RESEARCH PAPER

ASSESSING THE INTERSECTED RELATIONSHIP BETWEEN LAND USE AND TRANSPORTATION PLANNING

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ABSTRACT. This research analyses the causes of traffic congestion in urban corridors. It specifically studies the intersected relationship between land-use and transportation planning by examining Al-Madina Al Monawara street in Amman, the capital of Jordan, as a case study. Techniques implemented in data collection are personal observations, traffic counts, land use maps and questionnaires. The methods applied in analysing the collected traffic counts are: Level of Service (LOS), Automatic Traffic Counters (ATC) and Trip Attraction Analysis (TAA). The outcome of the research verified the relationship between the high level of traffic, where the traffic exceeds the actual capacity of the street by 43%, and the unregulated land use planning where 85% of the existing buildings along the street are commercial. The findings of this research will help to establish an assessment tool for testing the impacts of transportation and land use in congested developing cities. This study is important since transportation solutions receive little attention by planner's development agendas in Jordan and the neighbouring countries.

KEYWORDS: Urban corridors; Traffic congestion; Land-use planning; Transportation planning; Travel behavior; Jordan

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INTRODUCTION

Land use planning, among other factors such as economic and population growth, plays a vital role in controlling and mitigating traffic congestion in developing cities (Cervero 2013; Kandt 2018; Kesuma et al. 2019). Mixed land use area with dense commercial activities attract higher traffic volumes. Therefore, the integration of land use and transportation planning is crucial to account for traffic congestion solutions (Lucas & Porter 2016). In return, transportation has indirect impact on the spatial distribution of urban activities (Gakenheimer 1999; 2011). Ideally, one should provide a transport system that suits or matches the land use pattern in developing countries as they suffer from traffic congestion. Consequential traffic congestion affects our environment, health, and controls the decisions we make as to where we live, work, and shop (Kesuma et al. 2019; Bharadwaj et al. 2017). Transportation infrastructure consumes 10-25% of urban land. These spaces require available land and consume energy in both construction and maintenance.

In most developing cities, like Amman, mobility is dominated by personal motorization where people prefer to travel by cars. The high dependency on private transportation forms the main challenge facing urban transportation and mobility in Amman. The number of vehicles in Amman (Only those owned by the habitants of Amman, or do they include those coming to Amman every working day from other Jordanian cities is expected to reach 1,170,000 in 2025 out of 1,800,000 in the whole country. It is estimated that 112,000 vehicles enter Amman every day from different parts of the country, where 80% of these are privately owned vehicles. The daily trips in Amman reach seven million, where 70% are private cars and the rest are public transportation. (Smadi 2015).

The high dependency on private transportation primarily resulted from the lack of convenient alternative forms of transport; the horizontal expansion of the city; the lack of integrated transport and planning; psychological and behavioural factors related to the need of the newly rich people to show off and not to walk even 100 m to take the available public transport; and finally public authorities lack of control over transport operators. In general, the urban and transportation bodies in Jordan suffer from shortage in transportation expertise and lack in appropriate valuable data (Cavoli 2017; Shatanawi et al. 2018). Cavoli (2017) stated that Amman does not have a comprehensive urban plan. The Urban Plan of 2009 and Transport Master Plan of 2010 are limited in scope, lack evidence and do not comprise a consultation process. Furthermore, the transport and land use plans are not coordinated. In general, there is a lack of coordination between land use and transportation planning in Jordan.

According to the World Bank Report (2017), Jordan is a lower-middle-income country. Amman, the capital of Jordan is home to almost 42% of Jordan's population.

With the rapid urbanization, Amman's population is expected to increase from 4.4 million residents in 2019 to 6.4 million in 2025 (45% increase) (GAM 2020). From the time of its foundation, Amman growth and expansion are haphazard and uncontrolled due to the continuous political instability in the region which resulted of waves of immigrants and refugees who settled down in the city (Al Tal 2006). Amman's urban form is growing increasingly fragmented. Urban development solutions push towards developing periphery networks on the outskirts of the city. For example the area of Amman jumped over from 5 km^2 in the early 1920s to 680 km^2 in 2006 and then to 1680 km^2 nowadays. It increased 335 times in about one hundred years (GAM 2020). In recent years, congestion has grown to problematic levels in Amman through recent demographic and cultural changes. The distressing increase in population growth and urbanization in Amman results in an increase demand for mobility and affects the land use distribution. The governing institutes approach in planning and transport solutions in Jordan is a reactive approach rather than diagnostic and preventive. All these factors turn Amman into a congested city which increased the cost of productive time, wastage fuel, deteriorating quality of life of its inhabitants and affected the environmental quality. Unfortunately, the arterial streets that connect Amman with the new urban expansion are facing higher traffic densities and received less attention on planning level (Tawil et al. 2014). As a result, commuters in Amman are experiencing long and frustrating commutes to their daily businesses (Fig. 1). Congestion has become a major problem that now threatens numerous aspects of life in Amman.

Study area

Roads are categorized based on their service characteristics. The main considerations in this categorization are accessibility and mobility. The relationship between these two criteria is inversely related, which means the increasing of accessibility reduces mobility and vice versa (Mehdian et al. 2022). Al Madina Al Munawwara street is classified as a collector road due to the high developments around the residential areas and high commercial development along, around, and in the street. It can also be classified as a linear intensified corridor. Corridors are defined by the Urban Hamilton Official Plan (2011) as areas of street-oriented uses which incorporate a mix of retail, employment, and residential properties, developed at overall greater densities, located along arterial roads serving as major transit routes. Corridors link nodes and important areas of activity within Amman and are intended to be key locations for residential intensification. Corridors may form the boundaries of residential subdivisions or neighborhoods, but they should also act

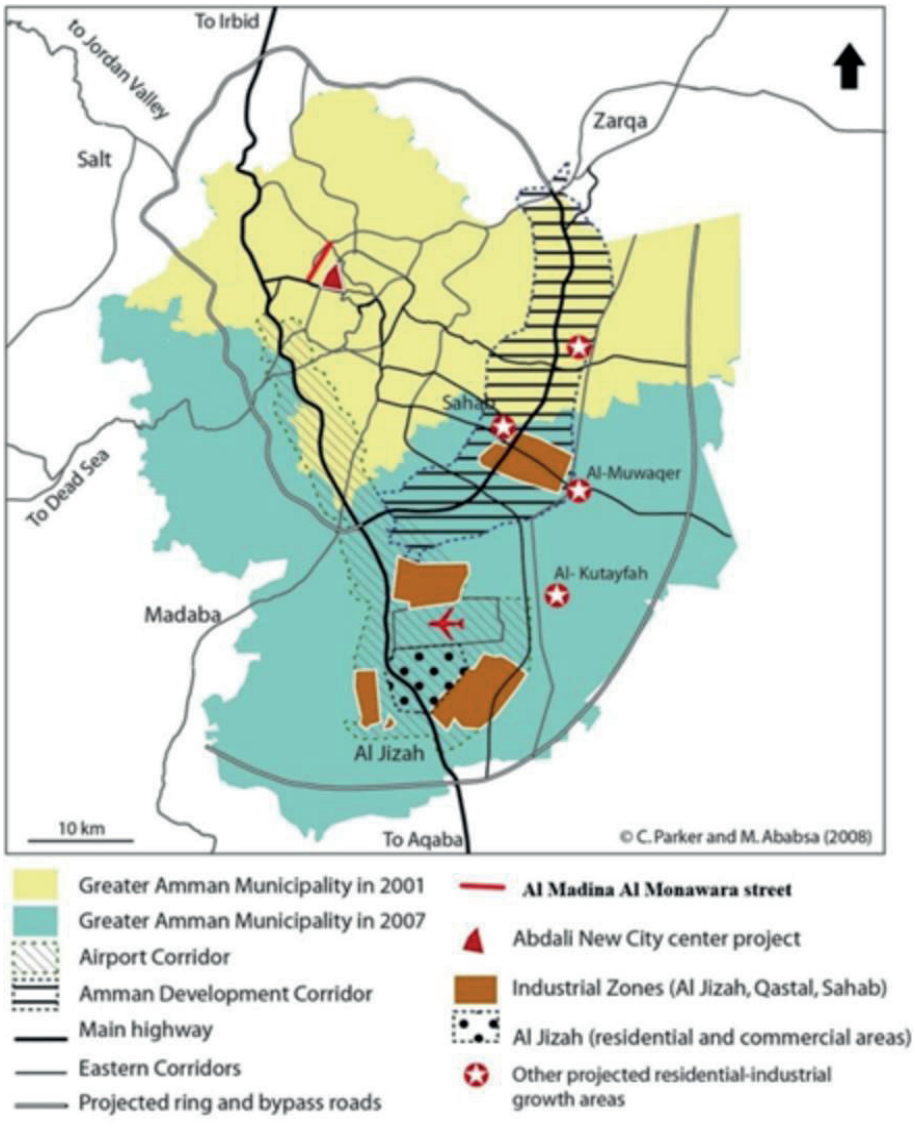

Fig. 1. The arterial streets that connect Amman with the new urban expansion

Source: Ababsa (2013), illustrated by authors (2022)

as a linear focus for activities and alternative uses within the community. They are planned to support development and investment that contribute to the economic and social vitality of a corridor and adjacent neighborhoods.

Al Madina Al Monawara street connects Amman with other governorates, and connect some of the most populous parts of the city. There is high concentration of commercial activities, especially restaurants, that attract large number of people in this street as it serves as a public space, commercial zone and the busiest urban corridor in the city. Urban corridors are defined by the Urban Hamilton Official Plan (2011) as areas of street-oriented uses which incorporate a mix of retail, employment, and residential properties, developed at overall greater densities, located along arterial roads serving as major transit routes. Urban Corridor Planning is focused on changing the City's land development regulations and infrastructure standards to accommodate a broad range of mobility options walking, bicycling, public transit, and driving in order to improve access to jobs, services, entertainment and recreation, now and in the future.

Corridors link nodes and important areas of activity within Amman. They are intended to be key locations for residential intensification. Amman's urban corridors provide a significant opportunity for creating vibrant pedestrian and transit-oriented places through investment in hard and soft infrastructure, residential intensification, infill, and redevelopment.

It is a main access leading to the University of Jordan (Fig. 2). The University of Jordan is the largest university in Jordan which host 49,000 students and 1,500 academic staff. In addition, the street leads to the university hospital that encompasses 64 major, sub-medical and clinical specialties (The University of Jordan 2020). In addition, the street acts as a transition zone between high traffic streets and adjusting neighborhoods. Figure 2 (right) shows that there are over 30 intersected streets on both sides of Al Madina Al Monawara street. The large number of the penetrated streets resulted from the "fine grained urban fabric" of the surrounding neighborhoods. These activities increased both the traffic flow of vehicles, and the load on the street which required more demand for traffic solutions (Al Habashnah 2013; Jawarneh 2021).

The street is divided into three sections defined by four major intersections: section 1 stretches from the Suhaib tunnel to the Al-Haramayn interchange that connects to Mecca street. Another collector street facing traffic problems is in section 2 which stretches from Al-Haramayn interchange to Waha circle, and section 3 stretches from Waha circle to the University Hospital interchange. This study focuses on traffic congestion in section 3, with 1258 meter in length and 30 meter in width (Fig. 2).

The mixture of complementary land uses in section 3 of the street and surrounded area includes housing, retail, offices, commercial services and large number of restaurants and coffee shops. Section 3 mainly attracts people who are looking for places to eat, teenagers to meet, and social interaction, specifically during afternoon and evening hours, to the limit it has been nicknamed "the street of hungers." Less evident but equally powerful is that the street forms a social hub for some of the most important social places such as the bus stop and the shops' steps where the social value has existed due to the existing social encounter, cultural exchange and building values (Fig. 3).

Commercial corridors act as an informal public space, but these corridors are also occupied by more vehicles and left with less space for pedestrian activities (Kamal & Waleed 2019). In this research we refer to the informal public space as a formal space which used for different purpose by people who do not own the space. Commercial corridors can accommodate different modes of transport while creating a safe public space for all commuters and users of the streets. Carmona et. al (2012), identified two

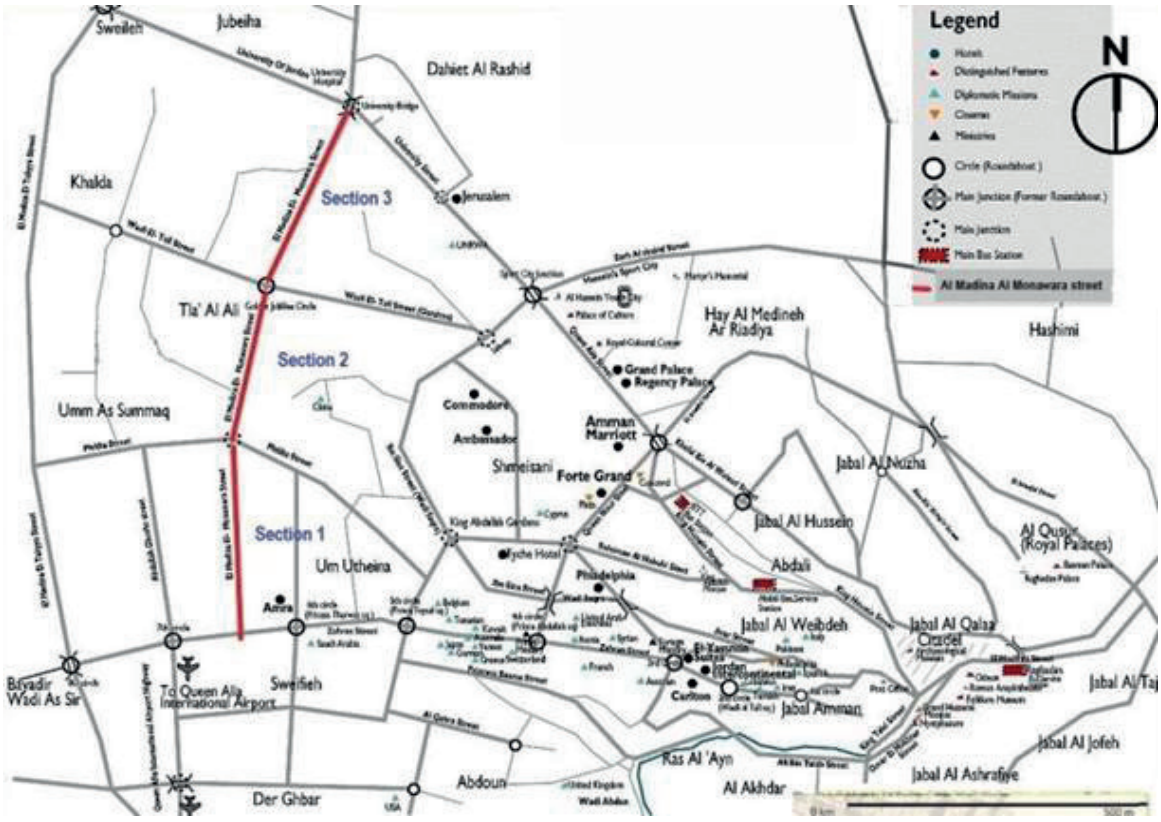

Fig. 2. Al Madina Al Monawara street

Source: Orange Smile illustrated by authors, (2022)

forms of containment of public spaces; the static space, represented by a wide area that suggests calmness and stability. The static space is a place designed to host social gathering and emphasizes the relations between the users. It can be seen in the shape of public, main squares, and residential areas; and the dynamic space which is defined as a space that takes the linear form where it has inspired through the movement like roads, streets or extended spaces such as seaside roads. While the static spaces are formal in layout and use, the dynamic spaces are generally informal spaces. Informal spaces are known in the fields of architecture, planning, design and urban theory as "dead zones" (Doron 2000), "spaces of uncertainty" and "the margin" (Cupers & Miessen 2002). Formal public spaces in Amman such as recreational parks and plazas are minor, while public activities are apparent more strongly within informal or unassigned spaces like streets, sidewalks, stairs, market places, and roundabouts. This research discusses the dynamic form of informal public spaces and its overlap with traffic congestion as Al Madina Al Monawara street acts as informal public space.

METHODOLOGY AND ANALYSIS

This research is based on a mixed method as includes qualitative and quantitative analysis. The qualitative analysis includes personal observations about the site and its traffic conditions; while quantitative analysis includes a study of the socio-economic profile of the area of age, sex, and composition of family, employment statistics, income, vehicle ownership and more. The qualitative analysis covers the land use and traffic survey in terms of type and intensity to conclude? trip attraction analysis. Since travel characteristics are closely related to the land use pattern; inventory of land use is crucial. Techniques implemented for collecting data are personal observations, traffic counts, and land use maps collection from the GAM and questionnaires. The method applied for analyzing collected details for traffic counts are: level of service (LOS) and trip attraction analysis.

The method of traffic counts data was collected through automatic traffic counters (ATC). ATC equipment is a pneumatic tubing that runs across the width of a road. They were temporarily installed to collect traffic speed data (85th percentile)?, vehicle classification and volume of traffic. Traffic data was collected at every intersection feeding Al Madina Al Monawara street. Traffic counts were carried out at 3-time interval; morning (0:00 am–10:00 am), after noon (10:00 pm–17:00 pm) and night (17:00 pm–23:00 pm) on Mondays, Tuesdays and Wednesdays as traffic in the rest of the weekdays is considered to be abnormal traffic movement and not recurrent travel.

Land Use Analysis

The problem of congestion can be reduced by comprehensive planning that considers the different aspects of spatial planning. If land use planning is regulated and accounts for the future number of trips attracted in reference to population growth, road classification and design, it could help to better control future volumes of traffic. The major variables that interplay in the land use pattern are land use intensity and density. Therefore, traffic congestion depends on the kind of land use on any street and its density. According to Kodukula (2018) the more compacted and mixed the land uses are, the less traffic congestion. In the mixed land use zones, commercial activities are placed on the edge boundaries of the residential areas forming commercial ring. Buildings are mostly placed close to the streets to create a vibrant pedestrian environment, provide a storefront character to the street, support future transit service, and encourage walking. Unfortunately, congestion arises in commercial corridors due to increasing number of vehicles on the road when there are the most number of people on these corridors, and the mixed land use zones lack solved planning schemes.

"Exploring the Interrelation between Traffic Congestion and Land uses in Amman: Challenges and Potential" is a recent master thesis by Hamza Jawarneh (2021) which focused on the land use pattern on two neighborhoods: Al-Baraka neighborhood, an adjacent neighborhood to Al-Madina Al Monawara street; and Al-Hasaniyah neighborhood next to Al-Hurriya Street. The findings of thesis revealed that the commercial land use, population density, location in relation to the city, and the inefficient public transportation system are the main causes of traffic congestion in the selected neighborhoods and in Al-Madina Al Monawara street (Fig. 3).

Al-Madina Al Monawara street is located in a very dense restrict with high mixed-use activities and residential types. The urban fabric of the adjacent neighborhoods is a "fine grained urban fabric", consisting of several small blocks close together and defined by street and blocks. The blocks consist of two rows of residential buildings in small land lots units. This layout creates an urban fabric that gradually changed by the time from residential to mixed-use retail facilities and then to a dense urban core that lacks amble public spaces.It causes a flow of vehicles from the neighborhood to Al-Madina Al Monawara street to meet the inhabitants' needs due to the lack of a central area inside the neighborhood that gathers all the needs of the residents. In addition, the longitudinal commercial lands that surround the entire neighborhood, especially restaurants, attract many vehicles from outside the district. To understand the setting of Al Madina street, the Kevin Lynch (1960) urban analysis was used to identify the paths, edges, districts, nodes, and landmarks in and around the case study. Al Madina street is connected with other major streets such as Mecca, Wasfi Al Tal, Zahran, and Queen Rania streets. It includes major nodes in Amman such as Al Kilo and Al Waha circles, and the University Hospital Bridge. The most important landmarks around the site are: King Hussein Cancer Hospital and the University of Jordan; finally the street forms an urban edge between the residential neighborhoods in Khalda district. The land use patterns on the edge of Al-Madina Al Monawara vary in area and usage. The commercial activities, for example, occupy 0.244 km^2 and form 50% of the neighborhood area. The backland uses of the edge buffer zone are residential that occupies 0.277 km^2 and form 46% of the area. Finally, 4% of the neighborhood area are mixed - use facilities (Fig. 3).

Mixed use commercial businesses (office building above a commercial base) form 85% of the existing buildings in the street, and are concentrated along 300-meter length as indicated by the black rectangle in Figure 3. They include a variety of the daily supplies, restaurants, and offices. The remaining 15% are pharmaceuticals, electronic stores, retail, hotels, health care and educational facilities. Restaurants form the higher percentages of these businesses. These local businesses attract recurrent and non-recurrent shoppers, travelers, restaurant customers, employees, health facilities employees and patients, and educational facilities employees and students (Fig. 3). Architecturally, the concentration, variation and the high marketing competitiveness among the commercial and business

activities in the street resulted in visual pollution created by the lack of one architectural language and strict building regulations (Shaban et al. 2018). The architectural design analysis of the building facades in the street by Shaban (2018) revealed that there are undefined architectural statements of the facades where each building owner seeks attention in the mixed use urban context.

The results of the field study and traffic counts show that the intense traffic activities in the study area resulted from the restaurants customers and daily suppliers of supermarkets, bakeries, and toasters, since most of the restaurants are concentrated in the middle section of the street (Fig. 3&4).

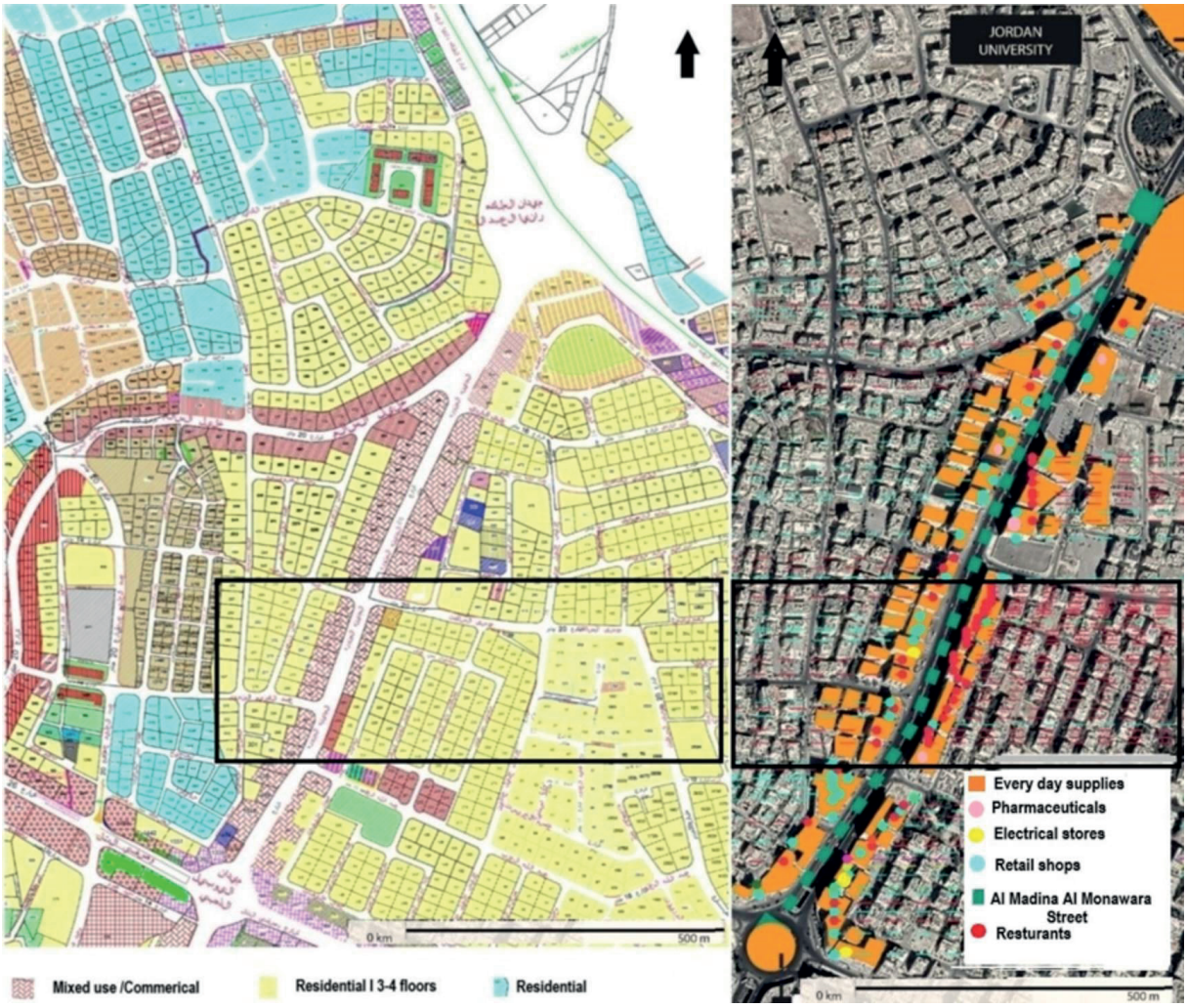

Fig. 3. Left: land use map , Greater Amman Municipality (2021); right: mapping commercial use activities in section 3 Al Madina street

Source: Authors

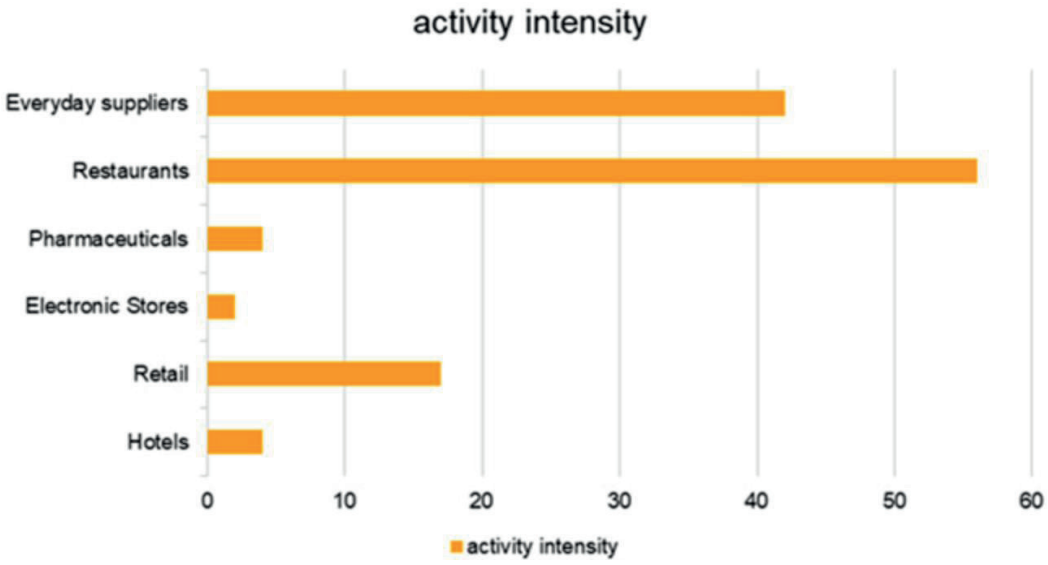

Fig. 4. Activity intensity

Source: Authors

Table 1 shows that traffic counts moving along Al Madina Al Monawara to Waha circle exceed the capacity of the street between 8:00-21:00 and reaches its highest capacity at 19:00 P.M, where the traffic counts exceed the actual capacity of the street by 43%.

General characteristics and field observations in Al Madina Al Monawara street are summarized as follow:

- Common double parking in the busy intersections causes delay, increased volume, and increased reaction time leading to congestion and a higher risk of traffic accidents.
- Only one frontage road on the east lane is available and always congested by food delivery drivers, shoppers running into a stores and restaurants to pick something up quick. It is not wide enough for a car to drive down or park
- Car parking spots are not enough to accommodate the high foot traffic in the street.
- The GAM installed pedestrian fencing and barriers in the middle island of street for redirecting pedestrians away from the dangerous traffic zones, and to save their life .
- Violations have been observed that show some people jumping over the pedestrian fencing.
- It lacks to vehicle-parking because parking facilities need large amount of land and lands are very expensive. There is no bus stop nor bicycle tracks.

Traffic Counts and Analysis

Data includes vehicles count at every entry point and exit of the site, counted at three-time intervals: morning (0:00 am– 10:00 am); afternoon (10:00 am– 17:00 pm); night (17:00 pm– 24:00 pm). Data was collected to analyze the traffic congestion at the street; it was gathered on a Monday, Tuesday and Wednesday as the rest of the weekdays are considered as an abnormal traffic and not recurrent travels. By doing this, the researchers understood the traffic flow behavior in and out the street based on time of day and its relationship to land use. Morning weekday peak hours are (8:00 am– 10:00 am) as the result of commuters from the residential areas around the streets and others from outside of Amman (Fig. 5).

The collected traffic data revealed high consistency in traffic movement on Mondays, Tuesdays, and Wednesdays: the highest traffic rate occurring in the morning;

Table 1. Traffic counts compared to Level of Service LoS/actual Capacity of street

Start Hour	Three-day Average	% of capacity of street compared to three-day average from 0:00 hour to 23:00
0:00	1,365	53.60
1:00	875	34.38
2:00	540	21.21
3:00	357	14.02
4:00	250	9.82
5:00	255	10.01
6:00	686	26.94
7:00	2,104	82.65
8:00	3,035	119.21
9:00	3,046	119.63
10:00	3,149	123.69
11:00	3,220	126.46
12:00	3,312	130.10
13:00	3,411	133.98
14:00	3,521	138.31
15:00	3,543	139.14
16:00	3,505	137.68
17:00	3,580	140.60
18:00	3,543	139.16
19:00	**3,650**	**143.36**
20:00	3,413	134.05
21:00	2,998	117.75
22:00	2,464	96.76
23:00	1,965	77.17

Source: Authors

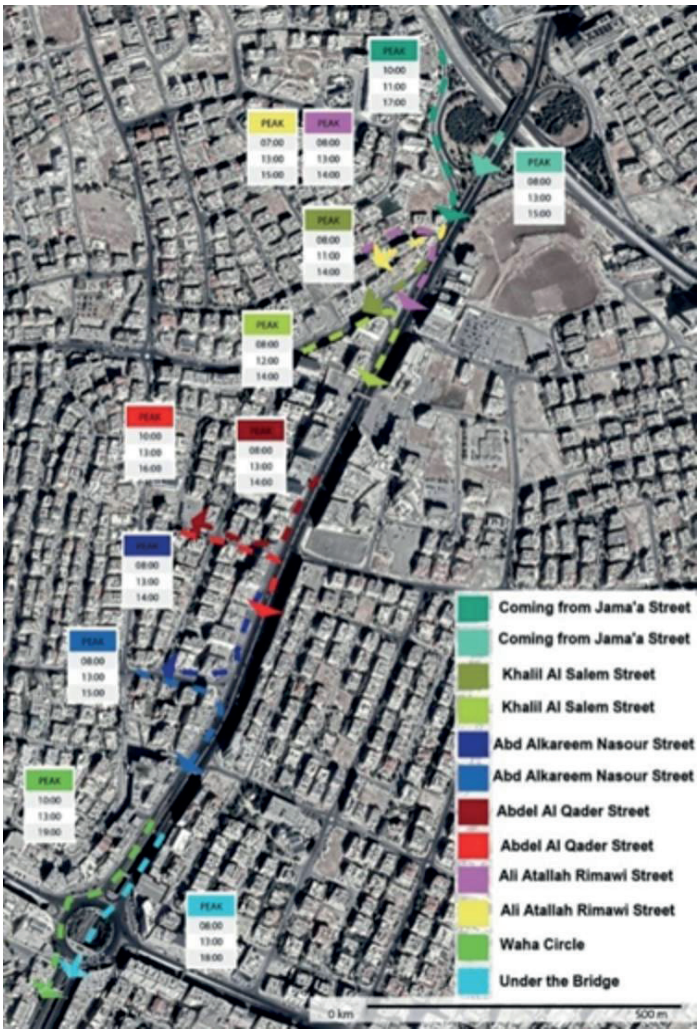

Fig. 5. Peak hours traffic analysis

Source: Authors

commuters of northern areas of the kingdom are using Al Madina Al Monwara street as a connector to the west Amman business concentrations. The same amount of traffic is happening at pm peak hours due to students and staff commuters traveling from Jordan University back to their homes as well as workers in the hospitals at the northern end of the street. Peak hour data is based on Average Weekday Traffic Volumes. It is noted that traffic peaks at the night hours (17:00 pm– 23:00 pm) at a rate of 53%, while morning (0:00 am– 10:00 am) rate is 27%, and after noon (10:00 am– 17:00 pm) rate is 20%. To understand the impact of the land use and the existing landmarks and nodes in the street, the traffic count gives a clear understanding about the size of the traffic passes in the street.

Determination of Capacity & LOS

This section describes the LOS and derives the same for an arterial section of studied street. The road is an arterial road of length 1.24km that links the Waha circle to the University Hospital interchange. Accordingly, the LOS of the project artery is in the direction from the University Hospital interchange towards the Waha circle. The guideline requires the input of an extensive data which are not all readily available for the case; therefore, reasonable assumptions have been made in the absence of the exact available data. While the manual provides for analysis of the LOS for different types of road users in the urban setting, this section only captures the motorized mode of LOS analysis. Road characteristics and Traffic count data are considered as follows:

- The road is observed as a one-way divided road.
- The number of lanes for through traffic is taken as 2.
- Each lane width is considered 3.6m (12ft) with shoulders width of a minimum of 30cm (1ft).
- The speed limit along the section is taken as 80km/h (50mph).
- The section is an arterial street connecting two interchanges with less than 3.2km (2miles) interval.
- The segment length is approximately 1.24km ≈ 0.77 miles
- The proportion of multi-unit truck, PT is assumed 2% of the total traffic volume.
- The proportion of single-unit trucks, PR is assumed 4% of the total traffic volume.

The traffic count data was obtained from the GAM, Department of Traffic Operations. The department has erected automatic traffic count systems at strategic points. The data comprises the hourly average data for the three days, and traffic count data for 12, 16, and 24-hour. Accordingly, the AADT is taken as 57,787 vehicles/day. The K-factor defines the proportion of 24-hour vehicle traffic that is expected during the design hour. Table 2 shows the typical K-factors as defined in HCM 2010.

Considering the recorded peak hour as the design hour, the proportion of traffic in this hour in relation to the AADT is:
Peak Hour Volume = 3,650 vehicles
AADT = 57,787 vehicles;
K-factor = 3650/57787 = 0.063

Table 2. Typical K-factors HCM

Area Type	K-Factor
Urbanized	0.091
Urban	0.093
Transitioning/Urban	0.093
Rural Developed	0.095
Rural Undeveloped	0.100

Source: Florida Department of Transportation (2010)

The D-factor defines the differences that are expected in traffic volume direction at different times such as the demand for entering and leaving the city at different hours of the day. The adopted value for the project road is 0.65.

The Peak Hour Factor (PHF) defines the relationship between the 15-min peak traffic volume and the hourly peak volume. Since only the hourly volume counts are available, PHF is estimated as 0.92 as per the provisions of HCM 2010.

Other parameters are assumed as follow:

•The Density of Accesses (DA) is estimated at 34 per mile.

The following generalized daily service table for an urban street:

•Arrival type is 4.

•Traffic signal cycle time, C = 120 seconds.

•The analysis time, T is estimated to be 0.25hrs.

•Initial Queue delay, D3, for each vehicle is estimated at D D3 = 0 seconds.

•Weighted average Green-to-cycle-length (g/C) = 0.67.

•Saturation flow, So = 1900 passenger cars/hr/lane.

The LOS is determined from the criterion set out by (HCM 2010) (Table 3).

For a travel speed of 70% the base flow speed and a capacity higher than the traffic volume, the LOS of the artery is found to be Class B. The LOS at Al Madina Al Monawara street from the University interchange to Waha circle is 2546 vehicles/hr. The traffic counts calculated as an average from hour 0:00-23:00; it is observed that from hour 7:00 to hour 22:00, the traffic counts are exceeding the capacity of the street traffic counts compared to LOS/ actual capacity of street reaching its highest maximum at hour 13:00, where the traffic exceeds the actual capacity of the street by 90%.

The LOS is determined from the criterion set by the HCM 2010. For a travel speed of 70% of the base flow speed and a capacity higher than the traffic volume, the LOS of the artery is found to be Class B. The LOS at Al Madina Al Monawara street from the University interchange to Waha circle is 2546 vehicles/hr in comparison to the traffic counts calculated as an average from hour 0:00-23:00; it is observed that from hour 7:00 to hour 22:00, the traffic counts are exceeding the capacity of the street, reaching its highest maximum at hour 13:00, where the traffic exceeds the actual capacity of the street by 90%.

Questionnaire and Survey

The questionnaire was carried on both sides of Al Madina Al Monawara street. The 200 questionnaires were distributed on Monday, Tuesday and Wednesday between 11:00 and 20:00. Shop and restaurants opening hours (10:00 am- 22:00 pm) were considered.

They were distributed equally among males and females. This is due to Amman's population equal gender distribution. The age groups 18-24, 25-44, 35-44, and 45-54 appeared to be the largest number of users at the study. The study groups were categorized into students, employees, business owners, retired individuals, and unemployed individuals. The study investigated one person per household as a statistic measure to correlate it to the owned number of vehicles per household.

The results of the questionnaire revealed that vehicle use and dependency referred to comfort and security. While 70% of commuters used their private cars for comfort, 30% used them for security. The study found that most attracted car users are one or two passengers per vehicle. This result indicates that the low vehicle occupancy is one of the major causes in increasing traffic load. Most users suffered from excess traffic mostly in the morning period where travel times exceeded 15 minutes, likely caused by common traffic commutes.

Table 3. LOS Criterion for Urban Roads

	Travel Speed as a Percentage of Base Free-Flow Speed (%)	LOS by Critical Volume –to-Capacity Ratio	
		≤	>
Exhibit 16-4 LOS : Automobile Mode	>85	A	F
	>67-85	B	F
	>50-67	C	F
	>40-50	D	F
	>30-40	E	F
	≤30	F	F

Source: HCM (2010)

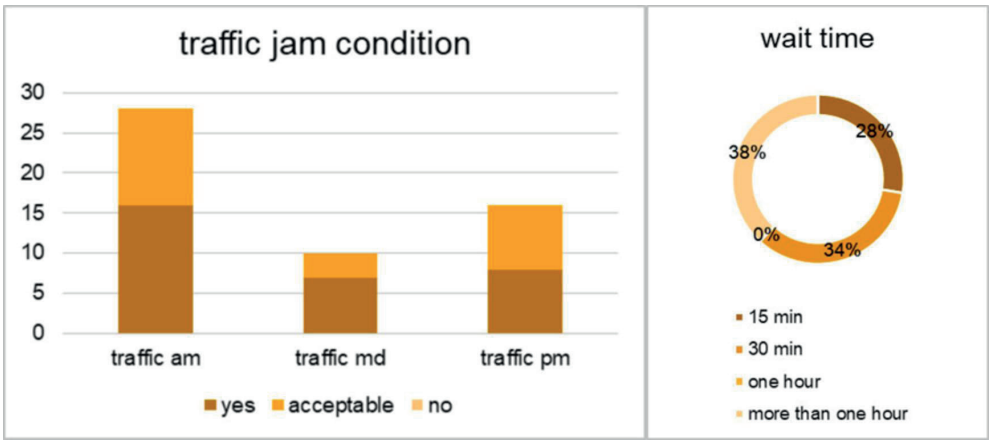

Fig. 6. Traffic jam condition and Wait time

Source: Authors

Table 4. Consequences of traffic congestion according to the surveyed population

Increased traffic and delay	Accidents	Frustration
52.43%	15.53%	32.04%

Source: Authors

Table 5. Mitigation strategies according to surveyed population

Increasing street capacity	Implementing street diversions	Encouraging food delivery	Regulating land use	Expanding parking areas	Decreasing traffic police interventions
10.17%	1.69%	3.39%	0.85%	44.07%	39.83%

Source: Authors

As reported by the surveyed population, the main causes of traffic congestion are unregulated development, unavailable parking areas, sudden stops due to accidents, and unreliable driver behavior. Based on the results of the questionnaire, 38% of users are spending more than an hour, and 62% are spending 15-30 minutes to cross the study area (Fig. 6). The majority of respondents stated that there is a lack of parking spaces. As a result, 79% of commuters continued to drive around to find a parking place, while 21% of commuters drove around more than once to find a parking place. A large number of those interviewed, 97.78%, declared that they will continue on driving around until they find a parking place, while 2.22% of commuters will go around the area until they find parking.Table.4 shows that the consequences of traffic congestion according to the surveyed population are increased delay time, accidents, and frustration.

Table 5. concludes solutions offered by the surveyed population that can help mitigate traffic congestion in Al Madina Al Monawara. Among these solutions are implementing street diversions, encouraging food delivery, regulating land use, expanding parking areas, and decreasing traffic police interventions. The survey revealed that expanding parking areas is one of the highest priority.

CONCLUSIONS AND RECOMMENDATIONS

The study revealed that the traffic counts in Al Madina Al Monwara street exceeds its capacity in relation to the Level of Service (LOS), where the traffic exceeds the actual capacity of the street by 43%. The traffic flow behavior in and out the street based on time of day and its relationship to the commercial activities established along the street. Another major factor is the location of Al Madina Al Monwara street and its relationship to the mixed use urban context. The neighboring residential areas and the educational and health facilities established around the street are the main reasons for the high traffic congestion. An important finding of this study is that Al Madina Al Monawara was developed over time into a densely commercial corridor (85% of the existing buildings along the street are commercials).

In transportation broader scope, the study advises improving the transport options, taking economic measures, introducing smart growth and land use policies, and other programs in the highly dense urban corridors. The transport options can be improved by: Public transit improvement; walking and cycling improvements; ride share/commute trip reduction programs; HOV priority lanes; Flextime/telecommuting; taxi service improvement; improving the condition of roads, infrastructure and sanitation; pedestrian awareness and provision of bridges and pedestrian paths; organizing construction permits for buildings and services.

The study recommended to apply measures in commercial corridors that include redistribution of carriageway space to provide cycle lanes, broader sidewalks, planting strips, bus lanes, redistribution of time cycles at traffic lights in favor of public transport and non-motorized modes, public awareness concepts, citizen's participation and marketing, and as well enforcement and penalizing. It is advised to integrate works of experts from all fields that fall under the spatial planning. As well, the preparation of feasibility and assessment reports that include technical, financial, spatial, and environmental aspects assessments in the mixed use commercial urban corridors.

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