

Exploring the Interrelation between Traffic Congestion and Land uses in Amman: Challenges and Potential

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Abstract

While traffic congestion is affecting life styles in cities and neighborhoods, this research paper is aiming at investigating and coming up with drivers that have and are causing traffic congestion in the different neighborhood of Amman. As a growing phenomenon in Amman, it was important to see where the roots for such are and try inevitably to conquer them and try to set up recommendations that can redirect planning regulations to proactively release the burden of such on residential neighborhoods.

Two comparative case studies were adopted for this purpose, the residential neighborhoods Al-Baraka and Al-Hasaniyah, adjacent to main arterial streets Al-Madina Al-Munawwarah Street and Al-Hurriya Street in Amman. The methods for this survey are on two levels, mixed methods using space syntax on one level, and interviews on the other level in addition to secondary and desk research analysis that contributed to building the bigger picture of what the case is in Amman.

Findings have shown that the phenomenon of traffic congestion in the study area extends its roots in a complex way to include a variety of reasons such as the increasing rate of commercial land uses, population density, location in relation to the city, street penetration for residential neighborhoods, the inefficiency of the public transportation system and community culture. Such drivers were further synthesized to see in what ways certain adjacency and location can differ in impact than others.

1. Introduction

Is there a relationship and impact between traffic congestion and land use development in Amman Neighborhoods and Streets? The research, which is based on an MSc Thesis at the German Jordan University has tried to explore the drivers for traffic congestion in urban residential neighborhoods. What kind of existing and developed land uses are affecting neighborhoods negatively

This research compares two neighborhoods in Amman to explore the relation between land use and traffic congestion. This research is made to confirm the reasons of traffic congestion phenomenon from a multi-dimensional perspective. Al-Baraka and Al-Hasaniyah neighborhoods are the case studies of this research.

Traffic Congestion is becoming associated with several development orientations as land use development in Jordan, especially in Amman Governorate. The later consequences of this problem have a negative impact on the community as a whole such as travelling time, air pollution and the expenditure of money on resolving these issues, (Kesuma, 2019). Traffic congestion is one of Amman's primary issues, which may be linked to a variety of causes such as rapid population growth, insufficient and bad road infrastructure, city structure, a quick increase in the number of automobiles, and a lack of a physical plan to govern city development, (Alshannaq, 2021).

What is obvious in Amman is the lack of an efficient Public Transportation System, the PT is characterized as low quality, and the citizen has no choice to use this system because they have no choice, (Shbeeb, 2018). Moreover, the absence of access to public transportation is most noticeable in Amman's residential zones, where medium and low-income households reside. These districts are not served well by the public transportation system. In those locations, thus, having a car is an absolute requirement, (Raqqad, 2017).

Amman was not intended to become full of various types of land uses that are intertwined with other kinds in locations not suitable for that, and it was not adequately planned and did not meet the harmony between different types of land uses as in the use of commercial lands and the direct relationship with the street. Despite this, there are many vital streets in the city where this problem has worsened more than expected and has become attractive to various types of land uses, although it was not planned for that, (Alnsour, 2012).

In other words, there is a lack of coordination between land-use and transportation planning, and the concentration of most commercial activities in Amman's city center is problematic. The bulk of main streets, employment centers, and other key services are concentrated in a few core zones, resulting in a large number of trips to these hubs, (Raqqad, 2017).

The reliance on a single system to reach multiple activity places, and the absence of an adequate public transit infrastructure. Furthermore, poor street planning and design that focuses on vehicle accessibility without considering parking and other access types such as pedestrian accessibility, as well as inappropriate land use locations (lack of studies and analysis for each land use type location based on sensitivity) and failing to keep pace with alternative solutions such as mixed-land use, reflects the extent of poor shared planning between land-use departments and transportation department. As a result, the value of this study demonstrating the interrelationship between traffic congestion and its direct and indirect variables affecting this phenomenon in the selected places cannot be overstated.

1.1 Literature Review

1.1.1 Amman City

The capital of Jordan is Amman and located in the north of the country part approximately 80 kilometres from the Syrian border from the north and 80 kilometres approximately from the east, specifically from the Jordan Valley. Amman terranean is famous for its high steep slope, which exceeds 50% in some places within the city. The hills and mountains are the main topography that shaped the city's layout, (Abu Helwa, 1990). The development within the city occurred between the mountains – in the valleys- those locations with the steep slope acted as edges and barriers of the development at the same time, the thing that limited the road development in specific directions to fit the existing hard terranean, (Abu Helwa, 1990).

Amman is considered the preferable living city in Jordan, which has absorbed several of domestic and external immigration waves of the population; the thing that worsens its problems, the city's population exceeds 4 million inhabitants, which is approximately half of the total population of Jordan (Department of Statistics, Jordan, 2017). The city witnessed fluctuated status of continuous urban growth due to geopolitical factors, but among all, one thing is constant, which is the disparity between its two parts that have been formed due to the differences in demographic composition, urban morphology socio-economic, and the level of urban services, (Khirfan, 2018).

1.1.1 Planning Condition of Amman

In the case of Amman, most land uses are concentrated individually and spatially separate from other land uses as in the longitudinal Commercial land use, which is always adjacent to the street as in the chosen locations for study and usually, the back areas of these streets are residential areas with a high population density where movement begins to and from the road directly, One of the causes of this problem is the lack of modernization on The Law on Regulating / Planning Municipalities, Villages, and Buildings (Temporary Law No. 79 of 1966, as amended), which the World Bank recommends updating this law to suit new global standards, (WorldBank, 2018).

Planning in Jordan and Master Planning lies in the British planning system. Moreover, the reliance on the British model came due to the British colonization era, which linked the planning in Jordan to the financial grants 1950s to design and provide the infrastructure development support and services. By the way, the reliance on the British came earlier during the 1930s when Amman Mayor appointed a to get consultant by the British military, (Abu-Dayyeh et al, 2004). Amman Initial Master Plan was adopted and written in the 1950s with few impacts on the

city's development, (Beauregard et al. 2011). Before the 1960s the municipalities law was published, which gave the municipal councils a role in regulating the Jordanian cities, (Alnsour, 2006).

The city Master Plan is considered an important document to govern the city's urbanization process, multi layouts as land use, social and physical infrastructure, construction, roads, and green spaces, (Bobylyev, 2009). These layers can be considered as a fundamental principle that can be managing the master plan in order to achieve sustainable development. Going back to Amman master plan 1987 completed after four years of preparation, it needs a lot of information on land use, economic growth, population, and laws levels, (Abu-Dayyeh, 2004). according to experience around the world, the master plans can become out of date quickly due to the rapid change in the demographic and social-economic properties and the occurred changes facing the cities, (Alnsour, 2006).

Eventually, several urban development projects and Amman Plan (AP) were born around 2008. The AP's affirm that the Amman Building Regulations and Zoning act as an incentive to promote and attract businesses and economic development as well as the industry, (Khirfan, 2018). According to Alnsour, the reason behind the failure to translate the objectives of the regional developments in Jordan, especially Amman and developing countries, is the lack of feasible implementation. They were unable to anticipate the market reaction, (Meaton et al., J. 2012).

Greater Amman Municipality in 2006 lunched to develop a new city planning framework. The main reason was protecting Amman's fabric and commercial culture and transforming from traditional low-rise buildings to a high-rise and modernist landscape, (Beauregard et al., 2011).

Traffic congestion in Amman has a historical root that began in the central business district (CBD) when housing development started in the middle of three massive camps that starts growing up on the eastern side of the central business district (Meaton et al., 2012). Much of the unregulated housing in eastern Amman was established without considering the regulation and building codes, unlike the western of Amman, where regular building and land use are common. The commercial activities center is located in the central business district, specifically between unplanned and planned housing types.

The CBD grew rapidly and became overcrowded, which directed the housing development towards the suburban areas in both Amman parts. Inhabitant seeks those places due to the clean environment. For more open spaces, unfortunately, the result is expanding the distances between the housing locations and the working and shopping areas, due that car ownership has grown, for example, the number of the registered vehicle in Jordan 1995 is 270000. The volume doubled in 2003 to be 566600 vehicles (Department of Statistics, Jordan, 2003) and 1,635,222 vehicles in 2018 (Department of Statistics, Jordan, 2018). The vast majority of these vehicles were registered in Amman, (Jaber et al., 1997). The volumes of cars have increased, but the speed average due to that has reduced.

Housing and commercial development done without taking any consideration to real planning for infrastructure and roads capacities, the result streets network unable to cope with the vehicles volume and the new strategies to deal with that by expanding street, building bridges and ring road can handle the situation for a certain time before the dilemma starts hitting again.

According to McGreevy (2018), in his review of city planning theories, there are three types of systems through which a city can be developed: nature bottom-up, engineered top-down (or blueprint), and hybrid developments. Although the city of Amman adopts an old approach for planning, and this generates many complications in its structure, it may be that hybrid development is the most effective solution, combining engineering solutions and solutions on the cultural and social awareness level gradually, (McGreevy, 2018; Portugali, 2011).

On the level of accessibility in Amman, as we mentioned earlier, dependence on mobility in the city is often through private vehicles, and this, in turn, increases the duration of access due to traffic congestion and one of the modern concepts to overcome this problem is the TOD Transit-oriented development: is generally defined as

“development that is located within a 10- minute walk, or approximately .5 mile, from a light rail, heavy rail, or commuter rail station. It also includes development along heavily used bus and bus rapid transit corridors in some communities from Planning and Urban Design Standards by (Steiner et al., 2006). TOD includes development at higher densities than usual, to take preference for transit proximity, design elements and planning that encourage pedestrian movement and create pedestrian connections to the surrounding community. TOD projects range in size from Mixed-use centers to whole new communities, (Steiner et al., 2006).

2. Methodology

2.1. Research area

Two neighborhoods were selected as a case study for this research as shown in [Fig. 1](#). Both sites are located within the Amman governate. The first site is the Al Baraka neighborhood located in the Tla' Al Ali area in the middle of the northern part of Amman. The sensitivity of this neighborhood came due to its centrality location between a high densely populated neighborhood as Al Rashid neighborhood at the north, Tla' Al Shamali and Al Salehien neighborhoods at the west, Ash Shumysany neighborhood at the east and Tla' Al Sharqi neighborhood at the south.

Al Baraka neighborhood is also surrounded by four main arterials classified as main streets with a high proportion of vehicle volume necessary for the vehicle's transit between Amman parts. According to traffic congestion reputation, the famous arterial is AlMadinah Al-Munawwarah Street in the western part.

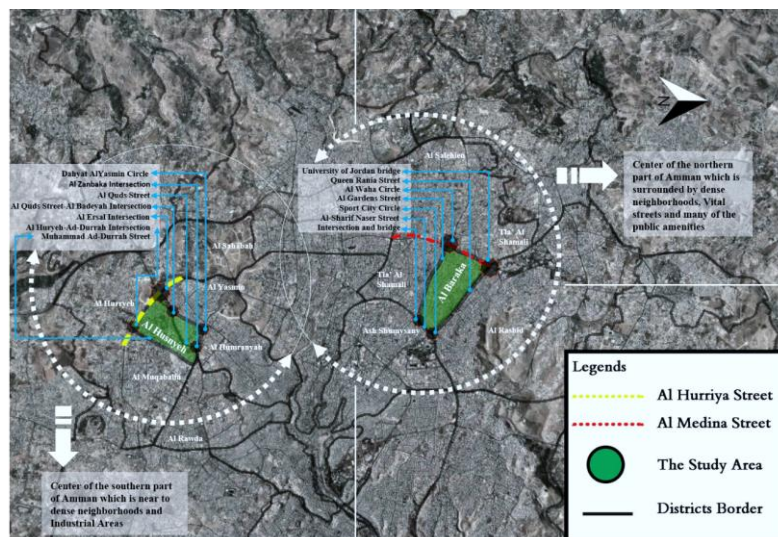
The second site is the Al Hasaniya neighborhood which is located in Al Muqabalin Area in the middle of the Sothern part of Amman; the neighborhood also has many features and is classified as a traditional neighborhood; it gains a central location between high densely populated neighborhoods as Al Humranyah, Al Yasmin and Al Rawada neighborhoods at the north, Al Sahabah neighborhood at the west, Al Hurryeh neighborhood at the Southern part and Al Muqabalin neighborhood at the eastern part. Several major arterials also surround Al Hasaniya neighborhood; some contain a massive traffic flow, most of them are considered main streets used by the inhabitant of the southern part of Amman for daily life transportation and even for non-inhabitant people travelling from outside the surrounding neighborhoods to reach these areas due to jobs purposes.

The criteria for selecting the site were determined by finding a comparison between two areas, according to location, area, demographic, planning characteristics, variation of land use, streets configuration and level of development.

Many commonalities exist between the two sites: centrality location between densely populated districts, direct exposure to the major arterial, and multiple junctions with streets that have shaped both neighborhoods. At the same time, differences are discovered, the most important of which is the difference in development pattern as the traditional neighborhood in Al Hasaniya and more developed and organized as Al Baraka neighborhood, with one located in the middle of the northern part of Amman and the other in the southern part.

Two to four neighborhoods are adequate for investigating the relationship between various patterns of urban functions and between space syntax measures, this number of neighborhoods is consistent with the earlier published studies found (Kim & Sohn, 2002; Lamquiza & López-Domnguezb, 2015; Lerman & Omer, 2016).

The planning conditions of the two sites are similar in regard to being surrounded by main arterials, located between highly densely populated districts, having direct exposure to commercial land use on the edges and being fully stuffed with residential land use in the centers. But the first neighborhood seems to be fully covered with buildings due to its location which is near the city center and preferable for the resident and the second is witnessing the same scenario nowadays thus it will be fully covered with buildings and potentially stuffed in future.



2.2 Spatial variables

Space syntax refers to a collection of ideas and methodologies for analyzing spatial configuration. This technique enables us to describe the spatial characteristics of a sustainable city and innovate in exploring spatial relationships to achieve the realization and explanation of the socio-spatial organization of the built environment, (Hiller, 1996). Hillier's contribution allowed an understanding of the built environment through the operational method to describe the spatial relationship between the built objects in a new and accurate concept regarding the relationship between space and society, (Yamu, 2021).

The relationship between two locations is a simpler idea than spatial layout. Its topology enables it to represent spaces, thus, numerous analytical methodologies may be developed as a result of this presenting style Hillier, Hanson, and Graham (1987: p. 363). The axial lines and axial segments technique was used to investigate the spatial configuration of the street networks in the selected case studies.

Despite the fact that the theory's initial focus was on pedestrian movement patterns, its application has been widely extended to many fields related to planning and urban design, such as the modeling of urban traffic and the evaluation of the potential of land-use distribution and retail development, (Ratti, 2004).

The space syntax hypothesis is based on the concept that spatial linkages between places (such as city streets) are important variables in shaping people's behavior in these areas (Hillier, 1996b). This covers actions including strolling, driving, socializing, and distributing retail activities. Later, the application of space syntax theory was broadened to cover not just conduct but also preferences and perception (Alalouch & Aspinall, 2007; Alalouch, Aspinall, & Smith, 2009).

The space syntax approaches quantify the spatial structure of urban environments and have been demonstrated to have a great explanatory capacity for a variety of urban activities, including land-use distribution.

The axial map of each area was constructed numerically and visually using DepthMapX and sDNA software to calculate space syntax characteristics in this study (Cooper, 2020; Turner, 2004; Varoudis, 2013). This study took into account the following variables:

- 1 Betweenness analysis. Assumes that the network is inhabited by entities ready to move from anywhere in the network to any other place. For the best simulation of human movement, whether on foot or by vehicle, these entities prefer to take the shortest possible path. This path is called geodesic, (Cooper, 2021).
- 2 Axial Global Integration. is known as the integration values of axial lines at an infinite radius that may be utilized to show an integration pattern at the greatest scale (Hillier, 1996, 2007).

3 Control. A local measure that assesses how many choices a location provides to its neighbors as a possible initial step in a journey (Alalouch, 2009).

4 Axial Choice. It counts the number of times an axial line is on the shortest topological pathways (turnings) between any two axial lines, (Hillier,1987).

5 Normalized Least Angle Choice (NACH). A normalized form of the Choice attribute that enables for comparisons of spatial configurations of varying sizes. It denotes whether an urban area is grid-like or organic in structure (Hillier, Yang, & Turner, 2012).

2.3 Land Use variables

For the investigation, four variables were chosen: residential, commercial, industrial and institutional. The data was obtained from the official authorities as Greater Amman Municipality, and the data was formulated and re-sorted in each neighborhood to fit with the common major legends of the land uses.

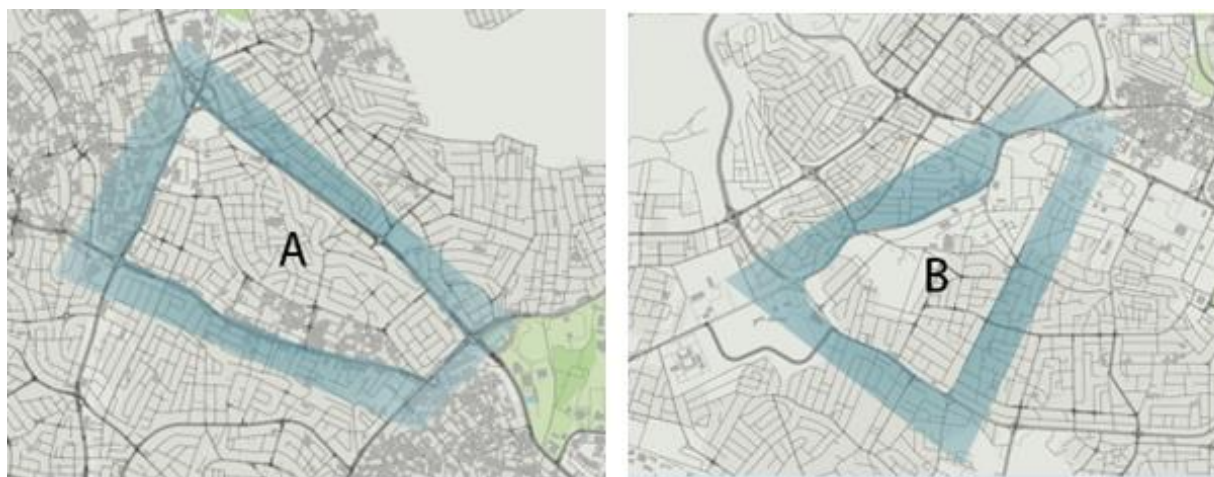
2.4 Data Collection

Neighborhood	Type	Commercial	Residential	Institutional	Green Spaces	Industrial	Others	Streets	Total Land Use	Total Area
A	Area	304519.4305	180862.0869	86776.8	15101.073	0	308.12	48307.988	221318.6123	2696.266
	Count	245	1744	15	2	0	4			
B	Area	152960.84	521448.74	100567.3982	8149.91	753422.29	363.5206	52303.523	190006.977	2423.105
	Count	152	544	3	5	443	258			

Greater Amman Municipality provided the plans for the designated areas. These plans were revised through site visits and comparisons to Google Earth Map and OpenStreetMap. This method was employed in prior studies on space syntax (Gil, 2015).

Table 1

The Land Use, Area and the number of plots



2.5 Land-use Mapping

The data was obtained from the official authorities as Greater Amman Municipality (GAM) and the data was formulated and re-sorted in each neighborhood to fit with the common major pattern of the land uses in order to produce land use maps for both neighborhoods.

2.6 Semi-Structured Interviews

The importance of interviews here to support and confirm the quantitative results derived from the primary data (Space Syntax) and secondary (Land use distribution). The interviews also come to test all the critical variables discussed in the literature review that simulation technology cannot test, (Creswell, 2012).

Semi-Structured Interviews will be selected to ensure that all questions that represent all the variables identified in the literature review are answered and ensure that the real responses about this phenomenon are recorded by the participants (Creswell, 2012).

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The questionnaire will be divided into several parts to ensure that the idea is communicated to the participant at the beginning, through introductory questions, and then move to research questions, which look at the reasons for this phenomenon, and then questions to collect feedback about the most affecting parties to reduce this phenomenon, and then questions to assess the challenges and explore the most difficult part for citizens to participate in reducing these phenomena, and moving to questions of strategies to overcome this phenomenon. Finally, questions to make recommendations by the participants to solve this phenomenon.

The interviews will also include closed-ended questions to support all variables in the literature review and to reduce the time for the participants due to a large number of variables to be investigated, (Creswell, 2012).

Interviews will be conducted with three sources to ensure diversity in the answers as well as to gain an integrated perspective on this phenomenon. The first source is the local community, for their daily tangible experience of this phenomenon, stakeholders. Finally, the Planning Authorities to know their viewpoint and their treatment of this phenomenon.

Key informants in both neighborhoods that were interviewed were selected using snowball sampling. For grounded theories, (statistics solution, 2015) suggested that the sample size for interviews can vary from 10-50. Based on the time and resource limitations for this research, 18 respondents were selected. Organizations in charge of planning and road infrastructures in GAM were selected using purposive sampling, but snowball sampling was used to find relevant respondents from stakeholders and from the local community groups. The interviews will also include closed-ended questions to support all variables in the literature review and to reduce the time for the participants due to a large number of variables to be investigated, (Creswell, 2012).

2.7 Hybrid Analysis

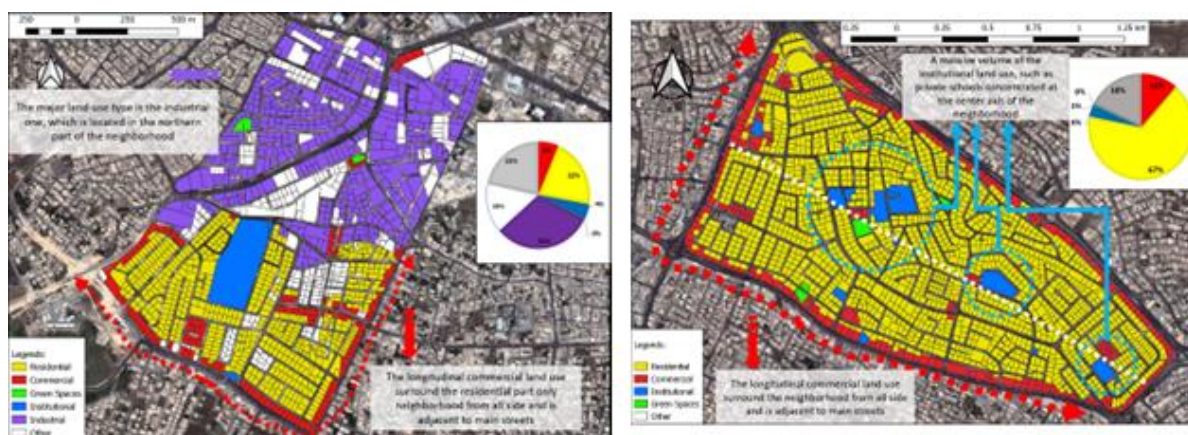
The analysis was conducted by creating an objective framework represented in a multi-dimensional model. This model is summarized in projecting all the analyzed data in the form of descriptive and graphic layers to prove the overlaps within these layers. These overlaps are the factors affecting or causing the phenomenon of traffic congestion within the boundaries of the study area. The following figure shows the methodology of this analysis.

3. Results

3.1 Land-use distribution

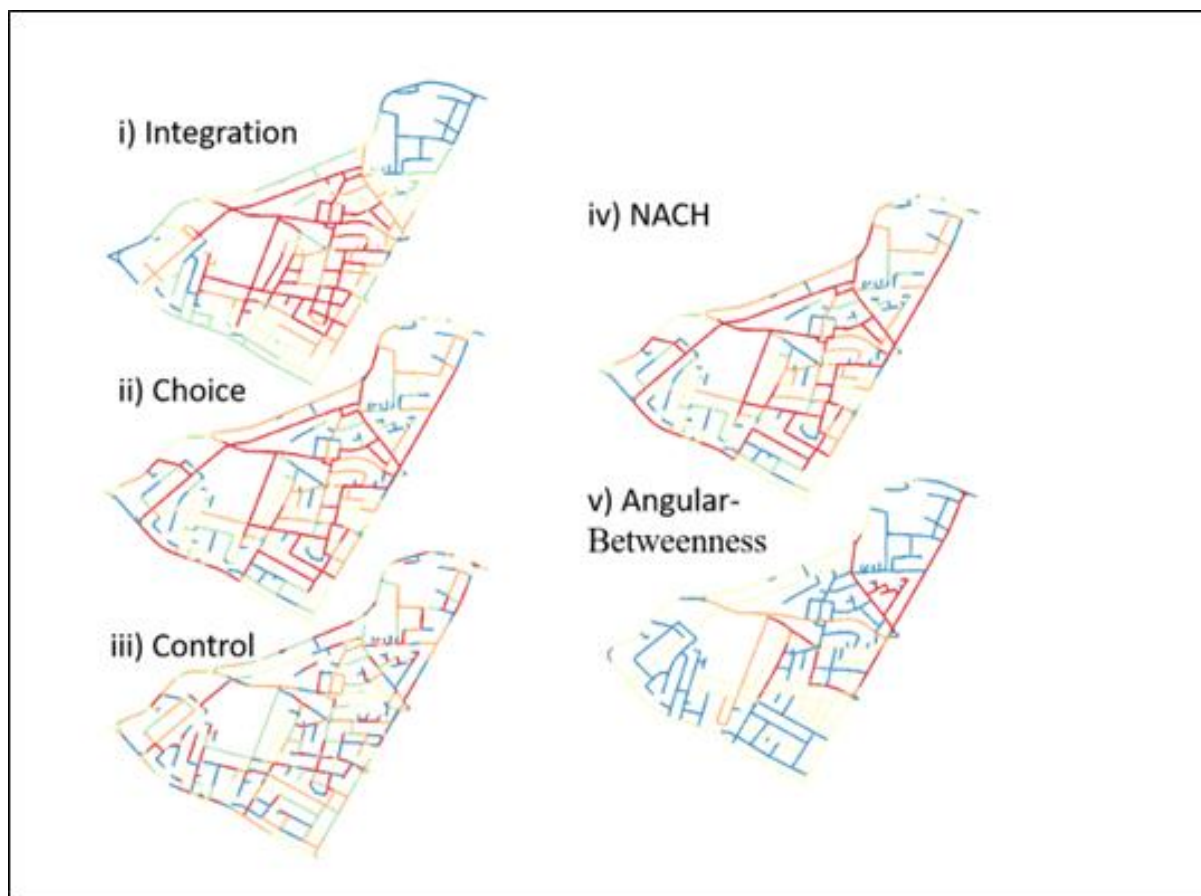
Fig. 5 shows the land-use distribution for neighborhood (A) and (B). An initial analysis of these maps provided a brief and preliminary understanding of how street configurations influenced the distribution of land use and the dominant land use in the area, as well as how different types of land use interact with one another.

In Al Baraka Neighborhood the most common land use is the residential one which is mostly located everywhere within the neighborhood except the borders which are adjacent to the main arterials that are surrounded, the total area of the residential land use is almost 1.8 square kilometers which are approximately 67 percent of the total area, the street area ranked the second from the total land uses with area 0.48 87 square kilometers which are approximately 18 percent of the total area, the commercial land use came at the third with almost 0.3 square kilometers which are approximately 11 percent of the total area, and the thing that is noticeable is most of the commercial land use mainly concentrate in this neighborhood at the borders adjacent to the surrounded main arterials and took the longitudinal shape and have a wide variety of several specific commercial land uses such as Offices, mixed, Trade fairs shops...etc., the institutional is contains several specific land uses as Schools, Hospitals, public parking and Hospitals with almost 0.86 square kilometers which are approximately 3 percent of the total area, the concentration of the institutional land use located in the center of the neighborhood which is mostly almost privet schools, finally the Green Spaces ranked the lowest with almost 0.15 area which is approximately 1 percent of the total area, see [figure \(5\)](#).



In Al Hasaniya neighborhood the situation is different the most dominant land use here is the industrial one which is the same with most surrounding, the industrial land use located in the northern part of the neighborhood with area 0.76 square kilometers which are approximately 31 percent of the total area and got separated by Al Quds Street and Khaled Ahmad Streets, the residential land use ranked the second according to the area with almost 0.52 square kilometers which are approximately 22 percent of the total area at located in the southern part of the neighborhood, the streets came in the third position with almost 0.52 area which is approximately 22 percent of the total area, the justification of this high percent is the penetration of arterials into the neighborhood such as Al Quds Street and Khaled Ahmad Streets, the commercial land use mostly located in the southern part and surrounded the residential area and got penetrated it from the eastern part, with almost 0.153 square kilometers which is approximately 11 percent of the total area, the institutional land use located in the center of the neighborhood and it contains school and the collage which are approximately 4 percent, the other types almost 0.36 square kilometers which are approximately 15 percent which could contains unregulated land uses and other specific types of the land use but mostly the when comparing to the satellite images it seems to be empty spaces, see [figure \(5\)](#).

3.2 Axial line analysis



As previously stated, axial line maps were created for each neighborhood using DepthMapX and sDNA. Figures 6 and 7 show the differences in urban street configuration between Neighborhoods A and B.

The axial maps for the spatial attributes considered in this study are drawn in these figures. The axial examination for both neighborhoods maps shows the highest integration values located in the centers of the neighborhoods but the integration values in neighborhood A are much denser than the values in neighborhood B.

The illustrated figures of the Control show that neighborhood A has the highest and most dense values distributed throughout the whole neighborhood unlike neighborhood B, the NACH values shown in the figures represent that neighborhood B tends to be in its nature formal grided structure with higher values in the centers and borders represented by the long streets, unlike neighborhood A. When comparing these results with the distribution of the land-use, it is obvious that the Industrial and institutional land-use are located in highly integrated streets.

The examination of the Angular-Betweenness maps shows that the highest values and most favored paths for both vehicles and pedestrians, which are the most straight and highly penetrating paths on the main arteries, and they are the same paths that surround the commercial and institutional land use in neighborhood A. These values are much higher than and more exposed to the main arteries in the neighborhood B.

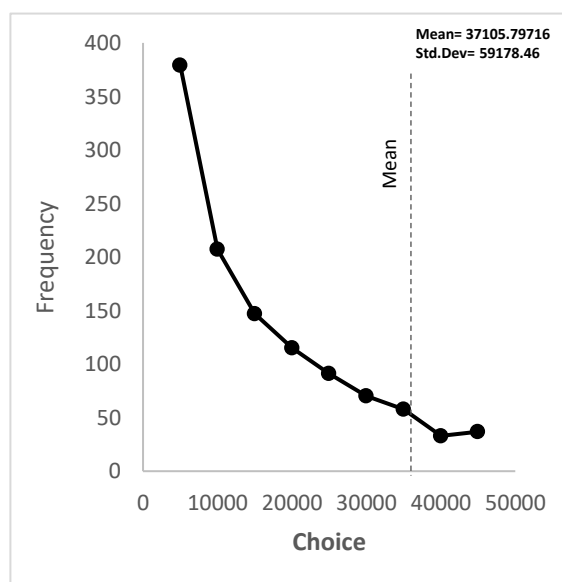
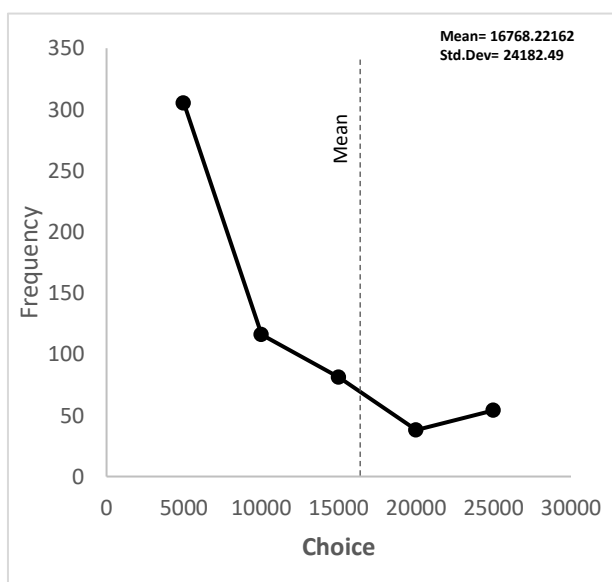
To continue investigating the differences in the spatial structures of the two neighborhoods as a whole, the averaged values have been made for all streets in each neighborhood. Neighborhood A has a higher Integration value and Control value than Neighborhood B, as shown in Table 2. This finding indicates that Neighborhood A is more accessible and offers more visual control than Neighborhood B. The difference in Control value, however, is not significant (Neighborhood A = 0.997, Neighborhood B = 995).

		Integration	Control	Choice	NACH	A-B
Neighborhood A	Mean	0.321	0.997	37105.797	0.033	23.838
	Max	0.449	2.083	493404.000	0.453	430.333
	Min	-1.000	-1.000	-1.000	-1.000	0.333
	Std. deviation	0.069	0.220	59178.457	0.066	60.583
Neighborhood B	Mean	0.303	0.995	16768.222	0.067	2.720
	Max	1.000	2.417	150834.000	2.000	27.333
	Min	-1.000	-1.000	-1.000	-1.000	0.333
	Std. deviation	0.103	0.357	24182.495	0.144	4.542

Neighborhood B has a higher NACH attribute than Neighborhood B, indicating that Neighborhood B has a more formal grid structure than Neighborhood A. In fact, this pattern is obvious and can be seen in the neighborhood plans shown in Fig. 2.

The standard deviation in both neighborhoods of the choice attribute is unexpectedly high. The sample is heavily skewed toward the lower values, according to the variable's histogram, as shown in Fig.2. As a result, the selected variable was left out of the subsequent analysis.

The Angular-Betweenness attribute for Neighborhood A is higher than that for Neighborhood B, which indicates that Neighborhood A have more favored paths for both vehicles and pedestrians with more straight and highly penetrating paths on the main arteries, Ad shown in Table.2.



3.3 Interviews Analysis

The interview questions were formulated to include all the variables that were mentioned in the literature review, as well as to include three main parties: the planning authorities, the local community in both neighborhoods, and the stakeholders who have an effecting role in reducing this phenomenon. Table (3) shows the questioner that was followed in the interviews, this questionnaire is a brief part of the overall matrix and has been abbreviated to suit this research.

Two interviews were conducted with division leaders, the first in the Traffic Management Division and the second in the Land Use Division in Greater Amman Municipality (GAM). All the questions mentioned in Table (3) were asked to M.H, who is the head of the Traffic

Regulation Department and for M.A, the head of the land use department in the Greater Amman Municipality.

Section	Inquiry Type	Variables	Digression	Q #	Question
Section 2-3-4-5-6 Research Questions" Causes of Congestion"	The interrelation of Traffic Congestion within Urban Settings- Pattern of Development	Land uses	It collects feedback about the contribution for each variable in traffic congestion	1	Do you think that the shops (restaurants...etc.) and companies (for employees) in ()Neighborhood and the () Street contribute to the increase in traffic congestion?
				2	Do you think the presence of government institutions contributes to increasing traffic congestion in ()Neighborhood and the () Street or in the surrounding area?
		Density of Vehicles in the Neighborhood		3	Do you think the Traditional neighborhoods in Amman are less crowded by vehicles than ()Neighborhood and the () Street?
				4	What do you think is the most penetrated street by vehicles coming from outside the neighborhood?
		Penetration Degree		5	Do you think that one of the main causes of traffic congestion in ()Neighborhood and the () Street is due to the influx of cars from outside the area?
				6	Do you think that the ()Neighborhood and the () Street represent a transit area for cars between the different areas of Amman?
		Location & Household Needs		7	Do you think that the ()Neighborhood and the () Street represent a transit area for cars between the different areas of Amman?
				8	The ()Neighborhood and the () Street is an attractive spots for residents due to its central nature and its proximity to various services and needs?
		School		9	Do you think that the vehicles (school buses or private vehicles) used to transport students contribute to increasing traffic congestion in ()Neighborhood and the () Street?
				10	In your opinion, the traffic congestion because of schools in the neighborhood is due to school buses, or because of parents who take their children to school in their own cars?

The second group of interviews have been conducted with the stockholders who have an influential role in creating or reducing traffic congestion from the non-governmental sector, such as the owners of commercial establishments, taxi drivers, restaurant owners and the traffic police, with a sample size of 6 interviews for each neighborhood. The third interview was conducted with the local community in both neighborhoods, with a sample size of 9 interviews for each neighborhood.

3.3.1 Land Use

This variable is unique and maybe the most important among all variables, and due to its sensitivity, it has only been discussed with specialists within the planning authorities' group, see Table (3), questions No. 1 and 2. M.H stressed that one of the most variables that increase traffic congestion is the land use, which is a variable difficult to control due to the private ownership of lands and what was previously regulated is outside the control of the Greater Amman Municipality and what makes the situation worse is the presence of commercial land use, especially restaurants, as it is considered one of the most influential factors in increasing traffic congestion on AlMadinah Al-Munawwarah Street at all times. In contrast to Al-Hurriya Street, which constitutes the trade fairs in the largest proportion. While M.A stated the contribution of commercial land use, especially the restaurants, increase the phenomenon of traffic congestion because it creates a lot of double-parking spots, and this, in turn, reduces the capacity of the street. In contrast to Al-Hurriya Street, in which the trade fairs constitute the largest proportion of the total land uses.

3.3.2 the Development Level of the Neighborhood

This variable study compares the developmental levels of neighborhoods within the study areas and those of the traditional ones. This clarifies the developmental impact of the two study areas on traffic congestion and shows the difference between the two study areas. These interviews were conducted only with specialists in the Greater Amman Municipality, see Table (3) Question No. 2 M.H stated that the residential neighborhoods that are on the outskirts of the city are closer in their developmental status to the traditional ones and are usually less densely populated because job opportunities and services are in the heart of the city and there is less traffic congestion, unlike the neighborhoods in the heart of the city such as Al-Baraka neighborhood and Al-Madinah Al-Munawwarah Street. While M.A. explained that the economic situation of the residents of the traditional neighborhoods is not necessarily less, and the residents of these areas chose to live in them for several reasons, including that it is less traffic congestion, as in the Al-Hasaniya neighborhood, unlike the Al-Baraka neighborhood.

3.3.3 Penetration Degree

The degree of penetration is one of the essential variables in this thesis due to its direct impact on residential neighborhoods and their future sustainability. The interviews in this part was conducted with all groups, see Table (3).

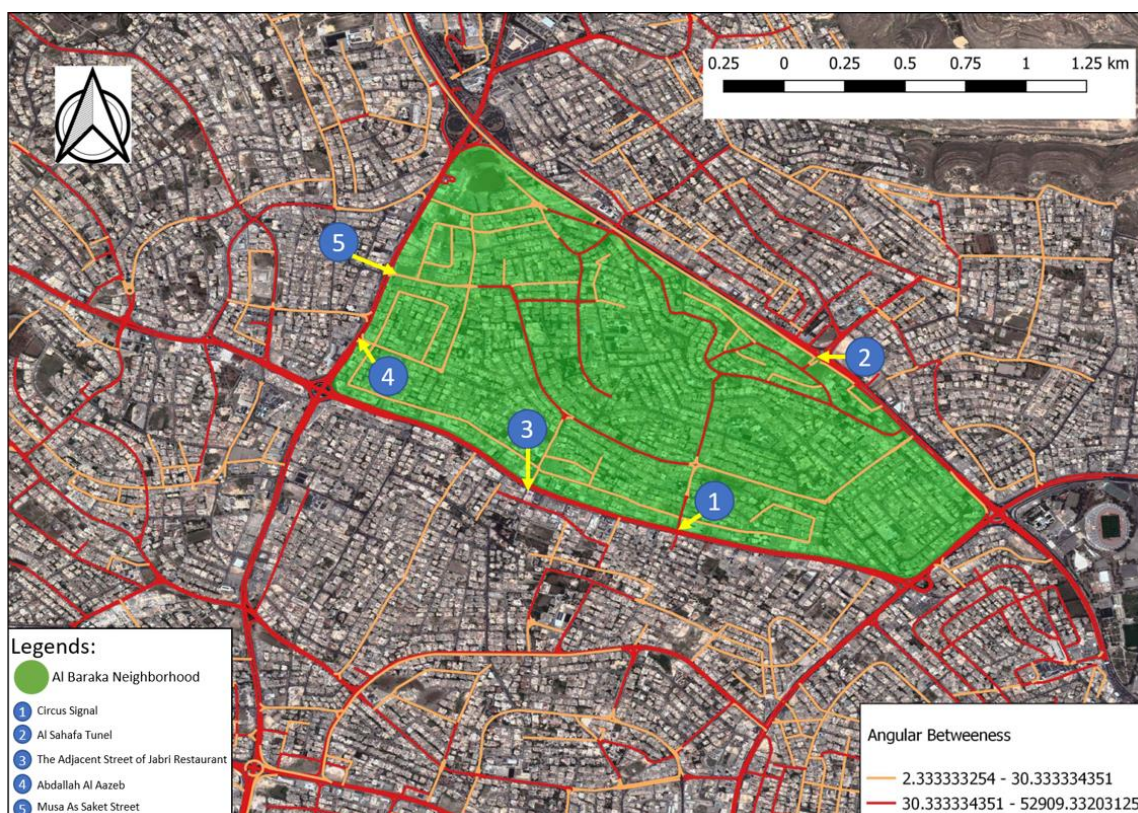
M.H stressed that one of the biggest causes of traffic congestion in Al-Baraka neighborhood and Al-Madina Al-Munawwarah Street is due to vehicles crossing from different areas of Amman and from different directions, and this, in turn, increases the possibility of penetrating the neighboring neighborhoods to avoid this traffic congestion as point No. 1, see figure (8), in Al-Baraka neighborhood known as a Circus Signal, and vice versa in Al-Hasaniya neighborhood and Al-Hurriya Street, as these percentages are much lower because they do not represent a transit point for vehicles from different areas. M.A has a different opinion he sees that one of the biggest causes of traffic congestion in Al-Baraka neighborhood and Al-Madinah Al-Munawwarah Street is due to the double parking of cars caused by the commercial land use, and he also stated that the second cause of congestion in this the neighborhood is the high penetration of vehicles to and from the neighboring neighborhoods, as in point No. 1 also, see Figure (8).

The stakeholder's group common answers came to show that the most penetrating arterials in Al-Baraka neighborhood and the street that feeds Al-Madinah Al-Munawwarah Street with the largest number of vehicles. All the answers were limited to four points: Al Sahafa Tunel, Circus Signal Street, Musa as Saket Street, and The Adjacent Street of Jabri Restaurant. The most frequent answer and what the interviewees focus on is Circus Signal Street, Point No. 1, see Figure (8). for the most intersections that feed the neighborhood street with vehicles, most of the answers focus on two main points, the first is Al-Haramayn Interchange, and the other is Abdallah Al Aazeb Street, i.e. point No. 4), and the justification of this point by two of the owners of commercial establishments is that the residents of Al-Baraka neighborhood prefer to get out of it to take advantage of the direction that passes by the largest possible number of restaurants and shops on this path to meet their needs in one trip.

The local community group answers came to support the previous results, the most penetrating streets in Al-Baraka neighborhood in question No. 3, the majority of the responses were divided into three main streets: Al Sahafa Tunel, Circus Signal Street and The Adjacent Street of Jabri Restaurant, which are points No. 2, 1 and 3, see Figure (8).

Question Number 3	Count	Percentages
Al Sahafa Tunel	3	33%
Circus Signal Street	2	22%
Do not Know	1	11%
Musa As Saket Street	1	11%
The Adjacent Street of Jabri Restaurant	2	22%
Grand Total	9	100%

The interviews of the stakeholder and local community groups were excluded in the second area due to the absence of any effects on the relationship between traffic congestion and street penetration in this area, as stated in most of the interviewees' answers.



3.3.4 The Location and Household Need

The location and the family's needs are two interrelated variables, so the reason for choosing the location came to meet the needs of the family, and here came the importance of studying these variables. The interviews were initially conducted with the planning authorities due to their awareness of this issue, see Table (3), questions No. 7 and 8. M.H stated that the middle areas in the city, as in Al-Baraka neighborhood, are considered one of the most attractive points for residents due to their proximity to all service areas such as transportation and the daily needs of the family, as well as schools and workplaces. M.A's responses were identical to the previous one, explaining that the central location offers many services, and this is what most families are looking for, as in Al-Baraka neighborhood, unlike Al-Hasaniya neighborhood.

As for the stakeholders, they confirm this theory, and one of them stated, “To achieve a good profit, the most appropriate site must be chosen, which is the most overcrowded site”. From the local community point of view, everyone considers that those who live in the central neighborhoods within the city enjoy many privileges, such as proximity to various services, as in the Al-Baraka neighborhood.

3.3.5 The Schools

This variable is considered important, and its effect is noticed in the city of Amman when schools

Question Number 5	Count	Percentages
Do Not Know	2	22%
School Buses	5	56%
Students Parents Cars	2	22%
Grand Total	9	100%

open their doors, and traffic congestion increases dramatically because of this variable. See Table (1) Questions No. 15 and 16 for the Planning Authorities Group and Question No. 5 for the Local Community and Stakeholders Groups.

M.H confirmed that a large percentage of parents contribute to increasing the traffic congestion because they prefer to take their children to school with their vehicles in the morning and bring them back in the evening, and Al-Baraka neighborhood is one of the neighborhoods in which there are many private schools, unlike Al-Hasaniya neighborhood, which contains only one public school.

M.A did not deny that the large percentage of parents contribute to increasing the traffic congestion because they prefer to take their children to school with their vehicles in the morning and bring them back in the evening. He described this phenomenon as a kind of "fake prestige", he further stated that this phenomenon is obvious in the central neighborhoods of the city for several reasons, including the fact that working parents take their children to school on their way to work, and this is observed in Al-Baraka neighborhood, unlike neighborhoods on the outskirts of the city.

The group of stakeholders in the first region confirm this phenomenon, especially the traffic policeman, who said that this effect becomes more complicated with the beginning of the semester, while shop owners in Al-Madina Al-Munawwarah Street and Al-Baraka neighborhood see that many parents take advantage of the opportunity after taking their children from schools to shopping. At the same time, this effect is negligible according to each stakeholder group in the second area.

For the local community group, the majority of the answers emphasize that the students' parents' cars are exacerbating traffic congestion in Al-Baraka neighborhood.

Question Number 5	Count	Percentages
Do Not Know	2	22%
School Buses	1	11%
Students Parents Cars	6	67%
Grand Total	9	100%

The largest proportion of the total interviews in the second area confirm that schools in this area are not considered a major cause of traffic congestion, and the explanation for these

answers from their point of view is that many residents of this area send their children to government schools, as government school students go on foot.

4. Conclusion

This paper investigates the relationship between land-use distribution and traffic congestion through space syntax technique in Amman, Jordan within different developed neighborhoods. As case studies, two Amman neighborhoods were chosen. The spatial attributes of the areas were calculated using Space Syntax, and land-use maps were created to suit the main categories that influence traffic congestion.

Four land-use variables (residential, commercial, institutional, and industrial) were correlated with five spatial attributes in this study (Integration, Control, Choice, Normalized Least Angle Choice [NACH] and Angular-Betweenness). These spatial attributes are linked to aspects of the built environment that are relevant to this study in the literature.

The results show that the control values in neighborhood A are higher than neighborhood B. In other words, it has the ability to attract movements and activities more than neighborhood B. These results are consistent with land use, as it appears that neighborhood A has a higher density of residential buildings than neighborhood B. It is also completely surrounded by commercial land use and owns many institutional-land use in the middle distributed entirely along the longitudinal axis of this neighborhood.

This draws a large number of automobiles on a regular basis in order to satisfy the demands of individuals from beyond the region. It also creates a flow of automobiles from the neighborhood to Al Madinah AlMunawwarah Street to satisfy the requirements of the residents due to the lack of a central place inside the neighborhood that aggregates all of the residents' demands as confirmed through interview part.

The Angular-Betweenness results reveal that neighborhood A has higher rates of human and vehicle movement than neighborhood B, in addition to that these paths are connected to a wider range with the overall network, where this connection is represented at higher rates with the surrounding main streets to form more penetrating paths to the neighborhood.

The results of the interviews support these findings and confirm that Neighborhood A is directly penetrated by five intersections: Al Sahafa Tunnel, Circus Signal Street, Musa as Saket Street, and The Adjacent Street of Jabri Restaurant to avoid traffic congestion that occurs on the main streets as alternative routes. This explains one of the most important reasons for traffic congestion in this neighborhood.

The difference between Control values within the two neighborhoods is not significant. Still, it tends to be higher in neighborhood A which is produced a higher rate of choices for residents of this space as a possible first step in a journey. These results are consistent with the land use, as neighborhood A is characterized by a higher density of residential buildings in the center than neighborhood B, which means more trips and movements towards the needs of individuals and families towards the outskirts, and this is supported by the interviews findings that were conducted with different groups.

Normalized Least Angle Choice (NACH) results confirm the neighborhoods B have higher values than neighborhood A which means it has a formal grid structure, this structure form larger (Coarse-Grained), while the situation in neighborhood A totally different the structure form of this grid is smaller (Fine-Grained), therefore require more streets to serve the residents of the area, which increases the percentage of commercial land use and makes it more vulnerable to the flow of vehicles.

This pattern of street network supported by the interview part, the findings of the interview imply the neighborhood B tend to be more traditional unlike neighborhood A which is tends to be overcrowded by buildings as result of urban sprawl development, which produce higher vehicle flow thus more traffic congestion.

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