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Investigating Informal Paratransit Stops Formation in Existing Urbanism: A Case Study in Greater Cairo, Egypt

Mariam Shaker[1,*], Ingy El-Baramelgy[2], Dalia Aboubakr[2]

[1]Department of Architecture, Modern Academy for Engineering and Technology, Cairo, 11837, Egypt
[2]Department of Architecture, Faculty of Engineering, Cairo University, Giza, 12511, Egypt

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Abstract Formal stops aroused the interest of many researchers. Many of these studies focused on calculating the walking distance to transit station. However, only few researches studied paratransit stops. The current study focuses on the phenomena of informal paratransit stops in Greater Cairo. The main purpose of this study is to investigate the parameters causing the formation of informal paratransit stops in existing urbanism. Investigating these parameters helps to build a knowledge base for this phenomenon and support future researches which could help in solving the problem of the formation of informal paratransit stop. The review of related literature leads to propose five main parameters affecting the formation of informal paratransit stops (quality of life, mobility and quality of public transit, transit station, built environment, and transit user). The researchers choose Dokki district in Giza as an example for studying paratransit stops in Egypt. The study then uses qualitative and quantitative methods to validate the proposed parameters. The methods include specialist questionnaire, user's questionnaire and field survey. Research results confirmed the importance of all the parameters especially, mobility and quality of public transit, and the importance of sub-parameters such as (land use – number of served routes – accessibility – reliability – etc.) on the informal formation of paratransit stops in existing urbanism.

Keywords Paratransit Stop, Life Quality, Transit Station, Built Environment, Transit User, Mobility

1. Introduction

Most developing countries, suffer from major problems in transportation. Cairo is considered one of the highest capitals where individuals are depending daily on public transit to reach different destinations (Figure 1) [1]. In Egypt, 2.2 billion users use daily transit (842 million users for metro and 2 billion users for public transport), 1395939 of these users are located in Greater Cairo [2]. Recent years witnessed different attempts to control urban sprawl using mobility and urban transport plans for supporting passenger's mobility requirements in large urban area [3]. Such studies proposed different effective approaches which depend on reducing traffic congestion, solving transit problems, and increasing the efficiency of current transit system performance [4]. The results of these studies stress on the importance of controlling the causes of traffic congestion to solve transit problems in Greater Cairo. Thus, this research aims to investigate the parameters affecting the formation of informal paratransit stops. Such investigation is significant as paratransit stops are one of

the main causes of traffic congestion in Greater Cairo [5, 6].

The term paratransit stops describe transit stops with low performance services where small-vehicles stop to load & unload passengers. These paratransit stops were created by the informal sector to fulfil the gap from formal transit by vehicles which can load a number of users larger than formal taxi and smaller than 50-passenger capacity buses [5]. Paratransit in Egypt is cited as one of the largest paratransit systems with about 80,000 non-licensed/unregulated microbuses in Greater Cairo spread in formal and informal areas [7]. The importance of microbuses which are one of paratransit vehicles came from the ability to choose their routes, to pick-up or drop-off passengers at any point, and the degree of freedom in setting fares [8].

There are different attempts to analyze and study formal stops. Some researchers focused on the influence of the built environment on distributing transit stops. Others focused on the quality of life and street connectivity. However, other researchers considered transit stops as a civic space to study and analyzed [9, 10, 11, 12, 13]. Despite a large number of researches, only few focused on studying paratransit stops.

Therefore, the main purpose of our research is to focus on studying paratransit stops. The research tries to identify the parameters that influence the formation of informal paratransit stops in existing urbanism. The research proposes (quality of life, mobility and quality of public transit, transit station, built environment, transit user), as the main parameters responsible for formation of informal paratransit stops. For paratransit stops, we need to understand the main characteristic of these stops. Therefore, the parameter of transit station was chosen for analyzing its main form and components [19]. Mobility and quality of public transit parameter are chosen, because it is an important factor that affects the whole transit system including paratransit stops [18]. Accordingly understanding mobility is a key factor in understanding the paratransit stops in the study area. Studying commute users of paratransit stops (residents or visitors) is also a significant factor that affects the location where paratransit stops start to form. Therefore, transit user's parameter is chosen to analyze all transit users using paratransit vehicles to reach their destination [25]. Other parameters such as quality of life and built environment are important parameters for studying the characteristics of the paratransit stops context [15, 23]. Thus, studying these parameters is essential for urban designer in taking design decisions redesign or determine the appropriate place for paratransit stops (see Figure 2). Investigating these parameters helps to identify their impact on informal formation of paratransit stops, build a knowledge base for this phenomenon, and encourage further researches which could help to reduce or prevent this problem from appearing again in new or existing urban areas. The researcher chooses Dokki district in Giza as one of central districts in Greater Cairo where paratransit stops are spreading for testing and investigating this hypothesis.

Figure 1. Photos of public transport in Greater Cairo, the researcher

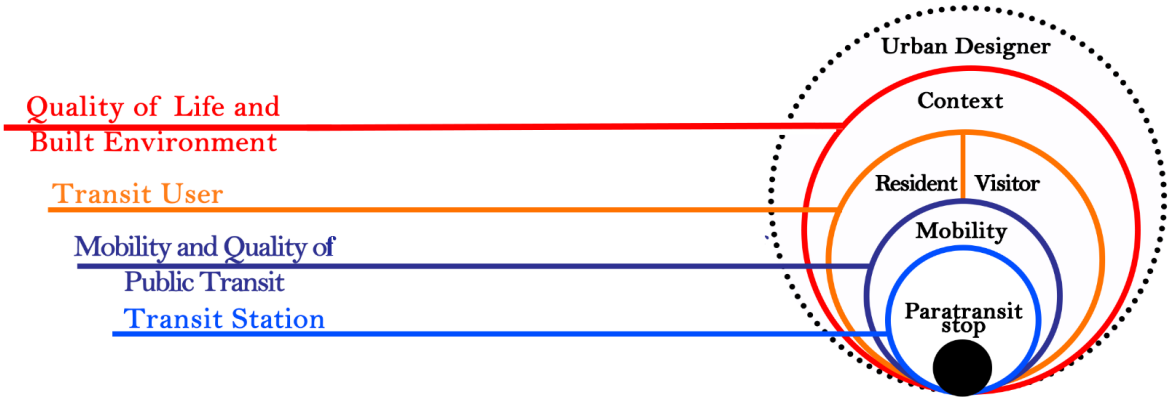

Figure 2. Analyzing research's parameters, the researcher.

2. Paratransit Stops

The presence of informal paratransit stops is one of the most important problems urban areas are facing in Greater Cairo nowadays. User's utilities in paratransit stops are also suffering from different problems such as, inconvenient boarding points, lack of adequate paved sidewalk, low number of formal stops which are not enough for the large number of users, lack of seats, and lack of convenient shaded areas to protect users from bad weather. Beside all of these problems, paratransit vehicles occupy a large part of the street in addition to the area occupied by a large number of paratransit users. Consequently, there is only one lane free for vehicles movement available for passing private cars which causes more traffic congestion [1, 7, 14].

2.1. Informal Paratransit Stops Parameters

Depending on the research hypothesis, the first parameter is the quality of life. **Quality of life** is a concept used to express satisfaction of community members about community factors, services, and resources and how these factors affect their life quality [15]. Researchers found that several transportation items are affecting quality of life such as; choice of transportation modes, safety, and commuting. Other researchers stated that living close to network of public transportation can generate feelings of belonging, competence, and freedom. Quality of life can be divided to six sub-parameters; access, integration, formality, noise, maintenance, congestion, and safety) [16,17] (see Table 1).

The second parameter is **mobility and quality of public transit**. Mobility refers to any potentials people can use to move from one place to another such as car, public transport, feet, etc. Mobility is also related to travel behavior which refers to where, when, by what type of transit, for how long and for how far trips will take. Mobility and quality of public transit depend on the quality of infrastructure, degree of proximity, grade of frequency, and availability. Degree of proximity means how near it is to other means of transport. Grade of frequency means that users can find transit vehicles available at any time. Availability of shades elements and seats is also an important parameter especially for elderly users. Accordingly, mobility and quality of public transit parameter can be divided to eight sub-parameters (infrastructure – diversity – frequency – reliability – acceptability – availability – accessibility – comfort) [18, 19] (see Table 1).

The third parameter, **transit station** is essential for measuring paratransit stops category, form, way of parking, and size. A well designed transit station is important to help users' access jobs, services, labour markets, and business. It helps users reach their destinations, reduce carbon emission, enhance attractiveness of the city, and improve user's health. Different design codes suggested principles to enhance passengers experience and increase the level of service in transit stations [19]. Transit station sub-parameters define how transit users can reach their transit stops, how transit vehicle parks, the number of destinations the transit user can reach, types of destinations near to transit stop such as train station or super markets, and how many cars can transit stop contain. Therefore, transit station parameter can be divided to ten sub-parameters (transit station vehicle access – number of route served – volume of waiting passenger – pedestrian crossing – catchment and spacing - transit station category – transit station form – stop placement – terminal size – boarding bay type) [20, 21] (see Table 1).

The forth parameter is the built-environment. **Built environment** is a parameter referring to the combination of land use patterns with urban design features and transport system characteristics. A large number of researches studied the relation between the built environment and transit stops and how the distribution of land use affects travel behavior. Size of district and population size are important sub-parameters for determining number of transit stops in urban area. Types of land uses affect the place where transit vehicles can pick-up or drop-off a large number of users. Therefore, built environment parameters can be divided to four sub-parameters (district size – population size – land use – the number of destination from transit stop) [22, 23, 24] (see Table 1).

The fifth and last parameter is **transit users**. Studying and analyzing the demographic characteristic of transit users plays a vital role not just for understanding users' characteristics but also for understanding how they choose the suitable transit stops to move from one district to another. Proximity to transit hubs influences mobility choices, choosing home district, and other aspects of daily travel [25]. Gender and age influence choosing the type of transit vehicle. Other parameters such as level of education and gross income also affect the choices of transit vehicles types. Other sub-parameters affect the choice of the easiest way to reach destination such as trip purpose, trip duration, the number of trips, and using frequency especially if transit users take transit vehicle daily. Subsequently, user parameters can be divided to 13 sub-parameters (gender – age – highest education level – the number of family member - the number of students – employment statues – gross household income – car ownership – job – using frequency – trip purpose – number of trips – trip duration) [26, 27] (see Table 1).

Table 1. Five main parameters and sub-parameters for measuring the main causes of formation of informal paratransit stops, the researcher

	Sub Parameters	Description	How to measure
Quality Of Life	Access	The available options to reach transit station	Car=1 Public transport=1 Walk=1 Metro=1 Bicycle=1
	Integration	Integration of transit layout with the surrounded layout	Not Integrated = grade from 0, 1, 2 Integrated = grade from 3, 4, 5
	Formality	Consideration as a formal stop from the authorities	Formal=1 Informal=0
	Maintenance	The grade of maintenance of transit station	Not Maintained= grade from 0, 1, 2 Maintained = grade from 3, 4, 5
	Congestion	The grade of congestion in the surrounded area	Not Congested= grade from 0, 1, 2 Congested= grade from 3, 4, 5
	Safety	Driver Behavior: To what extent drivers following good ethics	Bad behavior= grade from 0, 1, 2 Very good behavior= grade from 3, 4, 5
		Passenger Safety: The grade of user's safety while waiting transit vehicles	Not Safe= grade from 0, 1, 2 Safe= grade from 3, 4, 5
Mobility & Quality Of Public Transit	Infrastructure	The quality of public transit asset (pavements)	Very bad Quality= grade from 0, 1, 2 High Quality= grade from 3, 4, 5
	Diversity	Transport system diversity: Closeness to other transit station	Park Area=1 Public Transport=1 Metro Station=1 Train=1
	Frequency	Number of trips: Number of departure vehicles /hour	No./Hour
	Reliability	Waiting time: Amount of time user wait until transit vehicle arrive	Min
	Acceptability	Adaptability to climate: Availability of shading areas	- Yes - No - Sometimes
		Trip duration: Time transit vehicle take to reach to the other destination	Min
	Availability	Availability of transit stop within reasonable walking distance	Min
	Accessibility	The ease of reaching transit stop by walking	- Yes - No - To some extent
	Comfort	Refer to the availability of seating area	- Yes - No - To some extent

Table 1 Continued

Transit Station	Transit station vehicle access	Access should be convenient with traffic circulation of road network	- Not Convenient with traffic circulation - Convenient with traffic circulation
	Number of routes served	Number of destinations can user reach from transit stops	Total Number
	Volume of waiting passengers	Volume of waiting passengers until the transit vehicle depart	No. of users/ area/ min
	Pedestrian Crossings	Conflict between pedestrians and transit vehicles	No conflict = 1 conflict = 0
	Catchment and Spacing	Ideal spacing users can walk to reach transit stop/ station	- transit stops (400m) - transit station (800m)
	Transit Station Category	Refer to category of destination transit stop can reach	- Standard: near to residential area - Intra-model: near to shopping area, another transit stop - Multi-model: Bus, Metro, Train, Shopping Centre
	Transit Station forms	Refer to transit station form	- Open - Open and integrated with iconic urban space - Enclosed and in a utilitarian manner - Enclosed in a monumental manner - On-Street Terminal
	Stop placement	Place of transit stop from the intersection	- Near-Side Stops - Far-Side Stops - Mid-Block Stops Rest Areas
	Terminal size	Refer to number of transit vehicle park (vehicle/per 1 hour)	- Small Type (< 5 Vehicle/Hour) - Medium Type (5 to 15 Vehicle/Hour) - Large Type (> 30 Vehicle/Hour)
	Boarding bay type	Refer to how transit vehicle park in transit stop	- Saw tooth bays - Angular bays (60,45,30) - Perpendicular bays - Drive through - Linear/parallel bays
Built Environment	District size	Size of resident district	km^2
	Population	Number of total population in district	Number
	Land-use in urban area	Type of land-use in the all district	(□Entertainment – □Educational – □Commercial - □Green area - □ Parking - □ Mix use - □ Business - □ Religious - □ Culture - □ Residential - □Institutional - □ Health - □ Industrial - □ Empty-land - □ security services)
	Number of destinations from stop	Number of destination in 800 m from transit stop	Number

Table 1 Continued

Transit user	Gender	For transit vehicle users	- Man - Female
	Age	For transit vehicle users	- 12 - 29 - 30 - 49 - 50 - >70
	Highest Education Level	For transit vehicle users	- Primary school - middle school - High school - Institute - Under graduate - Master/ PhD
	Number of family members	For transit vehicle users	- 1 - 2 - 3 - 4 - More than 4
	Number of student	Number of students in household	- 0 - 1 - 2 - More than 2
	Employment Status	For transit vehicle users	- Student - Government employee - Housewife - Self-employed - Pensioner - Unemployed - Employee at private institution - Other condition
	Gross Household Income	(EGP)	- Low (< 2000) - average (2001-7,000) - High (> 7,000)
	Car Ownership		- Yes - No
	Job	Users has more than one job	- Yes - No
	Using frequency	frequency of using microbus	- sometimes - Weekends - From 2 to 5 days per week - Everyday
	Trip Purpose	Purpose of trip why user use microbus	(work - social/recreational - personal purpose - health or hospital purpose – shopping – home - to reach to another station – educational)
	Number of trips	Number of trips users take to reach to their destination	- 1 - 2 - More than 2
	Trip Duration	Average of users daily trip duration	- around 15 min - from 15 to 29 min - from 30 to 44 min - more than 45 min

***notes. Access, Diversity:** each transit equal 1 points, as an example larger number mean more access; **Integration, Maintenance, Congestion, Driver behavior, Passenger safety, Infrastructure:** grade from 0 to 5, as an example when grade equal 0 to 2 mean not integrated, when grade from 3 to 5 mean integrated; **Formality:** formal equal 1, informal equal 0; **Trip purpose:** multi choose are available.

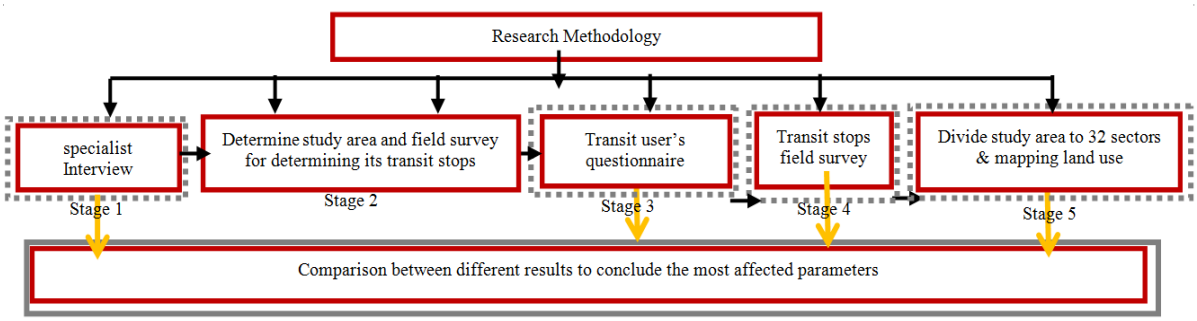

Figure 3. Research methodology, the researcher

3. Materials and Methods

The research assumes the effectiveness of the previously mentioned five parameters (quality of life, mobility and quality of public transit, transit station, built environment, transit user) on the formation of informal paratransit stops. To investigate this hypothesis, the researcher depends on a five stages methodology as described in Figure 3.

The **first stage**, used interviews to investigate the importance of the parameters. It included ten interviews. some these interviews were with specialists working in fields related to public transport and specialist in private companies (Uber & Careem bus and SWVL) who are working in the field of public transport in Greater Cairo. The interviews also included specialists working in governmental sector responsible for determining public transport policies and regulation in Greater Cairo (director of Giza traffic department – director of Cairo's serfes department). Another interview was held with Transport for Cairo which is a private institution working with the ministry of transport and Google map for determining places of transit stops in Greater Cairo (formal or informal). In addition to all of the previously mentioned specialists, the researcher interviewed specialists working in the field of urban design and urban planning (professor working in housing and building national research center – professor working in urban planning field – professor working in urban design field – professor specialized in road and traffic engineering). The interviewers were asked to rate the importance of the five parameters and related sub-parameters in affecting the informal formation of paratransit stops. They were asked to answer according to the following criteria:

1. Parameter/ sub-parameter which the specialist didn't recognize or have no effect = zero.
2. Parameters/ sub-parameter with moderate effect= 0.5,
3. Parameters/ sub-parameter which have an effect = 1 (see Table 2).

Table 2. Methodology of measuring parameters importance, The researcher.

	Specialist opinion in parameters important			
Symbol				
Refer to	No effect	Moderate effect	Effective	didn't recognize
Equal	0	0.5	1	0

The **second stage** was dedicated to select the study area. According to Serfes Administrations there are 29 informal transit stops in Cairo, and 134 informal stops in Giza [28, 29] (see Table 3). Therefore, the researcher focused on Giza governorate due to its high rate of informal paratransit stops. A field survey was held in Dokki district to determine the transit stops that users usually ride from. These stops were determined according to intensity of transit users, popularity of transit stops and proximity to vital areas. The survey results proposed nine transit stops as illustrated in Figure 4.

Table 3. Number of formal and paratransit microbus stops in Cairo and Giza, The researcher.

	Formal stop	**Informal stop**	**Main station**	**Total**
Giza	51	134		185
Cairo	34	29	19	82

Figure 4. Transit stops at Dokki district, the researcher.

The **third stage** includes a questionnaire to transit users using transit stops at Dokki district. Firstly, the research used a pilot study distributed randomly in Dokki streets to test the questionnaire design. After adjusting the questionnaire design, an online questionnaire was distributed on Facebook groups related to Dokki district in addition to other Facebook groups. This helped reach a large number of transit users who are using microbus transit stops in Dokki district whether they were residents or visitors. The questionnaire was divided to four parts related to the proposed five main parameters (quality of life - mobility and quality of public transit - transit station – transit user). Table 4 illustrates a sample of transit user's questionnaire. For quality of life parameters, transit users were asked about (access – maintenance – driver behavior – passenger safety). while for mobility and quality of public transit parameters, transit users were asked about (frequency - reliability – acceptability – availability – accessibility – comfort). For transit station parameter, the sub-parameters were (pedestrian crossings – catchment and spacing). And finally for the last parameter transit user, users were asked about sub-parameters (gender – age - highest education level - the number of family members - the number of student - employment status - user relation to Dokki district – job - gross household income - car ownership - using frequency - trip purpose - the number of trips – trip duration).

The sample of transit user questionnaire covered 385 subjects. The analysis of the questionnaire results leads to the identification of the frequency of use of each of the nine stops (high, medium, or low). Accordingly, four stops were selected, two with high frequency of use, one medium frequency, and one of low frequency. These transit stops are in order (6, 1, 5, 8 as illustrated in Figure 3). The reason behind choosing stops with different frequencies of use is to investigate if the significance of parameters and sub-parameters will differ from one stop to another.

The **fourth stage** included a field survey to identify significant characteristics of the four selected transit stops. The field survey was divided to four parts measuring parameters of paratransit stop (quality of life - mobility and quality of public transit - transit station-road network). Comparing between the significant of data for the four stops will help to understand which are the most effective parameters and sub-parameters.

In the **fifth stage**, the researcher divided Dokki district to 32 sectors to facilitate land use mapping for the four selected transit stops. A field survey was used to identify land use around the four transit stops. The documentation of the survey covered: types of land uses around each transit stop, the number of sectors around transit stops, and number of destinations (see Figure 5). Finally, to conclude the most effective parameters a comparison between the results of all stages was done.

Table 4. Samples of user's questionnaire, the researcher

	Sub parameters	Sample of users' questionnaire		
Quality of Life	Passenger Safety	What's your grade of safety while waiting microbus at transit stop?	Grade from 0 to 5, where 0 refer to feeling unsafe, and 5 refer to feeling very safe	
Mobility & Quality of Public Transit	Frequency	Which one of microbus stops you are usually use? (multiple choice)	Stop 1- stop 2- stop 3 – stop 4 – stop 5 – stop 6 – stop 7 – stop 8 – stop 9	
	Reliability	What's the amount of time you wait until microbus reach?	- from 5 to 10 min - from 11 to 20 min - from 21 to 30 min - more than 30 min	
	Availability	What's the time you take to reach closest microbus stop?	- 1 to 5 min - 6 to 10 min - 11 to 15 min - 16 to 20 min - 21 to 25 min - 26 to 30 min	
	User relation to Dokki district	What's your relation to Dokki district?	- Visitor	Where the district you are coming from?
			- Resident	Where the district you are usually go to?
	Using frequency	Frequency of using microbus per week?	- sometime - Weekends - From 2 to 5 days per week - Everyday	
	Number of trips	What's your trip purpose?	(work – shopping - social/recreational - personal purpose – educational – home - to reach to another station - health or hospital purpose	

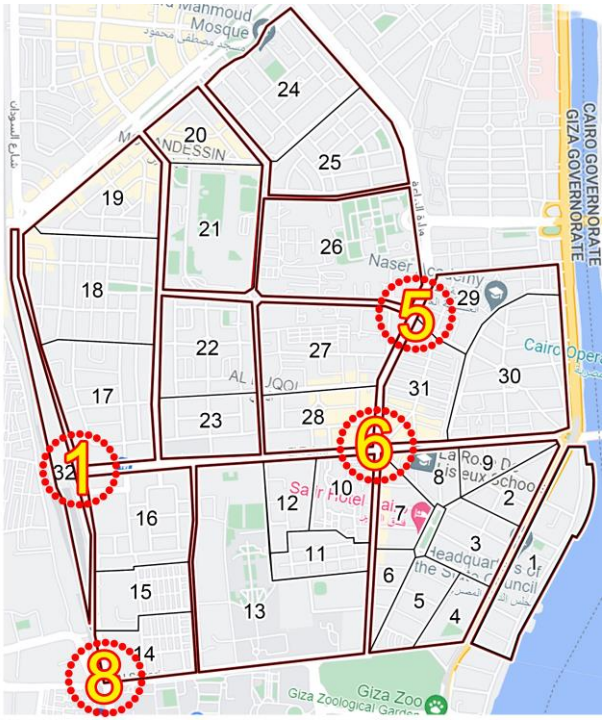

Figure 5. Dokki district divided to 32 sectors, the researcher.

4. Results

As mentioned earlier, the current study was divided to several stages and utilized several methods to collect data for exploring the importance of the proposed parameters and sub-parameters on informal formation of paratransit stops. This section presents the results of each of the five stages.

4.1. Specialist Interview (First Stage)

The results divided the importance of parameters to four categories: parameters from 100% to 85% = grade 1, parameters from 80% to 65% = grade 2, parameters from 60% to 45% = grade 3, and parameters from 40% to 15% = grade 4 (see Table 5). Then, the researcher selected parameters with grades 1 and grade 2 as the most important sub-parameters to compare with sub-parameters from other surveys. Results of specialist interviews for sub-parameters importance are illustrated in Figure 6.

Table 5. Sample of specialist opinion in paratransit parameters, the researcher

		1	2	3	4	5	6	7	8	9	10	Important	Grade
Quality Of Life	Access											100%	1
	Integration											35%	4
	Safety (Driver Behaviour)											65%	2

*note: each number refers to one of interviews, Uber & Careem bus (1), SWVL (2), Professor in Housing and Building National Research Centre (3), Director at Giza Traffic Department (4), Transport for Cairo (5), Director of Cairo's serfes Department (6), Mawaslat Masr (7), Professor in urban planning field (8), Professor in urban design field (9), Professor in road and traffic engineering field (10).

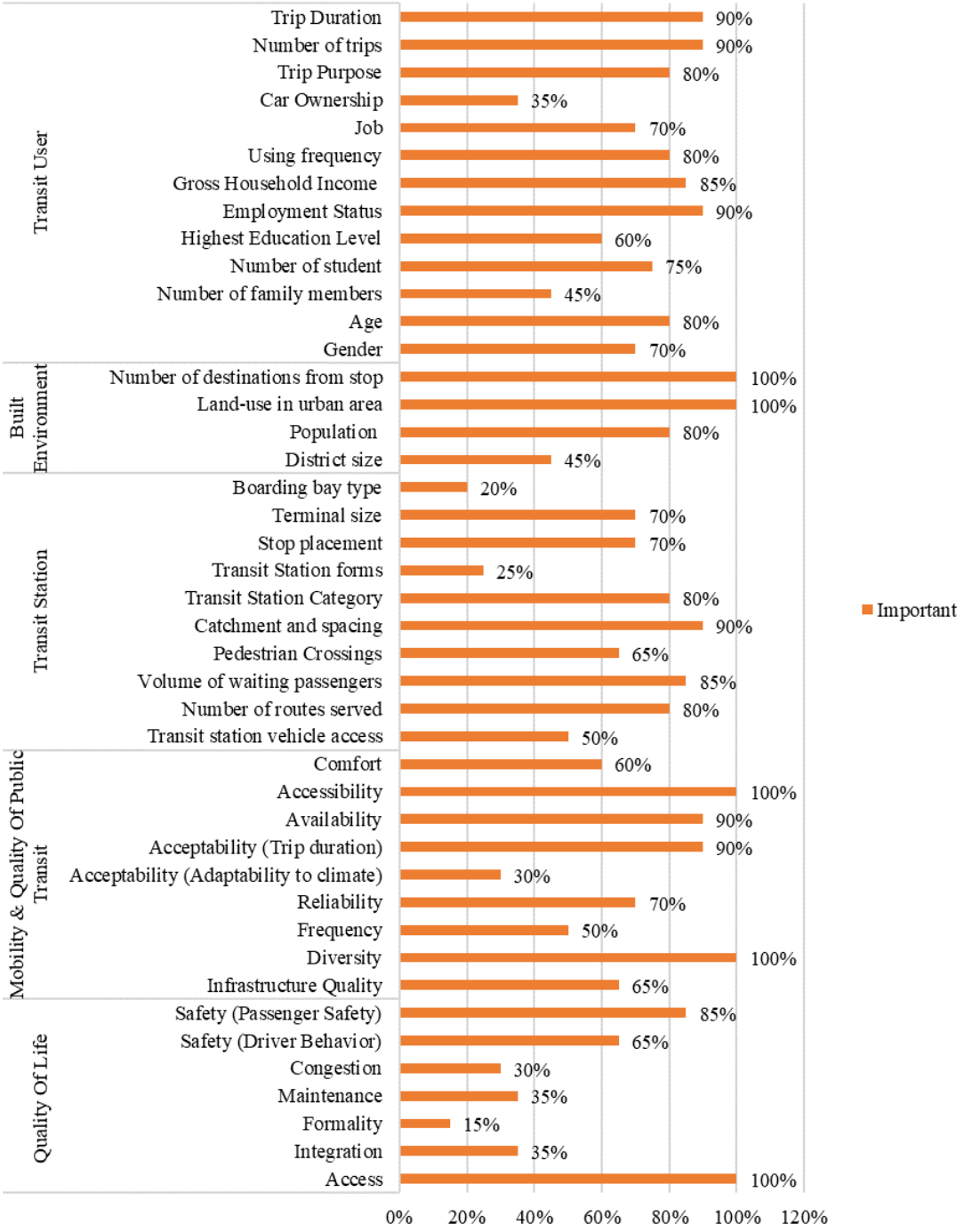

Figure 6. Results for specialist interviews, The researcher

Table 6. Comparing among Giza districts in (district area, residential area percentage, non-residential use percentage, roads percentage, occupancy rate, [30]

	District area	Residential area	non-residential use	Roads	Occupancy
North of Giza	2375.1	53%	22.6%	17.1%	70.9%
Dokki	**1282.7**	**40%**	**35.2%**	**23.7%**	**72.9%**
Al Haram	12976.9	27.6%	31.6%	22.4%	55.7%
Boulaq El Dakrour	2876.5	63.3%	19%	15.2%	69.9%
Al Agouza	1963.3	50.2%	22.2%	27.6%	63.4%
South of Giza	3232.2	24.4%	42.7%	17.3%	64.3%
Al Talbia	2392.1	24.4%	25.25%	17.8%	61.9%
Al Warraq	5276.6	27.5%	19.3%	13.9%	74.6%
Al Omraniya	1737.0	54.5%	21.3%	18.4.%	70.1%

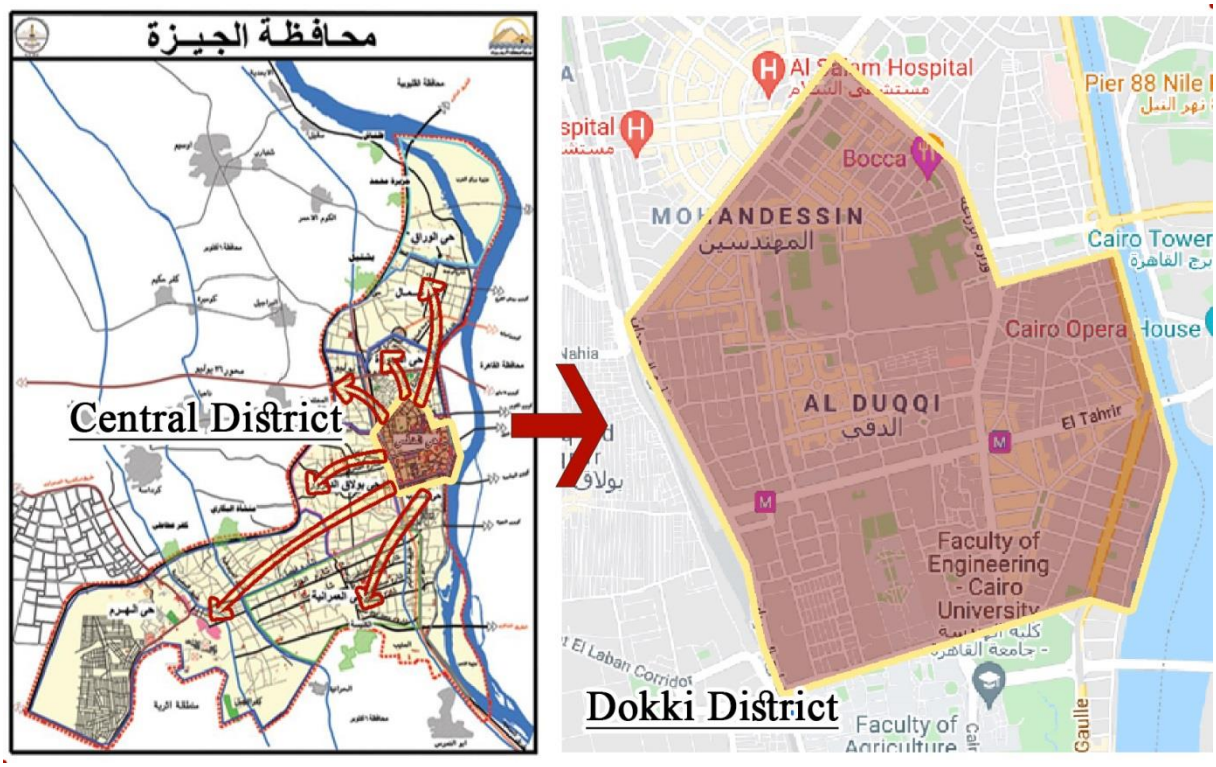

Figure 7. Map 1: show centralization of Dokki district to other districts in Giza governorate, Map 2: zoom in Dokki district, the researcher, based on [31, 32].

4.2. Determining Study Area (second stage)

Giza Governorate is divided to nine districts. Dokki district is one of Giza Governorate districts with a central location connecting between Giza and Cairo governorate. According to the report of planning and building regulations and requirements, Dokki district has a high occupancy rate comparing to other districts (the second highest occupancy, see Table 6) [30]. Therefore, the researcher chooses this district to be the study area due its high occupancy, importance and central location (see Figure 7).

4.3. Transit user's Questionnaire (third stage)

Several results were derived from transit user questionnaire. For gender, the percentage of males was 51.7%, and females 48.3%. Age ranged from 20 to 29 years old, that's may be due to the proximity to Cairo University campus. As for employment statues, the largest number of users was students. The trip purpose varied between (personal purpose – social/ recreational – reach to another station – work). From frequency of using transit stops, the researcher managed to determine transit stops with (high – medium – low) frequency use as shown in Table 7.

Table 7. Answer for transit user's questionnaire (most common answers), the researcher

Parameter	Most common answer		Percentage
Gender	Male		51.7%
Age	20 - 29 years old		62.6%
Educational level	under graduate		74.0%
Employment status	Student		37.1%
Gross household income	average from (2000-7,000) EGP		37.9%
Trip purpose	personal purpose		30.2%
	social/recreational		27.1%
Frequency	Stop 6	42.9%	High frequency use
	Stop 1	25.9%	High frequency use
	Stop 5	13.6%	Medium frequency use
	Stop 8	5%	Low frequency use

Table 8. Results of transit user's questionnaire (compare between the four stops), sub-parameters get the same results, the researcher.

	Employment status	using frequency	Access	Reliability	Pedestrian Crossing	Maintenance	Acceptability	Comfort
stop 6	Employee at a private institution	sometimes	Walking	from 5 to 10 min	1	1	No	No
stop 1	Employee at a private institution	sometimes	Walking	from 5 to 10 min	1	1	No	No
stop 5	Employee at a private institution	sometimes	Walking	from 5 to 10 min	1	1	No	No
stop 8	Employee at a private institution	sometimes	Walking	from 5 to 10 min	1	1	No	No

Comparing results of the four selected transit stops (6, 1, 8, 5) from transit user's questionnaire showed that the majority of answers for sub-parameters (access – maintenance - frequency - reliability – acceptability – comfort - pedestrian crossings - user relation to Dokki district – job - car ownership - using frequency) were the same answers see Table 8, which indicates that all these sub-parameters are not effective.

However sub-parameters such as (availability – catchment and spacing – trip duration – driver behavior - passenger safety – accessibility – number of trips – trip purpose) differ from the previous sub-parameters as shown in Table 9. Such as availability, stop 6 (high frequency use) is available at (1 to 5 min walking time), on the other side transit 8 (low frequency use) is available at (6 to 10 min walking time). Trip duration and the number of trips for stop 6 are less than stop 8. Other sub-parameters such as passenger safety and driver behavior are also varied between stop 6 and stop 5. Trip purpose is also varied between the four transit stops which affect using frequency (see Table 9).

4.4. Transit Stops Field Survey (fourth stage)

Another comparison was held for the four transit stops depending on the field survey. Parameters such as (integration – formality – maintenance – passenger safety – infrastructure – frequency - acceptability (Adaptability to climate) – comfort - transit station vehicle access - pedestrian crossings - transit station category - transit station forms - stop placement - terminal size - boarding bay type) are not influencing paratransit stops frequency use because it's not effective for attracting transit users as concluded from the field survey. For formality, stop 6 (high frequency use) is an informal stop even though, stop 8 (low frequency use) is a formal stop. For maintenance, stop 6 and 8 are not maintained. Availability of shades and sitting elements is also not effective because stop 6 and 8 are not adapted to climate and didn't have any sitting elements.

On the other hand, sub-parameters as (access –

diversity – reliability – trip duration – number of served routes – volume of waiting passengers) are very important. For access, accessibility options to reach stop 6 (high frequency use) is more than stop 8 (low frequency use) see Table 10. For diversity, stop 6 and stop 1 are better than others because it's close to different types of transit stations. Volume of waiting passengers for stop 6 is less than stop 8, which refers to the frequency of transit vehicles pass throw. On the other hand, the number of destination and trip duration are also effective sub-parameters because they influence the time transit user takes to reach to his destinations. Other Sub-parameters as reliability influences time transit vehicle takes to depart or reach other transit stops. All the affected sub-parameters are extensively described in Table 10.

Table 9. Results of transit user's questionnaire (compare between the four stops), sub-parameters get different answers, the researcher.

	Availability	**catchment and spacing**	**Trip Duration**	**Driver Behavior**	**Passenger Safety**	**Accessibility**	**Number of trips**	**Trip Purpose**
stop 6	1 to 5 min	10 min	from 15 to 29 min	3	3	To some extent	1	to reach another station
stop 1	6 to 10 min	10 min	from 15 to 29 min	3	3	No	1	Work
stop 5	1 to 5 min	5 min	from 30 to 44 min	1	1	To some extent	1	Work
stop 8	6 to 10 min	10 min	from 15 to 29 min	3	3	No	2	personal purpose

Table 10. Result of transit stop's field survey, comparison between 4 transit stops in Dokki district, the researcher.

	Access	**Diversity**	**Reliability**	**Trip duration**	**Number of routes served**	**Volume of waiting passengers**
stop 6	car-public transport - walk-metro	Park area - public transport - metro station	range from 5 to 20 min	1. 30-45 min 2. 30-45 min 3. 30-45 min	1- Faisl st. al eshreen 2- Tahrir 3- Shubra - Boulak - Aboud	From 2 to 15 (users/m2/min)
stop 1	car-public transport - walk-metro	Park area - public transport - metro station	range from 5 to 30 min	1. > 45 min 2. > 45 min 3. 15 - 29 min 4- 15 - 29 min	1- Faisl st. twabek 2- Faisl st. To Tahrir square 3- Faisal St ring road 4- Ard El Lewa - Boulaq - Imbabah - Gameat Al Dewal Al Arabeya st.	From 5 to 30 (users/m2/min)
stop 5	car-public transport - walk	Park area - public transport	range from 5 to 15 min	1- 30-45 min 2- 30-45 min	1- Cairo university - Giza - Haram 2- Ramses - Ataba	From 2 to 10 (users/m2/min)
stop 8	walk	Metro station	range from 5 to 15 min	> 45 min	kerdasa	From 5 to 10 (users/m2/min)

Table 11. Results of mapping land use for the four selected transit stops, the researcher.

	Types of Land use around transit stops	Number of sectors	Number of destination
stop 6	(□ Entertainment – □Educational – □Commercial - □Green area - □ Parking - □ Mix use - □ Business - □ Religious - □ Culture - □ Residential - □Institutional - □ Health)	5	12
stop 1	(□ Industrial - □ Empty-land - □ Mix use - □ Institutional - □ Culture - □ Religious - □Educational - □ Residential - □ Health - □ Entertainment - □ security services)	3	11
stop 8	(□ Business - □ Mix use - □ Institutional - □ Residential - □ Parking - □ Industrial - □Educational - □ Religious - □ Health - □ Culture)	4	10
stop 5	(□ Mix use - □ Residential - □ Industrial - □ security services - □ Health - □ Religious)	1	6

4.5. Mapping Land Use (Fifth Stage)

Transit stops with high frequency use are connected to the number of sectors larger than transit stop with low frequency use (see Figure 8, Table 11). High frequency transit stops are also connected to the number of destinations larger than other stops with lower frequency use. This implies that the number of connected sectors, types of land use, and the number of destinations are very important and have a great influence on frequency of use for transit stops.

Figure 8. Sample of documenting maps, the researcher

5. Discussion and Conclusion

The main purpose of this research is to investigate the main parameters affecting on the formation of informal paratransit stops in existing urbanism, to build a knowledge base for further researches which could help to solve this problem in the future. Accordingly, the researcher proposed five main parameters (quality of life, mobility and quality of public transit, transit station, built environment, and transit user) which could be responsible for the formation of informal paratransit stops. These parameters were selected to analyze the main principles of the paratransit stop, investigate the influence of mobility, understand the main characteristics of transit users and the context where the paratransit stops formed. Analyzing these parameters will consequently affect urban designer's decision for designing formal transit stops.

The research used a methodology consisting of five stages and different types of surveys. By comparing the results from different surveys (specialist interview – transit user's questionnaire – transit stop field survey – land use mapping), one may conclude the effect of the main parameters and sub-parameters. The results from different stages, confirmed the importance of all the main parameters on the formation of informal paratransit stop. The parameter of mobility and quality of public transit was confirmed to be the most effective parameter. (see Figure 9). Sub-parameters such as accessibility is an essential one as it measures the ease of reaching the paratransit stop. If there were different accessible means of transit to reach the same paratransit stops it will be more accessible than other transit stops. This result is compatible with the result of Blanco's research which indicates the importance of accessibility and how it affects user's walkability [4]. Availability is also a significant sub-parameter. If users couldn't reach the transit stop in a reasonable walking distance they will prefer to walk to another station or to use another mean of transit. The time transit user takes to reach from one destination to another determines if he will take a microbus, metro or bus …etc. It is important for the transit user to reach the stop as fast as possible. The availability of transit vehicle in reasonable time intervals is an essential factor. Therefore, the sub-parameter reliability was very important. Sub-parameter (diversity) was also an effective one. It is an influential factor for users to reach different means of transit from the same paratransit stop, because it will facilitate to reach different destinations. These results agreed with Putra's research that public transit reliability affects the quality of service and affects user's satisfaction [10].

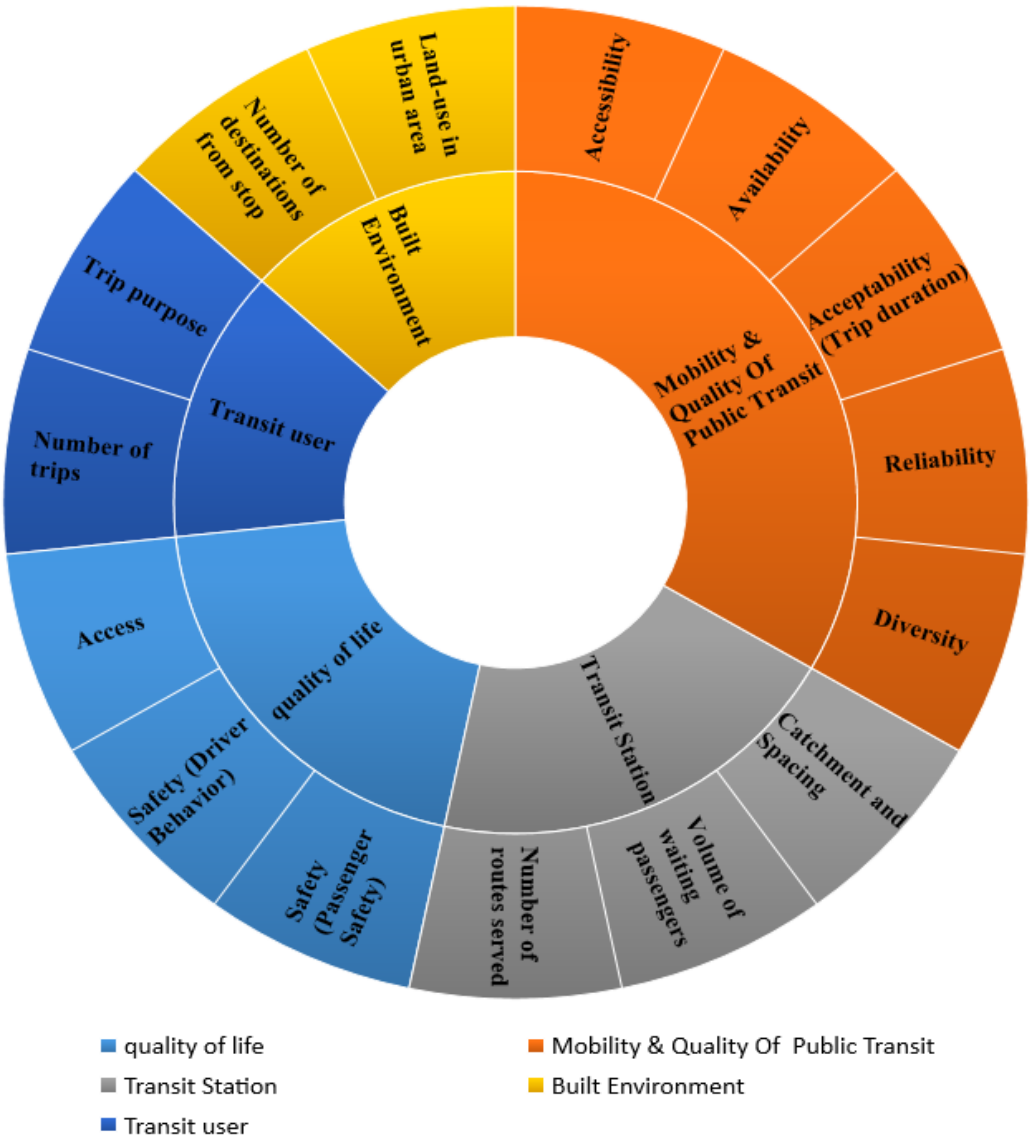

Figure 9. The grade of importance for all main parameters, the researcher

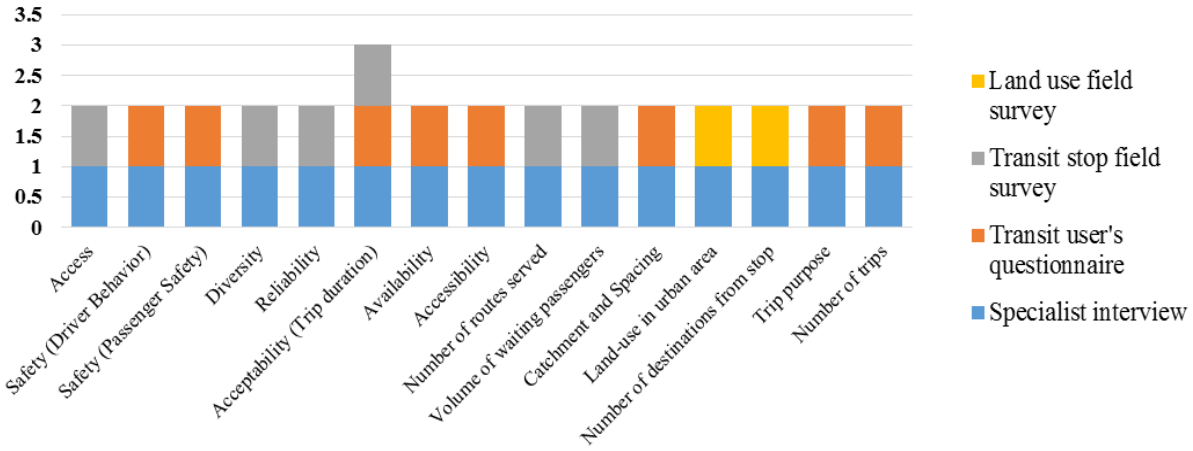

Figure 10. Comparing results from all surveys to confirm sub-parameters importance, the researcher.

Results also confirmed the significance and importance of sub-parameters from specialist interview and transit stop field survey such as (access – diversity – reliability – acceptability (trip duration) – the number of served routes – the volume of waiting passengers). Access refers to the number of available options to reach the paratransit stops which refer to how this stop is accessible for transit users. Other sub-parameters such as trip duration is an essential factor for vehicle drivers to decide where the best point to reach a large numbers of users (volume of waiting passenger), to take the shortest path, and to take the shortest time to reach their destination. At these specific points where paratransit stops are formed, transit vehicles could reach different destinations. Therefore, the number of served routes available at the same point encourages a larger number of users to ride from this paratransit stop.

The effectiveness of other parameters was confirmed from specialist interview and from transit user's questionnaire such as (driver behavior – passenger safety - acceptability (trip duration) – availability – accessibility – catchment and spacing – trip purpose – number of trips). Sub-parameters such as (driver behavior and passenger safety) are very important sub-parameters but they didn't have the same grade such as other sub-parameters. For transit users there is no escape from riding from particular paratransit stop if there is no other option to reach their destinations. For trip purpose and numbers of trips are essential for determining the best mean of transit to reach your destination, especially when the reason to take the paratransit vehicles is repeated daily such as going to work.

Finally, the importance of sub-parameters as (land use in urban area – the number of destinations) was confirmed through both specialist interview and land use field survey results (for all results see Figure 10). These sub-parameters are very important because some paratransit stops informally formed beside a great variety of land uses to reach a large number of transit users. This result is compatible with the recommendations of Mohareb's research of how informal transit system fills the gap of formal transit system and how the formal transit system didn't consider types of land use in the district [6]. Other parameters such as transit station form and transit station category are not very effective as showed in Lai's research [9].

All of the previous parameters and sub-parameters encourage users to use paratransit stops which are easily accessible and have many motivating factors which attract transit users, even if it was considered as a paratransit stop. The proposed methodology used for measuring parameters effectiveness, may guide future studies that can help in proposing solutions for limiting the formation of informal paratransit stops. Further researches are recommended to study other urban areas or to apply this methodology on studying and analyzing transit stations which connect governorates with each other.

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