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Assessing the Factors Associated with Urban Mobility Behaviour: Case studies from Alexandrian Neighborhoods, Egypt

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Abstract: ***With the rapid spread of urbanization, cities started to witness challenges related to its streets. It is becoming imperative that the mobility should be managed appropriately to minimize its negative impacts on urban areas. Unfortunately, city leaders in many developing countries like Egypt are following the same Car-Oriented development patterns made by cities in developed countries. Ironically, the developed countries are trying to recover from a car dominated development era by re-allocating road space for public and non-motorized transport. In this respect, this research aims at exploring the key aspects and factors that affect individuals' mobility choices in Egypt. It focuses on the socio-demographic, attitudinal and physical factors that are associated with commuters' mobility behaviour and their choice of mode for daily trips. Two neighborhoods in Alexandria are selected for comparative and analytical analyses . First, a survey is carried out in the two selected areas. Second, Pearson's Chi-square χ2 test is performed to explore the significant differences of commuter's attitudinal, personal and built environment factors between the two areas. Finally, cross-tabulation distribution of categorical variables are presented in terms of absolute frequencies, p-values from Pearson's Chi-square χ2 test and t-test so as to look for the association of the urban form and non-urban form factors to mobility choices.***

Keywords: Sustainable Urban Mobility (SUM) – Travel Behaviour - Mode choice –Non-urban form factors – Built environment factors – TOD development – Sustainable neighborhoods.

I. INTRODUCTION

Rising car ownership, income growth and the declining real cost of using cars have been identified as the key factors that have shaped personal travel patterns around the world **(Paulley, Balcombe et al. 2006)**. Consequently, urban mobility has been ever more dependent on the private car and, in many cases, by the existence of inefficient and costly public transport systems, with obvious negative impacts at the environmental, social and economic levels for the society as all. The externalities of transport are more severe if every individual prefers taking private car to public transport, because the cause of mobility problem will increase.

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The need to change individual choice from private car user to public transport user is urgently needed. One of the efforts to support the change is by improving the public transport quality, And identifying the factors affecting individual to choose mode of transport **(Ortu´zar & Willumsen 1999, Dewi.A. 2010)**. Understanding mode choice is important since it affects how efficiently we can travel, how much urban space is devoted to transportation functions as well as the range of alternatives available to the commuters. Furthermore, these factors are the basic knowledge which helps determine any effort to change travel behaviour and encourage the commuters to use the friendly and public transport modes.

Cities nowadays are also facing rapid population growth as an effect of urbanization. The urbanization process impacts the spatial distribution of land uses and travel demand created by the distribution of activities. People's travel decisions are based on residential, job, and activity location. It is also a physical outcome of interactions between cultural backgrounds and physical needs of a particular society and the potential of mode availability. Cities have traditionally sought to solve such challenges by adding new capacity to match demand. This is not only an issue for developed countries but also for fast developing countries. On top of the growing demand, mobility needs are changing and evolving and travellers' expectations of seamless movement are becoming ever greater **(Aoun, 2014)**.

The challenge is in creating an enhancement of individual's mobility, while at the same time reducing the issues that urban areas in cities were confronted with, such as "poor air quality, high levels of traffic and congestion, high levels of ambient noise, poor quality of built environment, greenhouse gas emissions and urban sprawl. Additionally, there is a stringent need that the future urban expansion will be accompanied by a sustainability transition, putting cities in the spotlight when trying to reduce the impacts of today's and future societies. Accordingly, this requires a profound systemic understanding of the term Sustainable Urban Mobility (SUM). In this respect, this paper aims at understanding sustainable urban mobility within an urban context, its issues related to society and built environment; and focuses on the factors associated with commuters' mobility behaviour. This paper is structured as follows; **first**, it reviews the concepts of sustainable mobility, its dimensions and indicators.

It also explores and classifies the linkages between different factors and urban mobility behaviour. **Second,** it selects two neighbourhoods in Alexandria and describes the method used in the analysis, the collection of primary data and the empirical results. **Finally,** the paper concludes with a discussion the results and suggesting recommendations for future research.

II. LITERATURE REVIEW

2.1. Sustainable Urban Mobility Concept, Indicators and Its Dimensions:

As presented in many literature, the first definition of sustainable development was established by the World Commission on Environment and Development and defined as follows: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" **(Brundtland, G. Harlem, 1987).** In this respect, transport is considered as an important factor in the context of sustainable development due to the pressure it places on the environment, social and economic impacts, and its linkages with other sectors. The evolution of sustainable transportation and mobility concept has arisen in the context of sustainable development definition. In 2002 one of the first concepts of sustainable urban mobility applied by OECD (Organization for Economic Co-operation and Development) has been concisely defined as: "The ability to meet the needs of society to move freely, gain access, communicate, trade, and establish relationships without sacrificing other essential human or ecological values today or in the future in order to ensure safe, affordable, quick, comfortable, reliable and sustainable access to all residents". **(OECD, 2002)**

The indicators in (Table 1) are used to assess the sustainable mobility of an urban area or region or neighbourhood, and not the sustainability of the transportation system as a whole., the selection is focused on the travel reduction and modal shift objectives, because these indirectly impact on the hazards reduction objective, and are to some extent directly affected by urban form and land use **(Jorge Gil, 2016)**. The evaluation is obtained by assessing if the indicators' results move in the desired direction of sustainability or to the baseline values of the regional context.

Table 1: Selected Sustainable Mobility Indicators Related to Travel Reduction and Modal Shift, Adopted From (Jorge Gil, 2016)

Objectives	Criteria	Indicators	Sustainability direction
Modal shift	Non-motorized share	Neighborhood walking share Neighborhood cycling share City-cycling share	Increase
	Car share	Neighborhood car share City car share Regional car share	Decrease
	Public transport share	Neighborhood transit share City transit share Regional transit share	Increase
Travel reduction	Distance travelled	Overall total distance Non-motorized distance share Car distance share Public transport distance share	Decrease Increase Decrease Increase
	Travel duration	Overall total duration Non-motorized duration share Car duration share Public transport duration share	Decrease Increase Decrease Increase
	Travel frequency	Overall number of trips per day	Decrease

Building on Brundtland Report of 1987, the idea of sustainability in urban mobility has moved beyond a focus on ecology and the natural environment to also include social, economic and institutional dimensions. Accordingly, four dimensions of sustainability are considered in the review and analysis of urban mobility in many researches as follows **(UN-Habitat, 2013):**

- **Social dimensions:** Urban transport is socially sustainable when mobility benefits are equally and fairly distributed, with few if any inequalities in access to transport infrastructure and services based on income, social and physical differences (i.e. ethnicity, gender, disabilities or age).
- **Environmental dimensions:** The urban transport sector is also a major source of air and noise pollution, with serious public health impacts. As urban form gets more compact and dense, CO2 emissions from transport decline. Mode share is also an important factor; energy consumption levels decrease as the share of trips on public transport and non-motorized modes increases.
- **Economic dimensions:** The urban transport sector is economically sustainable when resources are efficiently used and distributed to maximize the benefits and minimize the external costs of mobility. The fiscal challenge cities face worldwide is paying for ongoing road maintenance and expansion while lower-income cities borrow funds in to build transport infrastructure.

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- **Institutional and governance dimensions:** Translating visions and plans for sustainable urban mobility depends on the presence of supportive and nurturing governance, as well as sound institutional and regulatory structures. The lack of adequate institutional capacity poses immense challenges in advancing sustainable urban transport.

2.2. Factors Associated with Mobility Behaviour and Mode Choice:

There is already a substantial body of academic literature on travel behaviour and its association to several factors **(Handy 2002)**. At the most general level observed, travel behaviour depends on three main factors: (i) Travel components, (ii) external factors and (iii) individual factors (outlined in table 2). **(Hanson, S. and M. Schwab, 1986 & Shaoli Wang and Carey Curtis, 2015)**.

Table 2: The External and Internal Factors of Influence on Individual Mobility Behavior Source: The Researchers, after (Shaoli Wang and Carey Curtis, 2015)

Travel components	External factors	Individual factors (Internal factors)
Trip characteristics	Policy ,economic and physical environment **(urban-form factors)** while individuals are travelling	Characteristics of the travelers (Socio-economic & Demographic factors) & (attitudinal factors) , it is also called: **(Non-urban form factors)**
1- Trip purpose (activity choice) 2- Travel mode choice 3- Travel time 4- Travel cost 5- Travel distance 6- Trip frequency	1- Built environment 2- Infrastructure 3- Transit service quality 4- Transport policy 5- Economic situation	1- Income 2- Car ownership (including number of cars in household) 3- Possession of driver's license 4- Employment status 5- Gender 6- Age group 7- Family structure (Household composition) Includes presence or absence of children, age of children, students, and number of adults in employment. 8- Level of education 9- Attitudes and life style 10- Personality type

1.2.1. Individual factors (Non-urban form factors):

There are a large number of socio-economic and demographic variables that need to be taken into consideration influencing travel behaviour. From the literature eight types of factors and their potential impacts can be summarized (see Table 3). According to many investigations, some factors have a significant relationship with travel variation; the other factors such as gender or level of education do not have clear relationship with trip frequency or travel. **(Shaoli Wang and Carey Curtis, 2015)**. In measuring the socio-economic and demographic variables of a traveller, one difficulty is that those factors are always interconnected and it is difficult to separate the effect of one from another. Among the travel behaviour studies, the most constantly used research method involves an analysis of travel is a household travel survey which can give the information of individual characters as well as travel patterns. **(Hanson, S. 1982, Domencich 1975, Shaoli Wang & Carey Curtis, 2015)**

Table 3: The Potential Impact of Socio-Economic and Demographic Factors on Travel Patterns Obtained From Previous Studies, Source: (Shaoli Wang and Carey Curtis, 2015)

Socio-economic and Demographic factors		Travel pattern
1	Household Income ↑	Trip Frequency ↑ Travel Distance ↑ Proportion of car journey ↑ Transport energy consumption ↑
2	Car ownership ↑	Trip frequency ↑ Trip frequency → Travel distance ↑ Proportion of car journey ↑ Travel time ↑
3	Possession of driver's license per household ↑	Using car ↑
4	Workers per household ↑	Trip frequency (Per household) ↑ Travel time ↑
5	Gender	Trip frequency →
6	Age ↑	Trip frequency → Proportion of car journey → Transport energy consumption ↑
7	Household size ↑	Trip frequency ↑ Travel time ↑ Transport energy consumption ↑
8	Level of education ↑	Proportion of car journey ↑ Proportion of public transport use↑

Note:
"↑" stands for increasing the number of amount, speed or percentage.
"→"stands for remaining the same.

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Additionally, several studies show that people's attitudes are also important for the choice of travel mode while others maintain that even if this is correct, attitudes are formed according to the actual choices travellers have made or have been forced to make due to the particular circumstances. **(Olsson.A, 2003)** Travel behaviour is the outcome of a series of complex travel related decision-making process, besides socio-economics' impacts some other individual factors such as perception, identity, social norms and habit has attracted researchers' attention in the study of travel behaviour. Building on the work of Ajzen (1991), Jensen (1999),and Anable (2005),a grouping method was used to identify the mobility types of travelers based on their transport attitudes; through attitude statements were designed to group the participants into 6 mobility types. Those types are briefly summarized in table 4. **(Shaoli Wang & Carey Curtis, 2015)**

Table 4: The Survey Attitude Classification of Six Mobility Types, Source: Shaoli Wang and Carey Curtis, (2015) after Anable, (2005,) Jensen (1999) and Ajzen (1991)

Mobility Types	Name	Main characters of each mobility type (according to literate review)
Type 1 = CL	**Car Lover**	a) Enjoyment of driving b) No or less moral responsibility to use the car less
Type 2 = CH	**Car use of Habit**	a) Attachment to the car b) Positive effects of car use c) Perceived behavioural control
Type 3 = CN	**Car use of Necessity**	a) Negative effects of Public transport use b) Being ready to change when condition improves c) Social norms
Type 4 = PL	**Public transport Lover**	a) Enjoyment of riding on public transport b) Belief in freedom to use the public transport c) View of nature
Type 5 = PH	**Public transport use of Habit**	a) Perceived behavioural control b) Effect of congestion
Type 6 = PN	**Public transport use of Necessity**	a) Negative effects of car use b) Social norms c) "Green" activism d) Being ready to change when condition improves

According to Ajzen 1991, different mobility types also indicate the level of possibility on mode change as shown in (Table 5). In this case, classifying the people according to their attitude type can also help to understand their future trends of mode change.

Table 5: Indicator of Mode Change for Different Mobility Types, Source: Shaoli Wang and Carey Curtis, (2015) after Ajzen (1991)

	Indicator of mode change	Possibility
Lover Group	Lowest desiring to change to another mode no matter how good the alternative is.	**Low**
Habit Group	Persuasion can make changes and better alternative experience can make differences	**Medium**
Necessity Group	Changing the situation can make large differences	**High**

1.2.2. External factors (urban-form factors):

Urban form can also play a significant part in influencing travel behaviors and patterns**. (Cervero, R., 2002)**. Cervero studied the impact of 'new urbanism' areas on travel modes, more specifically whether compact, mixed-use and pedestrian-friendly developments could significantly influence travel modes. First, three factors are first coined by **(Cervero, R., & Kockelman, K., 1997)** as the 3D's of land- use influence on travel behavior; density, diversity and design .Later, researchers have identified five "5D" variables that are keys to analyzing the relationship between urban design and travel patterns: Density, diversity, and design (the original "three Ds") have since been supplemented by Destination accessibility and Distance to transit. **(Ewing, R. and Cervero, R., 2010)**.

Density always described as the variable of interest per unit of area. The area can be gross or net, and the variable of interest can be (population, dwelling units, employment, building floor area, or something else). **Diversity** refers to the act of putting different land uses such as (Residential-commercial-Business-..) in close proximity to each other, reducing the need to travel outside of the area for common trip purposes. **Design** includes the characteristics of a neighborhood's street network and streetscape. **Destination accessibility** reflects the ease of travel to a central business district or other concentrated area of jobs and attractions.

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Distance to transit measures the average distance from home or work to the nearest rail station or bus stop. Built environment factors related to non-motorized transport (NMT) and other travel behaviors are describing the characteristics of an individual's neighborhood environment **(Ewing and Cervero, R, 2010, DDC, et al., 2010).** Maintaining and developing these five qualities is therefore essential to promote active living through urban design and planning. To sum up, the researchers summarizes the previously studied findings (outlined in table 6) of the linkage between urban form factors and travel behaviour.

Table 6: Summarizing the Relationships between Urban Form Factors and Travel Behaviour Based on the Previous Studies, Source: The Researchers

5D variables	The influencing relationship between urban form factors and mobility enhancement (From previous research findings)	
Density	▪ Areas with higher population and employment density would have higher public transportation use rate and lower vehicle travel.	
Diversity	▪ It is found that increasing land use mix could shorten the commuting distance and even reach the destination through walking or cycling (encourage non-motorized travel). ▪ Land use mix could shorten the time for travel and distance effectively.	
Design	**Connectivity**	▪ The connectivity of roadways could lower the vehicle travel, decrease the number of trips and maximize the directness of travel. ▪ The connectivity of sidewalk could increase the proportion of walking and cycling.(increase non-vehicle travel)
	Roadway design and management	▪ Improving the conditions of sidewalk, cycle track, and public transportation so as to create convenient and comfortable traffic environment. ▪ The design of the transportation system e.g. the street with good connectivity, landscaping, street furniture, security and the walking environment friendly to pedestrian etc. would exert positive influence upon the performance of the city transportation system. ▪ Flexibility of grid network allow for more choice of movement options within the neighborhood area.
	Parking supply and management	▪ Decreasing the supply of parking space, increasing the parking fee and applying more parking management strategy could lower the trip number per vehicle unit.
Destination accessibility	▪ Improving the accessibility of one area could decrease the trip number of each vehicle unit.	
Distance to Transit	▪ Citizen living or working in public transportation oriented cities are disposed to less vehicle travel and less times of vehicle driving and they use public transportation system more than other areas. ▪ Improving the service quality of public transportation could increase the passenger volume and decrease the trip number, particular during the commuting time in cities.	

III. METHODS AND CASE STUDIES FROM ALEXANDRIA CITY

The research adopts a twofold methodology: one for selecting the case studies in Alexandria city for the study, and the other for analyzing the data obtained from the sample of the selected areas.

3.1. Sampling and Selection of Case Studies:

For narrowing the research for selection of case studies to study the factors affecting travel behaviour and collect fairly detailed data, the researchers adopts a multistage selection tool applied which divided into three stages. **First stage,** Alexandria districts are grouped according to two variables (i) High and low socio-economic conditions and (ii) Development pattern in terms of design attributes (Neo-traditional). Once districts are sorted into groups, two (Qism & shiaykha) cases of each district are randomly selected that also match the previous characteristics. Because by comparing neighborhoods similar in development pattern and different in socio-economic conditions, this allow the strength of built environment variables to be measured clearly while limiting the confounding effects of development pattern.

In the **Second stage,** selecting case studies for detailed analysis by choosing representatively sampled neighborhoods that was viewed as essential in recording enough interesting variations in term of built environment factors to support the study. The researchers adopted the block scale which is defined by **(Cervero, R., Sarmiento et.al, 2009**) as a buffer of 500 meter around the block centroid. It is believed that the basics of any residential neighborhood are identified by grouping the population around a range of services and its elementary school within an acceptable walking distance for children to school about 400 meter. Accordingly, the researchers assumes the school is located in its centroid, taking into account the distance mentioned as half diameter and not exceed 500 meter for the furthest point within the neighborhood boundaries. Based on that, two elementary schools are randomly selected among the chosen districts for each case study.

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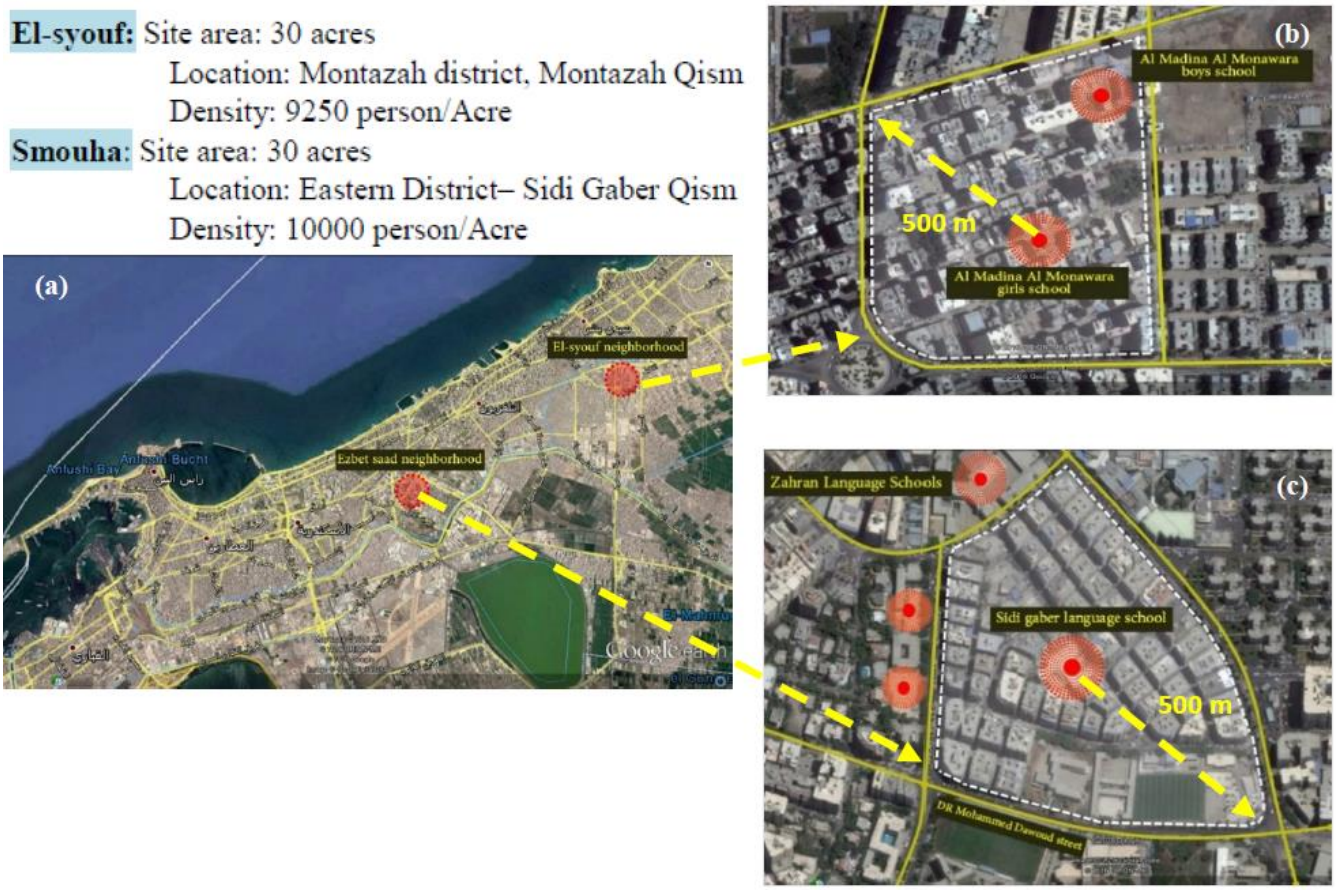
Finally the **third stage,** a sample of 182 respondents are randomly selected for both neighborhoods; 91 per neighborhood is the minimal required sample size to estimate an average difference at density (one of neighborhood aspects which affect mobility behaviour) = 6.6 pp/ha. Using alpha error = 0.05, 95% confidence level and study power of 80%.The sample size is calculated using (G*Power II).To obtain data on built environment, travel behaviour, individual characteristics among the sampled individuals, a survey is conducted and designed as a tool for cross sectional monitoring of self-reported data. Data are collected from both on-site/on-line surveys within a period of one month, conducted from June 30th, 2016 till July 25th, 2016 targeting the study areas. All the responders are 18 years of age and above. The statistics of sample data distribution are given in table 7.

Study areas:

The research is based on the selected two case studies where they are located in two different districts. El-syouf neighborhood within Montazah district and Ezbet saad (Smouha neighborhood) within Eastern district (sharq) in Alexandria city. They are close proximity that they have the same development pattern of Neo-traditional development, same area and slightly equal density but they differ in socio-economic condition.



Map 1: (a) Satellite Image Showing the Geographic Locations of the two study areas, Source: Google earth 20th of September, 2016, (b) & (c) Satellite Images of El-Syouf and Smouha Selected Neighbourhoods According to the Location of Elementary School.

Table 7: Total Employment Status Frequencies and Its Distribution at Both Regions, the Researchers by using SPSS

	El-syouf		Smouha		Total
	Number	%	Number	%	
Unemployed	**47**	**51.6%**	**52**	**57.14%**	**99**
Male	19	20.87%	25	27.47%	44
Female	28	30.76%	27	29.67%	55
Employed	**44**	**48.4%**	**39**	**42.9%**	**83**
Male	18	19.78%	24	26.37%	42
female	26	28.57%	15	16.48%	41
Total	**91**	**100.0%**	**91**	**100%**	**182**

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3.2. Data Analysis Methods:

The different types and sources of data that are required to support this study are identified. The data are collected by questionnaires, direct observations, Government reports, photographs, and maps (see table 8) then analyzed following three stages. **First,** the data are analyzed using descriptive statistics to identify the differences between different factors that are attained through frequencies and Pearson's Chi-square $\chi 2$ which explores the significant differences. The use of (ArcGIS 10.3.1) software to obtain the characteristics of the sample and Statistical Package for Social Sciences (SPSS version 17) to carry out data handling and analysis. **Second,** univariate comparisons and distribution of categorical variables are presented in terms of absolute frequencies and p-values from Pearson's Chi-square $\chi 2$ test and t-test where $p \leq 0.05$ is considered as significant. **Finally,** cross tabulation involved the process of creating a table from the Uni-variate frequency distribution of statistical variables. Cross-tabulations are used to determine whether there is any relationship between the tested variables using chi-square test function (χ^2) and to examine the association between Car mode share, Non-car mode share and various combinations of the characteristics of the physical environment, physical activity, and perceptions of neighborhood. Results of the statistical data analysis provided information that formed the basis for discussion and interpretation of the findings of the study.

Table 8: Data, Type of Data, Sources and Method of Collections and Analysis, Source: the Researchers

Stage	Data on	Sources	Method of collection and analysis (Tools)
Data collection	Socio-economic characteristics of the sample	Field	• Survey • GIS • Government reports
	Travel data & Trip information	Field	• Survey
	Built environment data	Field	• Survey • Direct observations • Field visits • Photographs • Maps
	Attitudinal data & preferences	Field	• Survey
Analysis	Urban form and Non-urban form factors	Field	• Survey results • Statistical analysis (SPSS) • Researchers • Some guide from previous research

IV. VARIABLES INCLUDED IN THE ANALYSIS

A. Dependent Variables (Non-Car Mode Share) & (Car-Mode Share) – (Outcome)

The dependent variables for the analysis are defined as 'car-mode share', which is using private car only and 'non-car mode share', which is the sum of public transport and 'other' mode shares; this measure includes all public transport use and also trips where walking and cycling is the primary mode of travel. These variables obtained from the self-reported data collected from the sample about physical activity, private car use and trip information.

B. Independent variables – (Predictors)

The independent variables included two groups, urban form factors and non-urban form factors. **The urban form factors** is the built environment variables including: density, diversity, design, destination accessibility and distance to transit. The density factor is obtained using GIS census data while the perception measures of the rest 4 built environment are obtained in which each factor is the product of a five item Likert scale ranges from (strongly disagree=1 to strongly agree=5) in the respondents' neighborhood. While the **Non-Urban form factors** are including: Individual (commuter) and neighborhood level demographics, self-reported physical activity and attitudinal variables.

V. RESULTS AND DISCUSSION

A. Differences in Socio-Demographics:

- Based on the results obtained from the survey of total studied sample (n=182), the first point to notice is that a higher proportion of respondents at el Syouf are females (59.3%) than males and vice versa in Smouha (53.8% are males). El-Syouf area has elder people (over 45 years old) than Smouha area (33% rather than 22 %).
- El-Syouf accommodates a higher number of high – educated people with 62.7%, about 7.7% who have master of PhD studies and about 55 % who have completed a bachelor degree. While only 55% in Smouha area. Household size of Smouha people is slightly smaller than those of el Syouf people. But, families with kids or students have higher rate in Smouha than El-Syouf.
- Moreover, 50.55% of El Syouf people have no cars and only 25.3% of Smouha residents are without cars. On the other hand, while 8.8% of el Syouf residents possess two or more cars and 24.2% in Smouha. Only 32.96 % of El Syouf people have one car while 45% for Smouha people. These statistics clearly explain the more reliance on cars for Smouha people than El-Syouf people.

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B. Differences in Attitudes:

There are large differences of the attitude towards car and public transport when the population composition of 6 mobility types in two case studies is examined; Compared with El-syouf, Somuah's Car user group is larger than PT user. The largest mobility type responds in Smouha is “Car habit”, “Car necessity” comes after; “Car lover” comes third and "PT use of habit" fourth. The number of “PT necessity” and “PT lover” people are both quite small. This also suggests that they get used to a certain type of traveling method resulting in less attention to the alternatives, regardless of the level of availability (bearing in mind that Smouha is public transport accessible location and high economic status). However it can also be suggested that an experience of an alternative mode could result in changes.

In comparison, El-syouf PT user group is larger than Car user group. It has the largest population of PT Habit Group. There is not as such an obvious difference between the numbers of “PT Lover” group at both regions. It is found that some of them significantly associated with commute mode choice and travel behaviour for daily trips at the studied neighborhoods.

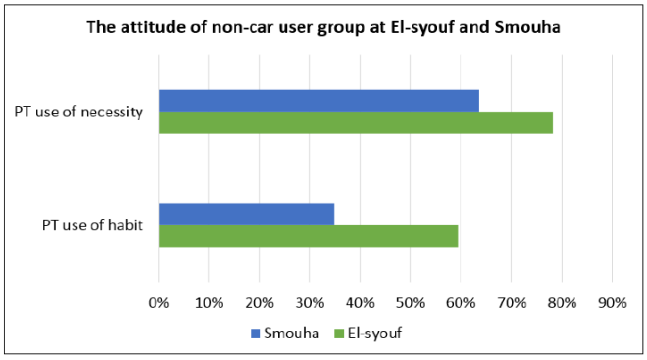

Chart 1: Illustrates the Attitude of Non-Car User Group at El-Syouf and Smouha, Source: The Researchers

Table 9: Descriptive Analysis and Significance of the Variables Obtained from the Sample, Source: The Researchers

Non-Urban form Factors	El-Syouf (n=91)	Smouha (n =91)	^{MC}p
Socio-demographic data			
Gender			
Male	40.7%	53.8%	0.075
Female	59.3%	46.2%	
Age group			
aged between 18-24	28.6%	36.3%	0.224
aged between 25-34	34.1%	30.8%	
aged between 35-44	4.4%	11.0%	
aged between 45-54	12.1%	9.9%	
aged between 55-64	15.4%	6.6%	
elder than 65	5.5%	5.5%	
Education level			
Completed PHD or other degree or Post graduate	7.7%	17.6%	0.017*
Completed bachelor degree	54.94%	37.36%	
Vocational education	10.98%	7.69%	
Basic education	23.1%	34.1%	
(School)	0.0%	2.2%	
Read and write	3.3%	1.1%	
Un educated			
Driving licenses ownership			
Yes	49.5%	63.7%	^{FE}p = 0.050*
No	50.5%	36.3%	
Car ownership			
Households without car			0.002*
Households with 1 car	50.55%	25.3%	
Households with 2 cars	32.97%	45.1%	
Households with 3 cars	6.59%	20.9%	
or more	2.20 %	3.3%	
Others (Motor cycle-cycle-rickshaw-…)	7.69 %	5.5%	
Number of children			
None	65.9%	68.1%	0.290
1 child	9.9%	16.5%	
Two Children	16.5%	12.1%	
Three or more children	7.7%	3.3%	
Household size			
Only 2 persons in the household	13.2%	17.6%	0.194
3 persons	15.4%	14.3%	
4 persons	27.5%	38.5%	
5 persons	28.6%	24.2%	
6 persons	14.3%	4.4%	
7 persons or more	1.1%	1.1%	
Own/rent home			
Own	80.2%	79.1%	0.854
Rent	18.68%	20.9%	
Shared	1.1%	0.0%	
Length of residence			
Less than 1 year	5.5%	5.5%	0.001*
From 1-2 years	1.1%	5.5%	
From 3-5 years	8.8%	25.3%	
From 6-10 years	17.6%	28.6%	
>10 years	67.0%	35.2%	
Number of trips per day			
1-2 Trips per day	50.5%	47.3%	0.340
2-3 Trips per day	22.0%	30.8%	
3-4 Trips per day	17.6%	17.6%	
4 or more Trips per day	9.9%	4.4%	
Attitudinal variables **			
Public transport users			
I get freedom from driving responsibilities	2.2%	9.9%	^{FE}p = 0.029*
When you can afford a car, you will consider to drive	27.5%	15.4%	0.047*

Urban form Factors	El-Syouf (n=91)	Smouha (n =91)	^{MC}p
The D variables of built environment			
Diversity			
High	1.1%	1.1%	0.935
Moderate	38.9%	36.3%	
Low	60.0%	62.6%	
Design			
Poor	63.7%	30.8%	0.001*
Moderate	36.3%	61.5%	
good	0.0%	7.7%	
Destination accessibility			
Low	24.2%	3.3%	0.001*
Moderate	63.7%	49.5%	
high	12.1%	47.3%	
Distance to transit			
Low	22.0%	24.4%	0.920
Moderate	65.9%	63.3%	
High	12.1%	12.2%	

Note: ** The presented results of attitudinal variables in this table obtained from the survey are only the variables found to be significant, but the overall findings are also discussed in this paper.

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* The results of (Travel patterns) trip characteristics are not presented in this table but the final findings are presented in this paper.
* ^{MC}**p**: Mont Carlo exact probability for Chi square test, ^{FE}p: Fisher Exact for Chi square test –
* Statistically significant at **p ≤ 0.05**
* **Poor/Low:** Score % < 50%**, Moderate:** Score % 50 % -< 75%**, High/Good:** Score % ≥ 75%

C. Differences in Travel patterns:

➢ **Primary commute mode - all trip purpose**

Chart 1 summarizes the findings of travel pattern for both work and non-work trips at the two regions. It is clear that mode share for car is higher in Smouha than el syouf. For work trips, using a private car for the trip to work is preferred in El –syouf than Smouha by (34.1% of the employed sample in el syouf than 25.60% employed sample in Smouha) but the car is the dominant mode for non-work trips of Smouha than El-syouf region ;although 7% can't find space to park at their destinations. About 39% of non-work trips in El-syouf are taken by public transport against 21% in Smouha. While using public transport for work trips is slightly higher in El-syouf than Smouha by 13% only. Walking for work trips are low nearly 3.2% in el syouf than Smouha. Another point to notice is that no one use cycling for their work trips for both regions while in el syouf cycling for non-work trips exceeds Smouha by 2.4%, but cycling still the least preferred mode for all trip purpose.

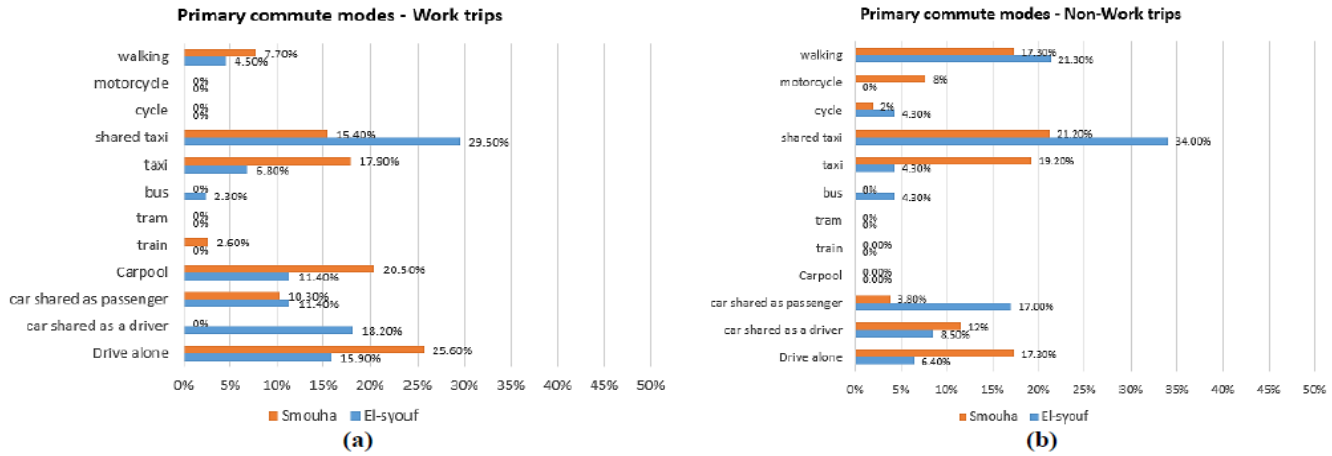

Chart 2: (a) & (b) a comparison shows the primary commute mode for work trips and Non-work trips for both regions, Source: The researchers

➢ **Commute Distance - all trip purpose**

Commuters in the survey sample had a wide range of commute distances, from less than 500m up to 16 Km .In Chart 2, the stacked bar chart shows results for this travel characteristic. At El syouf, more than quarter of the respondents commute over 6.4Km and up to 16 Km for work trips while it is much lower in Smouha by 26.7%. Nearly more than two-thirds in Smouha travel less than 6.4 Km while more than one third at El syouf. From the previously mentioned frequencies, it is notices that the percentage of short trips which is less than 2 km in Smouha more than El- syouf by 7%. This result could be a great evidence that the opportunities needed activities at EL-Syouf locate far away from the neighborhood.

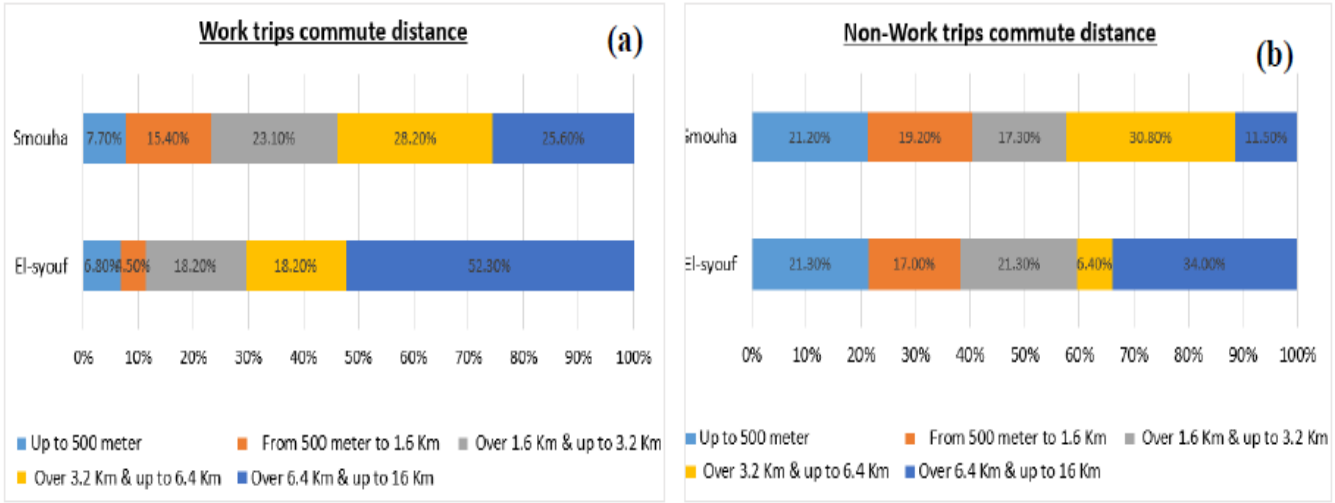

Chart 3: (a) & (b) shows the commute distance covered to work and non-work destinations for each region, the researchers

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➢ **Commute Time - all trip purpose**

Respondents were asked how long it takes to get to their destination, results are shown in (Table 10). By using SPSS for cross tabulation analysis, it is found that commute time statistically significant with mode choice; El syouf commuters who drove their private cars to their destination have used this mode, considerably longer on average than have commuters who used alternative modes. The long drive alone duration is likely related to some commuters having no option other than driving for their destination. At El-syouf, Alternative mode users had used these modes for shorter times on average than Smouha, but a substantial portion of alternative mode users still were long-term users. The maximum time car users at Smouha consume is between 45-60 minute and no one reached an hour, on the contrary, at el syouf about 40% spend more than one hour using this mode. This great significance compile a number of answers which is; facing major bottlenecks, the destination is too far or no direct roads to their destinations or their residence is located far away from important opportunities.

Table 10: Duration of Mode Use Sorted By Primary Mode at El-syouf and Smouha for all trip purpose, source: the researchers

Smouha area	How long does it take you to get to your destination?										χ^2	^{MC}p
	About 15 min (n = 13)		15-30 min (n = 11)		30-45 min (n = 26)		45-60 min (n = 31)		> 60 min (n = 10)			
	No.	%	No.	%	No.	%	No.	%	No.	%		
Walking	8	47.1	1	3.3	2	8.3	0	0.0	1	11.1		
Cycle	0	0.0	1	3.3	0	0.0	0	0.0	0	0.0		
Motorcycle	0	0.0	3	10.0	1	4.2	0	0.0	0	0.0		
Private car (Driving alone)	3	17.6	8	26.7	7	29.2	0	0.0	1	11.1		
Car shared as a driver	1	5.9	1	3.3	2	8.3	1	9.1	1	11.1	56.687*	0.001*
Car shared as a passenger	0	0.0	1	3.3	1	4.2	3	27.3	1	11.1		
Train	0	0.0	0	0.0	0	0.0	0	0.0	1	11.1		
Taxi	3	17.6	11	36.7	3	12.5	0	0.0	0	0.0		
Shared taxi	1	5.9	3	10.0	5	20.8	4	36.4	4	44.4		
Carpool	1	5.9	1	3.3	3	12.5	3	27.3	0	0.0		
Car mode use	**4**	**23.5**	**9**	**30.0**	**9**	**37.5**	**1**	**9.1**	**2**	**22.2**	**3.227**	**0.525**
Non-care mode use	**13**	**76.5**	**21**	**70.0**	**15**	**62.5**	**10**	**90.9**	**7**	**77.8**		

El-syouf area	How long does it take you to get to your destination?										χ^2	^{MC}p
	About 15 min (n = 13)		15-30 min (n = 11)		30-45 min (n = 26)		45-60 min (n = 31)		> 60 min (n = 10)			
	No.	%	No.	%	No.	%	No.	%	No.	%		
Walking	7	53.8	2	18.2	2	7.7	1	3.2	0	0.0		
Cycle	1	7.7	0	0.0	0	0.0	1	3.2	0	0.0		
Private car (Driving alone)	0	0.0	0	0.0	4	15.4	3	9.7	3	30.0		
Car shared as a driver	1	7.7	3	27.3	3	11.5	4	12.9	1	10.0		
Car shared as a passenger	0	0.0	2	18.2	6	23.1	5	16.1	0	0.0	38.254*	0.046*
Bus	0	0.0	0	0.0	0	0.0	2	6.5	1	10.0		
Taxi	1	7.7	0	0.0	1	3.8	3	9.7	0	0.0		
Shared taxi	3	23.1	3	27.3	9	34.6	11	35.5	3	30.0		
Carpool	0	0.0	1	9.1	1	3.8	1	3.2	2	20.0		
Car mode use	**1**	**7.7**	**3**	**27.3**	**7**	**26.9**	**7**	**22.6**	**4**	**40.0**	**3.501**	**0.469**
Non-car mode use	**12**	**92.3**	**8**	**72.7**	**19**	**73.1**	**24**	**77.4**	**6**	**60.0**		

Note that all these results almost certainly are not representative of the City's actual commute mode split.

VI. THE CROSS-TABULATION ANALYSIS

A. The Non- Urban Form Factors

1. It is found that a higher share of men drive alone than did women in Smouha. In addition, taxi seems to be highly significant between the user groups at Smouha, where female respondents prefer to choose taxi as their primary mode than men***. The analysis also shows that females tend to make greater use of public transport and alternatives than males at both regions.

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2. The other notable difference in primary mode was related to respondents' age at El-syouf only**. The drive alone percentage increased as respondents' age increased; 32% of respondents at the age between age 18-34 drove alone, compared with 49% of respondents who were 55 years or older.
3. The majority of respondents at el-syouf make more than 2 trips per day in a typical week; from the results it is found that that number of trips has a significant influence on mode choice and travel behaviour at El-syouf only. About 72% of car owners chose to use their private cars as a first choice because of the number of trips they make per day.
4. The ability to satisfy travel demand is affected by the availability of the alternative modes. From the results it is found that the number of vehicles available for use by each household who holds a driving license has significant influence in choosing transportation mode at both studied neighborhoods.
5. From the results it can be seen that household composition has a significant influence at Smouha only. The analysis shows that Smouha households with two or more children are highly dependent on private cars (52%) as their primary mode than alternatives (24.3%). This high variation may be related with the fact that commonly a person with family including children tend to have their private car to accommodate travelling with the other family members.

Table 11: Relation Between Mode Choice in El-Syouf and Smouha According to Demographic Data, the Researchers

El-syouf area / Factors	Car mode use (n = 22)	Non-car mode use (n = 69)	χ^2	^{MC}p
Socio-demographic data				
Gender				
Male	59.1%	34.8	4.085*	0.043*
Female	40.9%	65.2		
Age group				
aged between 18-24	13.6%	33.3%	10.588*	^{MC}p= 0.038*
aged between 25-34	22.7%	37.7%		
aged between 35-44	9.1%	2.9%		
aged between 45-54	18.2%	10.1%		
aged between 55-64	31.8%	10.1%		
elder than 65	4.5%	5.8%		
Driving licenses ownership				
Yes	100%	33.3%	29.659*	<0.001*
No	0.0%	66.7%		
Car ownership				
Households without car	0.0%	66.7%	39.006*	^{MC}p <0.001*
Households with 1 car	77.3%	18.8%		
Households with 2 cars	4.5%	7.2%		
Households with 3 cars or more	4.5%	1.4%		
Others (Motor cycle-cycle-rickshaw-…)	13.6%	5.8%		
Employment status				
Unemployed (Non-work Trips)	31.8%	58%	4.569*	0.033*
Employed (Work Trips)	68.2%	42%		
Number of trips per day				
1-2 Trips per day	27.3	58.0	12.880*	^{MC}p= 0.003*
2-3 Trips per day	40.9	15.9		
3-4 Trips per day	9.1	20.3		
4 or more Trips per day	22.7	5.8		
Smouha area / Factors	**Car mode use (n = 25)**	**Non-car mode use (n = 66)**	χ^2	^{MC}p
Socio-demographic data				
Driving licenses ownership				
Yes	100%	50%	19.612*	<0.001*
No	0.0%	50%		
Car ownership				

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Households without car	0.0%	34.8%		
Households with 1 car	52.0%	42.4%		
Households with 2 cars	44%	12.1%	21.518*	^{MC}p = <0.001*
Households with 3 cars or more	4.0%	3.0%		
Others (Motor cycle-cycle-rickshaw-…)	0.0%	7.6%		
Number of children				
None	48%	75.8%		
1 child	20%	15.2%	8.475*	^{MC}p = 0.024*
Two Children	24%	7.6%		
Three or more children	8%	1.5%		

Note:

- The factors found to be significant are only the factors presented in this table.
- A trip can consist of one or more stages, a new stage is said to occur if there is a change in the form of transport.
- This survey treats short walking trips as stages in the trip (e.g. walking trips that are more than 50 meters). This is done to fully account for the importance of walking as a mode and its importance in transfers.
- Public transport includes Local bus - Tram – Train – Shared Taxi.

*** The cross-tab analysis distribution between gender, age and the used modes is not presented here but the final findings are mentioned in this paper.

B. The Urban Form Factors:

The results below in table 12 show some differences for each variable at each region. The possible reasons is that the micro elements of a neighborhood, like sidewalks, landscape or even convenience stores may have little bearing on travel demand. Using the univariate analysis, among the tested variables in built environment, distance to transit is the only factor found to be associated with mode choice at Smouha. This is not far from the existing situation because residents often take taxis to reach a tram or train besides walking to reach the station. Moreover, there are no shared taxis stops near the neighborhood, but shared taxis sometimes randomly operated

Table 12: The Relation Between Mode Choice in El-Syouf and Smouha and the Tested Built Environment Factors, The Researchers

El-syouf area / BE Factors	Car mode use (n = 22)	Non-car mode use (n = 69)	t	p
The D variables of built environment				
Diversity	7.82 ± 1.59	7.78 ± 1.58	0.092	0.927
Design	33.14 ± 8.74	33.49 ± 8.02	0.178	0.859
Destination accessibility	11.27 ± 2.51	11.62 ± 2.54	0.564	0.574
Distance to transit	5.73 ± 1.72	5.59 ± 1.70	0.319	0.751
Smouha area / BE Factors	**Car mode use (n = 25)**	**Non-car mode use (n = 66)**	**t**	**p**
The D variables of built environment				
Diversity	8.12 ± 1.59	8.21 ± 1.65	0.240	0.811
Design	39.48 ± 9.83	39.94 ± 9.37	0.206	0.837
Destination accessibility	14.52 ± 3.33	14.20 ± 2.72	0.433	0.667
Distance to transit	4.84 ± 1.57	5.71 ± 1.74	2.186*	0.031*

- t, p: t and p values for Student t-test for comparing between the two groups , *: Statistically significant at $p \leq 0.05$

(a) **(b)**

Figure 1: (a) Residents sometimes take two to three separate collectives (shared taxis, taxis, mini buses- informal motorized rickshaw) to reach main arterial roads that provides low-cost connections to the city and job opportunities. (b) Poor condition of pavements, absence of landscaping and cars blocking the rest of space for Pedestrian Source: The researchers from field visits

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Figure 2: Smouha Neighborhood (a) the intensive spread of public park areas of private cars which reduces the roads width, (b) there are no shared taxis stops near the neighborhood, but shared taxis sometimes randomly operated at Victor Emanuel square, Source: The researchers from field visits

VII. CONCLUSION

Considering the differences in socioeconomic and built environment characteristics and their effect on the travel pattern; in this study an attempt is made to understand their respective relevance in the choice of non-motorized, alternatives and private motorized vehicles, while making different types of trips. Trips made for work, shopping, and for all the purposes have been analyzed. For doing this analysis, the researchers worked on two case studies to study the status quo. A vast amount of data was accumulated to enable the researchers to divide the districts under scrutiny into clusters and thus choose the neighborhoods for analytical study. Two selected neighborhoods; EL-Syouf and Smouha, are considered as the study areas. The following are the important conclusions drawn out of the present study analysis;

1. According to data analysis the frequencies shows that the private car use in Smouha is still high compared with public transport for work trips while shared taxi is the most preferred mode for non-work trips. In El-Syouf, it is showed that private car is also preferred for work trips but slightly higher than Smouha while shared taxis and private cars still very dominant for non-work trips.
2. The objective of the current research is to identify factors which influences respondents' perception and the interpretation for the reasons they choose a transportation mode for supporting their activity as individuals. Based on the uni-variate analysis result we can see:

   At El-Syouf Neighbourhood

   a) Factors affecting respondents in choosing private cars or alternatives are:
   - **Internal and attitudinal:** employment status, gender, age, the ownership of vehicle, and driving license - use of necessity and habit.
   - **External:** Trip characteristic (commute time and distance - number of daily trips)

   At Smouha Neighbourhood

   a) Factors affecting respondents in choosing private cars or alternatives are:
   - **Internal and attitudinal:** The ownership of vehicle, and driving license, Number of children in household - use of necessity and habit.
   - **External:** trip characteristic (number of daily trips – commute time) – built environment factors (distance to transit).
3. The number of household, driving license ownership, travel distance, time and cost are associated with the probability to choose transportation mode for working activity, so it is possible to make some policies related with those factors. Because it is believed that work activity contributes to traffic congestions at rush hours.
4. The factor which influences respondent is not just from the external factor related with the vehicle or trip characteristic, but the attitudes and motives of the respondent are also important. This can also trace their willingness to shift into other modes in the future.

In conclusion, the unique findings from both case studies are: travel patterns are closely related to internal socio-demographic factors and a partial association to urban form factors. Travel behaviour is also impacted by internal attitude factors such as perceived attitude and lifestyles. Of the current travel behaviour research, empirical evidence from the two neighborhoods in El-syouf and Smouha analyzed in this research provides support for the understanding that individual factors especially travel attitude factors are an important dimension which should not be exclusive. The urban form, socio-economic and attitudinal characteristics indeed interact and influence each other in a bi-directional relationships. To what extent the travel behaviour is affected by those factors and how could these factors affect each other still a question that needs further research.

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