, the changes that occur in the structure of the center are in three directions:

- a- Active change:** It includes actual transformation processes resulting directly or indirectly from changes in the civilizational data, whether these changes represent a positive or negative development.
- b- Passive or Relative change:** In this, the built environment or parts of it remain intact for a period of time that may be prolonged or shortened despite the changes in the surrounding civilizational conditions.
- b- Counter change:** Many counter-change attempts are supported by special laws and regulations that represent independent special laws or specific paragraphs within

general building laws. It takes different forms, such as attempts to preserve historic city centers, projects to redevelop old areas and projects aimed at filling the voids in the traditional urban fabric.

A change in urban structure is caused by a sudden movement in appearance that leads to a change in the substance. Appearance refers to the 'phenotype', while the core refers to the deep structure or 'genotype' (Satie, 2008). These two expressions were introduced by geneticist Wilhelm Johansen in 1911 to distinguish between inherited differences and those resulting from the influence of the environment. The terms 'genetic makeup' and 'phenotype' were adopted in architecture by Hillier and Leaman at the beginning of the twentieth century.

1.3.1 Genotype

Genotypes are models that govern the order of a place, and the principles governing the phenotypes. Hillier (1984) defined genotype as those primary generators that produce different urban space forms (phenotypes) and correspond to the deep structure of the language. Hillier (year) derived these names by identifying urban settlements with the biological makeup of organisms, and took on the social logic behind the formation of the urban settlements (Hillier, 1984).

Hillier classified the genotype into two main categories (Satea and Shukr, 2000:63). They are as follows.

- a. **Short genotype:** It is a reduced, substantial and deep relationship model, characterized by the phenomenon by which it is built by its acceptance of deletion and addition and a high possibility of surface variations. Stability is achieved through diversity.
- b. **Long genotype:** It is a model of relationships with several limitations. It is described as having limited deletion potential for the generated output, with a specific possibility for surface variety.

1.3.2. Phenotype

Phenotype is the true perception of the genotype in the physical environment in the form of physical elements. Phenotypes represent the results of environmental interactions of the genotype that are comprehensive and related to all living organisms (Guney, 2007). The so-called surface structure related to the characteristics or direct relationships felt and perceived of the urban phenomenon and at the same time represents the final product in the process of the formation of the phenomena (Satei and Shukr, 2000). Buildings are symbols of innate human cultures and symbols of individual and cultural communities that store cultural information in the human environment. For example, in the traditional homes, cultural structures can be passed down from generation to generation, but produce significant differences on an observable level. The stable structure is referred to as a genotype, compared to a phenotype, which is a diverse observable form (Bafna, 1998)

Piaget (1976) has pointed out that the phenotype represents the various superficial states taken by the phenomenon, and Hillier (1984) has linked it to a dialectical relationship with the genotype, pointing out that phenotype represents the surface characteristics taken by the phenomenon according to its objective conditions, provided that it retains deep bases. He has pointed out that there are two principles in his presentation of the dialectical relationship between the genotype and the phenotype (Satie and Shukr, 2000).

- a. The phenomorphosis or surface structure represents random events from which certain bases are retrieved, reused in the production of other phenomena of the same type, in which case the phenotype precedes the genotype.
- b. The phenotype is a variety of states of the genotype, but this relationship is variable, the variations of the phenotype may contradict to make the phenotype equal to the genotype.

2. Literature Review

The city consists of two basic systems: a slow-changing physical system consisting of buildings defined by streets, roads, and infrastructure. The other system is the human system considered to have rapid change consisting of human movement, interactions, and activities, interacting with each other within the city (Hillier, 2012). Hillier raises a question about the nature of the relationship between the physical system and the human system, because the human system seems to be imposed on the physical system with functional relationships that express the structure-function relationship, because the city has structural and functional characteristics based on the influence of one on the other (Hillier, 2012).

Mumford refers to the city as a social network, an economic organization, an institutional process, a social act, and an aesthetic expression. Accordingly, there is a set of basic systems of the city: the political system, the economic system, the social system, the urban system, the environmental system, the administrative system, etc., that interact with each other, forming a larger system that is the urban system of the city. (Mumford, 1961)

The physical system is one of the city systems consisting of the traditional organic system and the regular planned system. Batty and Longley (1994) explains that organic cities arose and developed by accumulating over time and in parallel with the changes in the society, and describes them as spontaneous or gradual self-emerging cities. These cities arose and grew without the intervention of authority in their planning but on their own, independently of each other, in different parts of the world and in different cultures (Batty and Longley, 1994).

The other physical system is the planned system, also called the grid system, as the shape of the geometric city is intentionally designed as a result of the development of all cities. Nilsson and Gil (2015) show that planned cities consist of different types and structures, depending on the types of distributions enjoyed by some ideal city forms, and in a perfect network.

Al Hankawi and Venus Suleiman (2008) explain the morphological transformations and their impact on the original (organic) systems and the new (planned) and transformed systems within the city structure. They refer to the comprehensive transformations in the urban structure at the level of the part (buildings), and at the level of the whole (urban fabric), as one of the most important aspects of the urban transformation that the city is witnessing in the stages of its existence, which may lead in some transformations to negative effects on the urban structure. Thus, Al-Ani defines transformation as a feature of the development of livable city systems. He argues that the city needs to adapt to the transformation of the urban structure, road entrances, regional communication axes, green areas, parks, and open squares. He says that there are continuous patterns of urban transformations able to adapt to different patterns in different civilizations of transformation and that there are also ones which are unable to adapt (Al-Ani, 2012).

Salman (2018) defines the formal transformations in urban centers that occur dynamically in the built urban environment as a result of the continuous interaction between the physical parts and aspects of life. He says that changing the physical and urban features of the structure by introducing new structural relationships and urban elements reflect different and renewed intellectual orientations.

Odeh (2016) explains the most important reasons for the urban transformation of cities that occurred due to social, cultural, economic, technological and ecological influences, and the response of contemporary urban development to these changing factors. Cities respond to change in varying ways depending on their economic potential, prevailing political conditions, the nature of their societies, prevailing values and norms, as well as the urban policies adopted by the governments.

Satie and Al-Dujaili (2013) refer to the formal transformation in the historical paths due to urban growth, which means spatial and functional change, which subsequently leads to changes in land use. According to them, the dynamics of the urban growth of the city start from the continuity of urban sprawl when converting the traditional (organic) fabric into urban lands (planned fabric) for the purpose of development.

These show that urban systems of the city is generally exposed to transformation processes as a result of development processes, and these changes may be positive if they are compatible with the nature of the formative relationships within the system that control it, or negative if they are the opposite.

Research Methodology

The research adopts the descriptive analytical approach of the selected study area in the Rusafa side of the city center of Baghdad. It first presents concepts and theoretical proposals related to urban systems, morphological transformations, and urban changes that occur in city centers in order to reach effective and measurable indicators. Afterwards, it analyzes a case study morphologically during two different times in order to reach evaluate them by the indicators by changing the shape of the city with the influence of the urban systems.

3. The Case Study: The Old City Center of Al- Rusafa

Rusafa is located on the Eastern side of the Tigris River and opposite Karkh on the Western side as in Fig. 2. It is still by far the heart of the capital Baghdad and an integral part of the central trade and business sector. It is the most prominent and largest of the four historical sections in the city, the other sections being Karkh, Kadhimiya and Adhamiya. The elected study area is located between the Al-Jamhourih Bridge, Al-Ahrar Bridge, the river bank in the middle of which is the Al-Sinak Bridge from the South, and the Al-Kifah Street from the North. The area includes a number of streets such as the Al-Rashid Street, Al-Khulafaa Street, Al-Jamhourih Street, and a number of squares that represent important urban nodes in the area such as the Tahrir Square, Al-Khalani Square, Al-Wathba Square and the Al-Hafiz Qadi Square.



Fig. 2 The boundaries of the study area.
Source: Author based on Google Earth maps

The research traces the emergence and development of the Rusafa region in general and the elected region in particular, through successive historical stages in order to monitor the morphological transformations in its urban structure and the extent to which the urban system affects these transformations.

The construction of Rusafa began after the fading features of the rounded city, where a new center was established on the Eastern side of the Tigris River in Baghdad by Al-Mansur to control the soldiers by making them Eastern and Western parts. Baghdad expanded quickly after its establishment on the Western side, so the construction extended to the Eastern side

(Rusafa), which later became the headquarters of Al-khalifeh. The mosque was established, which was then known as the Rusafa Mosque, and next to it was built the Rusafa Palace. Construction was completed in 154 AH. Most buildings were made of clay, except the mosque and the palace, which were built with bricks. Then the Eastern side expanded and Rusafa became the only one as much as the city of Mansur (Makiya, 2005). The proposition here refers to the beginning of the emergence of the Rusafa side in Baghdad with a traditional (unplanned) organic fabric consisting of a group of monolithic buildings built using clay.

The center of old Baghdad in Rusafa includes many main squares and joints of movement, which are represented in the intersections extending on the Rashid Street and other squares and open areas, each of which carries many characteristics that make it important centers for recreational and social uses. Its urban fabric is a complex urban organization, consisting of dense and unorganized traditional fabric and modern straight or mesh lines, often contradicting each other in form, scale and function.

The first sector starts from the Republic Bridge to the Al-Sinak Bridge, and consists of many private houses overlooking the river, which were inhabited by the Baghdad nobles, which turned into offices, stores and workshops, in addition to private accommodation shops and hotels. This area is predominantly modern and the areas were demolished when the Sinak Bridge was built. The riverbank in this sector used most of the area as informal parking (Al-Waeli, 2017)

The second sector starts from the Al-Sinak Bridge to the Al-Ahrar Bridge. This area, which contains an interlocking urban fabric was demolished in the eighties of the last century. Nearly a fifth of this area is still empty and used to house cars in informal parking. At the Southern end are three heritage buildings: the British Consulate, the British Residency House and the Captain's House. A number of old houses are lined up on the edge of the empty square that ends with the courtyard of the Sayyid Sultan Ali Mosque, which crosses the river path. (Al-Waeli, 2017:167)

Therefore, the city of Baghdad has witnessed a significant and rapid growth that has led to rapid changes that had a clear role in determining the features and shape of the city planning and urbanization. The fabric with a grid layout appeared in an engineering manner resulting from the expansion and entry of the car and the construction of the first street for the passage of cars (Al-Rasheed Street). Thus, the city consisted of a network of main and secondary streets extending longitudinally and transversely on both sides of the city. The building blocks are formed around it that appeared differently from the traditional style in terms of the nature of construction, the nature of building materials, termination, height and the design, to suit the needs of the contemporary city. The old fabric suffers from severe disintegration, as it has fragmented and large parts of it demolished. It has continued to deteriorate over time with urban development projects.

3.1 Application of Depth mapX 0.8.0

The quantitative measurement procedures for this research included several steps. The first analysis includes the use of the program (Depth mapX 0.8.0) subject to the rules of space installation to analyze the practical study area and reach the results of quantitative measurement of the indicators extracted from the theoretical framework. The second analysis is the descriptive morphological analysis of the selected area plans through the succession of morphological transformations of the region over two different time periods (1958 plan – 2023 plan) leading to its final transformations at the present time. Space Syntax is a set of theories, techniques and methods of analysis of urban structures and forms of human settlements, used to analyze cities as networks of spaces formed by placement, assembly and orientation of buildings. It provides techniques to analyze how each public place or part of the street relates to all the other public places or proximity to each part of the street in relation to all the other parts of a built environment. It helps in monitoring how space networks relate to the functional patterns such as mobility: the movement of cars and pedestrians through cities, and the possibility of different movements and land use patterns. Space syntax theory can provide a spatial understanding of the social organization in the settlements from different cultures by

showing how these buildings and settlements were created. That is, it allows understanding the social organization of the settlement, by applying mathematics to the spatial relationships of the built environment. It is a single software platform that enables us to analyze the spatial networks designed to understand the social processes within the built environment (Hillier, 2007)

The basic idea of the space syntax theory is that urban space can be represented by focal lines for the purpose of analysis and to describe the relative correlation of these spaces or lines (Hillier & Hanson, 1984). Spatial structure analysis generates two types of space extensions: Extension Convex and Extension Axial and these two extensions can actually be represented through the axial map that represents the least number of straight lines that pass through the convex spaces, and the convex map that represents the lowest set of convex spaces that cover the system (Hillier & Hanson, 1984). Through pivot and convex maps, it becomes easy to see the structure of the urban space while the difference between the urban settlement plans can be observed depending on the relationship between them.

3.2 Morphological analysis using (DepthmapX 0.8.0)

Based on the objectives of the research and the accuracy of the information and maps available about the urban form of the city of Baghdad, the research dealt with measuring the indicators of the urban system of a selected area on the side of Rusafa during two time periods and morphology in order to study and show the morphological transformations of the shape of the area over time by the influence of the urban system.

- a- The first morphological phase in 1985, i.e. before the region witnessed a major urban change and the demolition of parts of the traditional fabric. Fig 3
- b- The second morphological stage in 2023 Fig 4 is the current day or time of the current study.



Fig. 3: The city of Baghdad / study area in 1958

Source: Google Maps

Source: www.lib.utexas.edu/maps

Fig. 4: Satellite image of the study area in 2023
Source: google earth maps

The analysis of the axial plan of the selected area in the Rusafa side of the first stage in 1958 show the formal analysis through the Depth map program, in which the formal analysis determined the number of axial lines ref for this stage as 301 axial lines for a comprehensive radius (n). The number of axial lines for the second phase in 2023 indicated 1784 axial lines for a comprehensive radius (n). This indicates the significant growth and expansion of the region by 6 times during the period between the two periods of time.

A pivotal analysis of the main urban indicators related to the morphological transformations was carried out. The results, through a review of the schemes resulting from the analysis process for the two time periods show the following.

1. Connectivity indicator: shows an average of 3.72 for the first time stage 1958 AD with the highest value of 24, and an average value of 2.5 and the highest value of 32 for the second time stage 2023 AD.

The first time period is noted from the Fig. 5 that the axial lines with the highest value of connectivity, appear in red according to the color gradient of the program. They are straightened axial lines such as Al-Kifah Street (A). It is then followed by the Street (B) extending from the Al-Ahrar Bridge (currently) towards the intersection of Al-Sadriya within the selected area. It is noted that the highest values of connectivity appear in the main straight streets (linear) that penetrated the organic fabric. Then the connectivity values are graded and appear in the streets C, D, E, and F and some streets that appear in yellow (i.e. they represent a lower connectivity value than streets A and B), while the rest of the streets (shown in blue) have the lowest connectivity value.

During the second time period, the connectivity scale recorded its highest value in the Al-Kifah Street, which appears with the number 1 in the Fig. 6, followed by the streets that appeared in yellow. This is the street extending from the Al-Ahrar Bridge towards the intersection of Al-Sadriya numbered 2. It was then followed by the Al-Rashid Street from the side of the Republic Bridge to the Al-Sinak Bridge numbered 3., followed by the same value of the street extending from the Al-Khalani Square to Al-Tayaran Square No. 8 within the Bab Al-Sharqi area. The organic network did not achieve a high communication value in the two time periods, and therefore connectivity recorded a weak value at the localized level of the urban structure after the large expansion. This makes the urban system weak, as the low connectivity value negatively affects the effectiveness of the formal and functional systems. It is noticed that a decrease in the rate of connectivity in the second time period and the reason is attributed to the new linear streets that penetrated the old traditional fabric and led to a small number of old connections between the fabric.

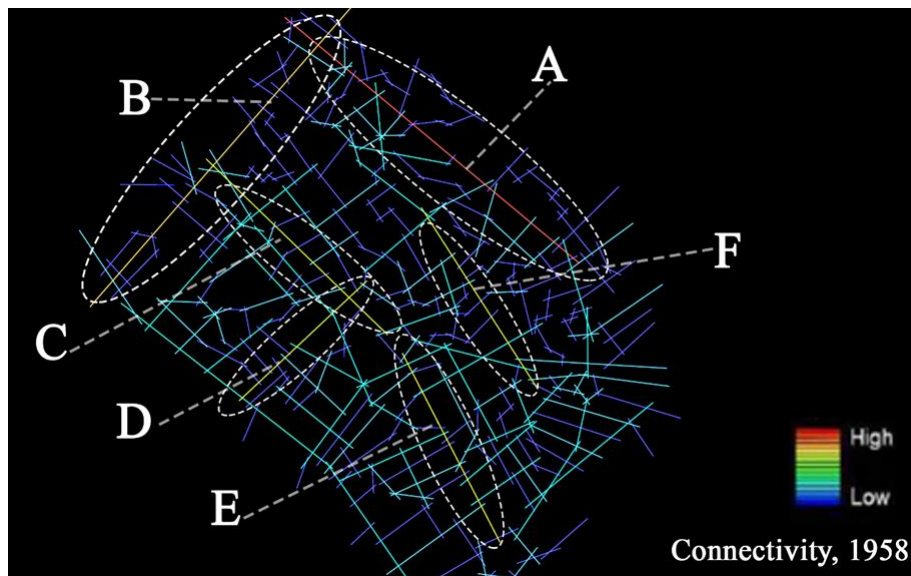


Fig. 5: Connectivity indicator, 1958

2. Control and Controllability: The urban structure achieved a degree of control for the first time period at a rate of 1, and the second time stage at a rate of 0.99 and the places of control achieved an average of 0.26 for the first time period and an average of 0.38 for the second time stage. Weak values are observed for the control scales and control places for the two time periods, as the spaces with a value of less than 1 indicate poor control between their parts.

In the first time stage, the Fig. 7 shows that the Street B extending from the Al-Ahrar Bridge has the highest control value according to the color gradient of the program, followed by A, the Al-Kifah Street (in orange), meaning that it has a lower degree of control than the Street B, followed by the Street E. Then, the other streets are graded according to the color gradient of the program.

The second time stage indicate the highest value of control in the Al-Kifah Street numbered 1 in the Fig. 8, followed by the Street 2, extending from the Al-Ahrar Bridge to Al-Sadriya Intersection, followed by the Al-Rasheed Street 6 (in yellow).

According to Hillier (2007), the easier the places become to reach through the control of space in the permeability to it by its direct neighbors as a space to move to and from it, the greater the number of possibilities for them to be preferred attractions over the most difficult places to reach. There, it can be seen that the main linear spaces at the edges of the region show higher levels of control than the organic fabric (residential areas) in the heart of the area, which appear in blue according to the color gradient of the program.

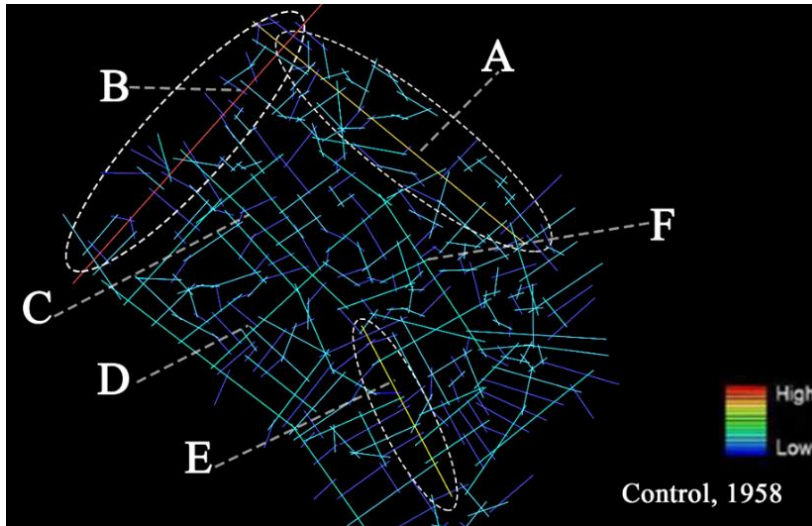


Fig. 7: Control indicator, 1958

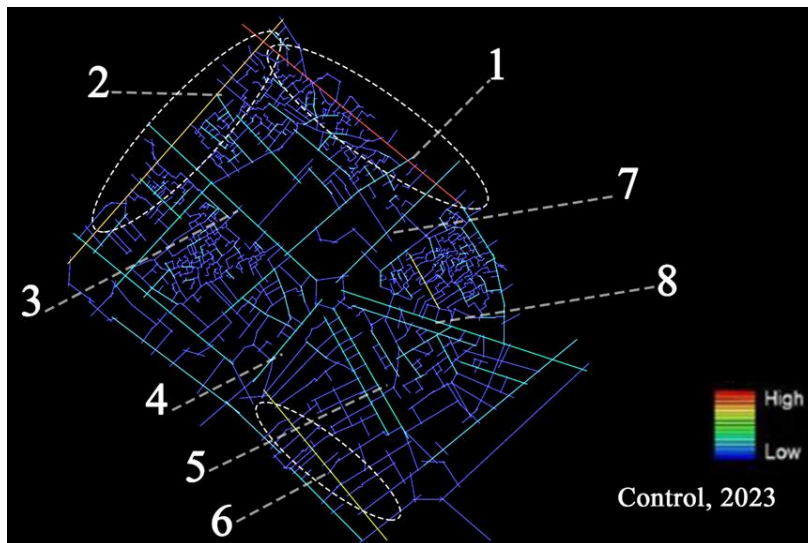


Fig. 8: Control indicator, 2023

3. Integration indicator: The axial analysis of the integration and isolation scale for the two time stages, the integration index measurement show a rate of 1.35 for the first time stage and a rate of 0.69 for the second time stage.

In the first time stage: the axial integral scale indicated its highest value in the streets A, B, C, D and F, which appear in red in the Fig. 9 and the scale is graded in orange and yellow in most of the fabric within the area.

In the second time stage: the axial integration scale indicated its highest value in Al-Kifah Street numbered 1 in Fig. 10 and the street numbered 3 extending from the Al-Shuhada Bridge to Al-Kifah Street and Al-Khulafaa Street numbered 3 and the street extending from the Al-Khalani Square towards the Al-Kifah Street No. 7, as these streets have higher integration than other streets that appear in orange, such as the Street No. 8 extending from the Al-Khalani Square towards the Al-Tayaran Square and Al-Rashid Street from the confined side. Between

Al-Sinak Bridge and Al-Ahrar Bridge, followed by the streets that appeared in yellow, such as Al-Gomhouria Street numbered 5 and Al-Rasheed Street from the side between the Republic Bridge and Al-Sinak Bridge numbered 6.

It is noted that in the first time period, the kernel of integration was widespread in the heart of the urban area (main streets and the heart of the urban fabric / alleys). This shows a clear homogeneity in the symmetry of the pivotal spaces of the urban structure of this stage. The second time stage appeared as an isolation kernel within the old traditional fabric (alleys), which weakened the old fabric integration as a result of the construction of the streets in an unstudied linear manner that penetrated the old fabric and these streets became the main integrated axis within the region.

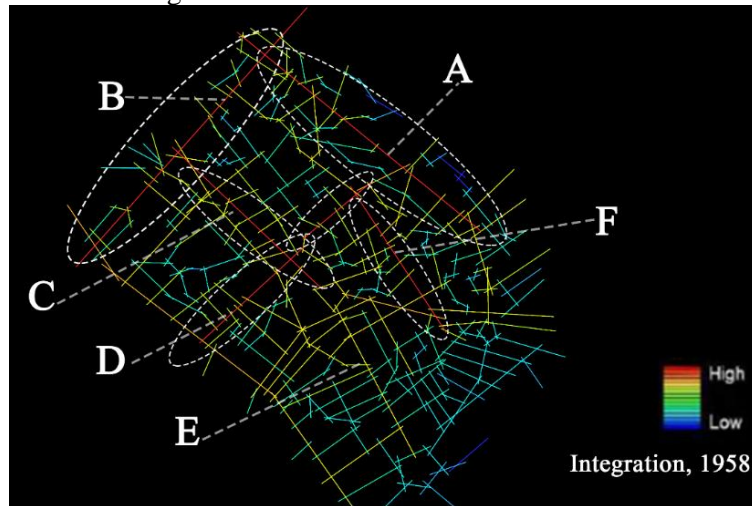


Fig. 9: Integration indicator, 1958

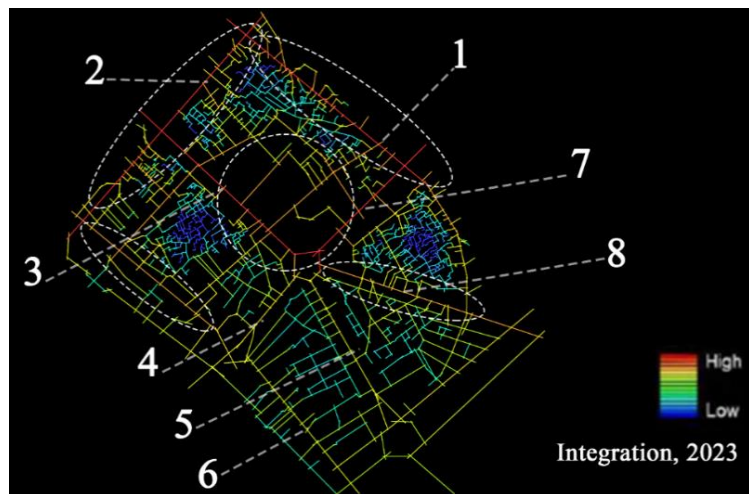


Fig. 10: Integration indicator, 2023

4. Choice indicator: Through Axial analysis, there were significantly different rates of the option scale between the first- and second-time stages, the option rate for the first-time stage was 1299 and reached in the second time stage 22774.

The first time stage achieves the highest ratio of the option scale in the main peripheral axes of the urban structure in the form of main arteries radially emanating from Al-Kifah Street A and Street B extending from the Al-Ahrar Bridge towards Al-Kifah Street, which appeared in red as in Fig. 11, followed by the streets that appeared in yellow. This represent a lower option value, which are the streets C, E and F and then the other streets are graded according to the color gradient of the program.

The second time stage achieved the highest ratio of choice in the form of multiple main arteries emanating from the center (Al-Khalani Square), which was represented by Al-Kifah

Street in red according to the color gradient of the program representing the highest percentage of control. It was then followed by the streets in orange, which is Street 2 extending from the Al-Ahrar Bridge towards Al-Kifah Street and Al-Khulafaa Street numbered 3, followed by the streets emanating from the Al-Khalani Square, which is the street extending from the Al-Khalani Square towards the Al-Tayaran Square 8 and the street extending from the Al-Khalani Square towards Al-Kifah Street 7 s in Fig. 12.

The option scale expresses the property of spreading within the urban structure, as urban spaces are scattered when there is more than one way to reach them, which was achieved in the second stage of time. This indicates that there has been a significant change in the urban authority as a result of the transformation and the emergence of new axes, which causes a decrease in the number of pivotal links between the streets between the two stages, which was due to the unstudied development of the area, which reduced the plurality of choice in the formal system between the first and second stages.

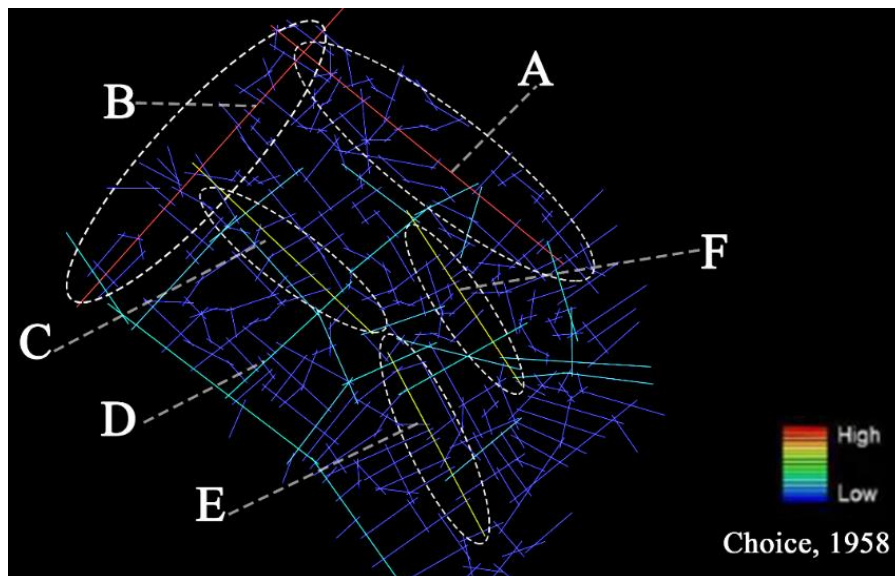


Fig. 11: Choice indicator, 1958

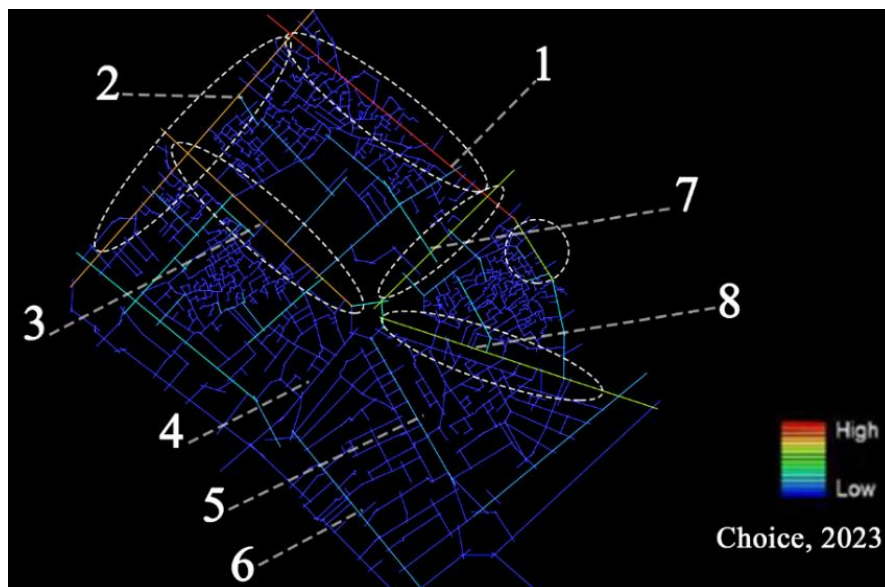


Fig. 12: Choice indicator, 2023

By reviewing and analyzing the results of the quantitative measurement of the morphological transformations of the elected area on the Rusafa side for the two time periods 1958 AD and 2023 AD, the research finds the following: (Table 1)

Table 1: Research indicators and their impact.

Source: Author

indicator	The extent to which the indicator has been achieved for the two time periods		The extent of the indicator's impact on the urban structure of the urban system
	1958	2023	
Connectivity	↑	↓	A decrease in the rate of connectivity in the second time phase due to the new linear streets that penetrated the old traditional fabric, which led to a decrease in the number of old connections between the fabric, as the decrease in the value of connectivity negatively affects the effectiveness of the formal and functional systems, which makes the urban system weak.
Control	↑	↓	Weak values of control and controllability appeared for the two time stages, but the control rate for the stage appeared higher in the first time stage, which indicates weak control between parts of the urban structure with the increase of engineering inputs and weak connection to the organic urban structure within the structure of the region.
Integration	↑	↓	The point of the integration scale was higher in the first stage than in the second stage, due to the increase in visual and motor axial correlations in the second stage, which was the result of the rapid, ill-conceived development that was in an engineering form that moved away from the old city pattern, which made the old organic fabric lose its integrity in the second time period.
Choice	↓	↑	The second time phase achieved a choice indicator at a higher rate than the first time period, which indicates a significant change that occurred in the urban structure as a result of the transformation and the emergence of new axes, which causes a decrease in the number of pivotal connections between the streets between the two phases, which was due to the unstudied development of the area, which reduced the plurality of choice. In the formal system between the first and second stages.

4. Conclusions

1. The urban system of Baghdad is subject to transformations as a result of development processes and these changes may be positive if they are compatible with the nature of formative relations within the system that control it and negative if they are the opposite.
2. In Baghdad and within the study area, the engineering organization is applied at the level of the front network lines, which appeared in the main streets. This creates a strong emerging structure for the front network at the expense of the old back grid structure that was strong before the addition process. While cities use a space strategy that goes from top to bottom in order to create equality between space, the city of Baghdad before the changes was using an engineering strategy that goes from the bottom up in order to create a variation and difference in space and a large gradient front network system. That has resulted in a dense pattern of centers and secondary centers linked to the residential background and distinct from it. At the same time, it has been affected by the change that occurred in it and in a manner incompatible with its original urban structure.

3. The process of developing cities and producing a good urban form is through a good reading of the general context and the shape of the city. This emerged in the old city of Baghdad, but when a new development plan is developed differently from the method that is in line with the context of the city and its organizational form, the best urban products of a variety of social, technological and economic variables are those that develop and grow in the city over time forming a gradual hierarchy.
4. The development process cannot be carried out for a city that includes or contains a cumulative old traditional urban structure and the establishment of a contemporary scheme without reference or taking into consideration those urban structures that have continued over time for long periods. Exceeding them leads to interruptions between their ties and thus the incoherence of their general structure. The research highlighted the contrast between the two different periods (old Baghdad - new Baghdad) and was clear in the form that indicated that the development process in the city center was not gradual and not a suitable Morphology with its old urban structure and comprehensive structure. This has caused a disintegration and incoherence between the organic and engineering parts, which have greatly affected its urban form and general structure.

5. Recommendations

1. The research recommends knowing the type of urban fabric that makes up the system of Baghdad with knowledge of its connections and development to take advantage of the morphological transformations that occur in the urban systems of this city.
2. There is a need to pay attention to the historical center of Baghdad because of its great importance by setting development plans that suit its specificity and traditional identity.
3. Reconsider planning laws and controls and make them more useful towards the natural changes imposed on the city with plans in line with the future functional requirements.
4. Adopt the methodology of structural analysis of space installation rules, such as the DepthmapX space installation rules analysis program in urban studies before developing the urban plan and designs. This in turn provides logical solutions and can be adopted in the analysis and development of cities to come up with positive results that suit the requirements of the times.

References

- Abbas S, Aldujaili S. (2013), Historical Paths and the Growth of Baghdad Old Center: J Eng.
- Abu Sobha, A. (2003), The Geography of Cities, Amman: Dar Wael for Printing, Publishing and Distribution.
- Al Ani, Mohammed Q. (2012), Urban Types and Transformation of the City, 17th International Conference on Urban Planning and Regional Development in the Information Society GeoMultimedia, pp. 1041-1054
- Al Hankawi, W. and Suleiman, V. (2008), Transformation in the urban structure, the impact of freedom contracts in totalitarian transformations within the urban structure (the city of Sulaymaniyah, a case study), Iraqi Journal of Architecture, Vol. 4, No. 14-15, pp. 30
- Al-Hinkawi, W. and Alkubaissy, Sh. (2017), The impact of planning policies on the cities' morphological transformations city of Kirkuk as a case study, International Journal of Civil Engineering and Technology (IJCIET), Vol. 8, Issue 4, pp. 1104–1116
- Alobaydi, D. and Rashid M. (2017), A Study of the Morphological Evolution of the Urban Cores of Baghdad in the 19th and 20th Century, Proceedings of the 11th Space Syntax Symposium, SSS Lisbon.
- Al-Waeli, T. (2017), Baghdad: Between the development of Al-Rasheed Street and the neighborhoods of the historic city. Second Edition, [online] Available at: https://issuu.com/turath/docs/part_2

- Al-Zubaidi, S. and Al-Dalifi, H. (2017) The Impact of Modern Urban Transformations on the Urban Landscape of Historic City Centers, An Urban Study of the Historical Center of the City of Najaf, *Engineering Journal*, Vol. 28 Issue 8, pp. 2
- Bafna, S. and Rashid, M. and Wineman, J. (1998), Describing plan configuration according to the covisibility of surfaces, *Environment and Planning B: Planning and Design* Vol. 25 (5), pp.693-708
- Guney, Y. (2007), Type and typology in architectural discourse, *BAÜ FBE Dergisi Cilt:9, Sayı:1*, Vol. 3-18, pp. 3
- Hillier, B. (2007), *Space is the Machine: A Configurational Theory of Architecture*, Cambridge: Cambridge University Press.
- Hillier, B. and Hanson, J. (1984), *The Social Logic of Space, Place*, Cambridge: Cambridge University Press.
- Jawad, S. (2011), Change in the centers of historical cities, *journal of planner and development*, Vol.16, Issue 2, <https://jpd.uobaghdad.edu.iq/index.php/jpd/article/view/154>
- Lynch K. (1960), *The Image of the City*, Cambridge, MA: MIT Press
- Makiya, M. (2005), *Baghdad: Al-Warraaq Publishing Company Limited*.
- Mumford, L. (1961), *The City in History*, New York: Harcourt Brace & World Inc,
- Odeh, A. (2016), *Variation in the Morphological Characteristics of Cities: A Comparative Analytical Study of the Urban Form of the City of Baghdad*, an unpublished doctoral dissertation submitted to the University of Baghdad/College of Engineering/Department of Architecture.
- Salman, M. (2018), *Formal Transformations in Urban Centers (Al-Mansour Case Study)*, Unpublished Master's Thesis, Department of Architecture, University of Technology, University of Baghdad, Iraq.
- Satie, S. (2008), *The Change of Genotype in Old Traditional Areas in Baghdad City (Analytical Study Using Geographic Information System)*, a research published in the *Iraqi Journal of the Department of Architecture, University of Technology*, Issue 14, pp. 6
- Satie, S. and Shukr, M. (2000), *The Deep Structure and the Variation of Its Characteristics in the Facades of Urban Cells*, *Journal of the Association of Arab Universities for Research and Engineering Studies*, Issue 1, Vol. 7, pp. 60
- Shakibamanesh, A. and Behzadfar, M. (2011), *Promoting City Center Parking Qualities by Using Urban Design Guidelines*, *International Journal of Architecture & Urban Planning*, Iran University of Science & Technology, Vol. 21, No. 1. pp. 37