Towards an Integrated Mobility System; The First and Last Mile Solutions

The Case Study of New Cairo

A Thesis submitted in the Partial Fulfillment
for the Requirement of the Degree of Master of Science
in Integrated Urbanism and Sustainable Design

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Abstract

With the urban expansion and the suburbanization happening in Egypt, especially in Cairo, satellite cities are getting more and more planned to be car-dependent. As a result, the efforts are lacking in the mass transit sector in those cities. On the one hand, the mass transit networks are limited in capacity as well as in coverage. And on the other hand, even the available services are hard to reach from most of the areas in those new urban communities. This inefficiency in first and last-mile solutions might reflect in the ridership of those mass transit services.

Thus, this research aims to explore the relationship between the first and last-mile solution, as part of an integrated mobility system and the ridership of mass transit in new urban communities, such as New Cairo. To do so, the current public transportation network and the current first and last-mile options are mapped and analyzed. Furthermore, the mobility patterns of New Cairo residents, as well as their willingness to use first and last-mile options and thus their encouragement to use mass transit, is being examined through an online survey. Moreover, interviews with service providers are conducted to explore possible cooperation and integration between the different stakeholders to try to achieve an integrated mobility system.

As a result of this research, New-Cairo's transportation system has a variety of different trunk network services that manages to connect New-Cairo to the GCR. However, there is an intra-city mobility deficiency that appears in the lack of First and Last miles' solutions. Based on the analysis results, there is a clear relationship between the lack of First and Last mile options and mass transit ridership.

This research acts as a base to explore the approaches of planning an integrated mobility system in Egyptian cities, especially new urban communities. Further research needs to build on the findings of this research and enhance the potential solutions for the first and last mile system.

Keywords: First and last-mile solutions; Integrated mobility systems; Mass transit ridership; Satellite cities; New Cairo; Online Survey; Willingness to shift; MaaS

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Part I: Introduction

1. Chapter 1: Introduction

1.1. Problem statement

Urban mobility is a huge challenge facing megacities nowadays. The urge for people to move from one place to another daily requires a reliable mobility system that supports various modes of transportation. Walking, cycling, riding a bus, underground or a taxi are the known traditional transportation modes in most cities. However, due to the vast urban expansion and population growth, a lot of informal modes started to take place in different neighborhoods. Also, technology began to take initiatives. Some private companies started to introduce new means of transportation, be it car sharing (carpooling), ride-hailing applications like Uber and Careem or by having privately-owned buses that run parallel to the governmental buses like SWVL and Uber Bus. These services were created to fill in a demand niche and targets specific people in our society.

Nevertheless, for the mobility to become better and enhanced, there needs to be an integrated system connecting all these services. This integrated system needs to start right before the homes of people and end when they arrive at their destinations. Here is where the first and last mile solutions need to step

in. These solutions act as a gateway to all mass transit modes and thus require special attention.

With the urban expansion and the suburbanization happening in Egypt and Cairo, satellite cities are getting more and more planned to be car-dependent. As a result, the efforts are lacking in the mass transit sector in those cities. On the one hand, the mass transit networks are limited in capacity as well as in coverage. And on the other hand, it became hard to even reach those mass transit services from most of the areas in those new urban communities. This inefficiency in first and last-mile solutions reflects in the ridership of those mass transit services.

In this research, the relationship between the first and last mile solution and the ridership of mass transit in new urban communities, such as New Cairo, is being explored. This research acts as one of the first steps in exploring the approaches to plan for an integrated mobility system in those cities.

1.2. Research Question

The research explores the effects of having integrated first and last-mile solutions on the ridership of mass transit services. Thus, it also identifies the current gaps in the network to see if these gaps were to be filled by adequate first and last-mile solutions, how it would reflect on the ridership.

Hypothesis

The absence of integrated solutions reduces the use of mass-transit services system in New Cairo.

1.3. Objectives

There are five objectives for this research to be able to test the research questions and hypothesis.

The first objective is **to analyze the mass-transit network in New Cairo.** The mass-transit network of New Cairo will be analyzed to identify the hotspot

areas with most of the mass transit services. These hotspot areas are indicators for the points to which the first and last mile solution should connect to.

The second objective is **to analyze the first/last/only (FLO) miles' options in New Cairo**. The FLO miles' options available in New Cairo will be identified and mapped. These options will be further analyzed to understand the types and characteristics as well as identify the gaps, strengthes, and weaknesses of each option.

The third objective is **to explore the impact of an integrated first and last-mile system on the mass transit ridership in New Cairo.** To achieve this, the types of first and last-mile solutions that might encourage residents to commute using mass transit needs to be explored and identified.

The fourth objective is **to understand the planning approach used by service providers to plan their routes including the FLO miles.**

1.4. Scope and Limitation

The scope of this research is limited to the objectives listed above. While the main limitation for this research is the corona virus pandemic, as the country was in partial lock-down and in quarantine state from March 2020 until June 2020 when it started to partially re-open. As a consequence, during this period the mobility system was not working in its full capacity and the commuters' travel behaviors were affected. Thus, the methodology is modified to target the ordinary state before the pandemic. Moreover, there is a lack of open source data in the mobility field in Egypt, as most the available data is confidential. Also, some of the main Cairo mobility literature were outdated, as the last decade has witnessed major changes in the mobility sector that was not efficiently reported and documented.

1.5. Overview

To be able to investigate the hypothesis and fulfil the objectives of this research, a variety of methods and approaches need to be used. Thus, the methodology is divided into two main parts, the data collection part and the data analysis one. The data collection is the base of the research as its aim to collect data within several areas and with several approaches. International trends and data regarding the topic of the research will be collected through literature review and desktop research, acting as a secondary data source and including resources from worldwide and Egypt. Primary data will be collected on the current public transportation network through public transportation mapping, desktop research, as well as interviews. Studying the current network gives a solid background knowledge to be able to build upon it the rest of the research regarding the FLO services and the effects on the ridership. Furthermore, data on the FLO will be collected through mapping and interviewing commuters, as well as from getting insights from the survey, which is the primary tool to gather data for identifying the potential impacts of the FLO services on the ridership.

As for the data analysis, the same division is present as the data collection part. The current network is being analyzed on two aspects, the public transportation network and the FLO solution. Each aspect is being analyzed through qualitative approaches varying from network analysis, mapping, and interviews. As for identifying the potential impacts on the ridership as well as understanding the mobility patterns of the New Cairo residents, a quantitative analysis of the survey will be conducted.

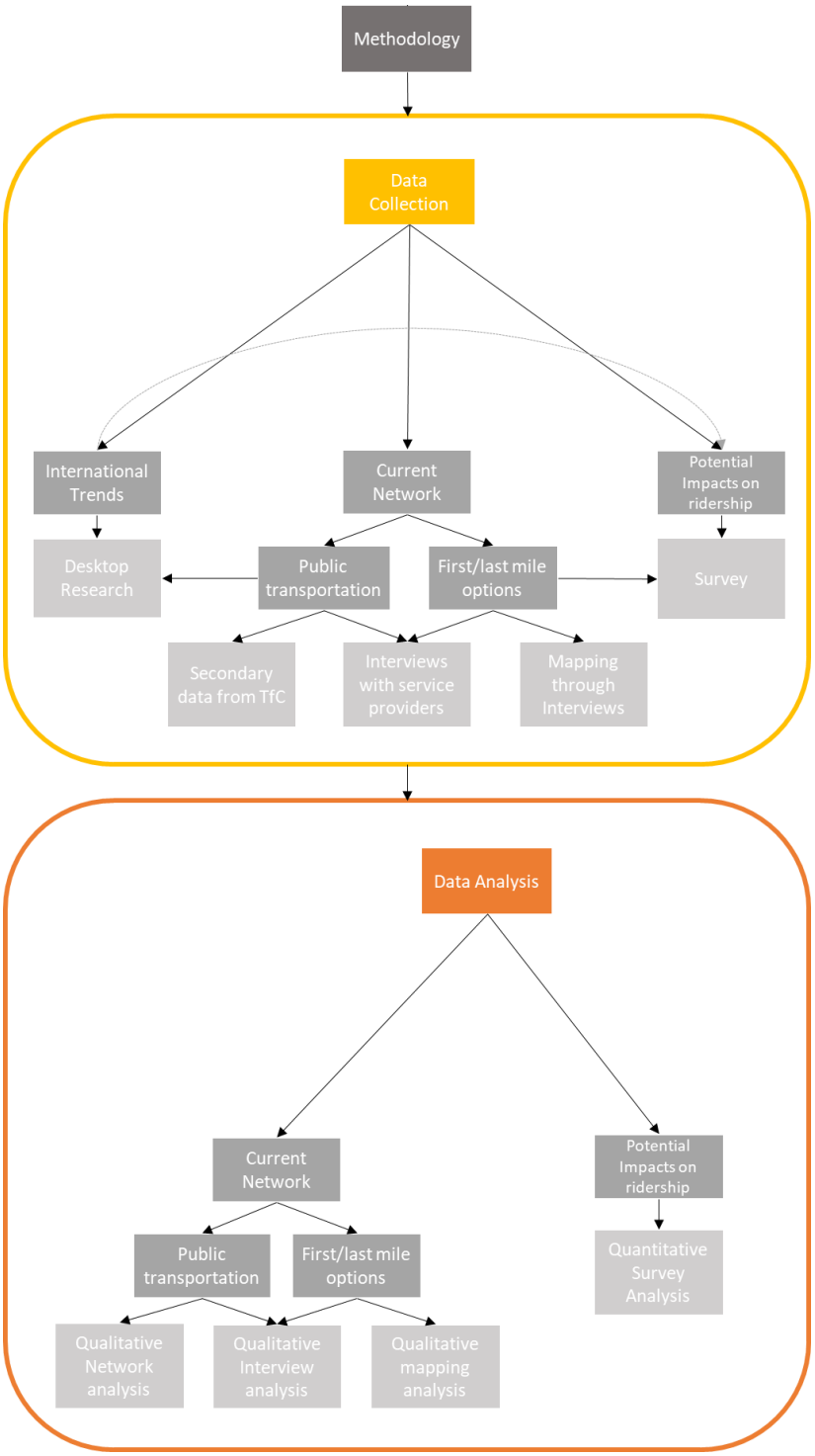


Figure 1: Overview of the research flow

Part II: Background

2. Chapter 2: Integrated mobility systems worldwide

In this chapter, an overview of integrated mobility system approaches will be presented and mainly the evolving Mass as a Service (MaaS) systems. In addition to that, the international first, last and only (FLO) miles' approaches and trends.

2.1. MaaS as an integrated mobility system approach

Mobility and city planning are two directly related challenges. With time, cities tend to expand or shrink, and consequently the mobility systems get affected by these changes and should reflect on it. In the 19th century, after the inception of public transportation, mainly expressed in railways, people used to live where the stops of these services existed, and these services were chosen to be located where the people were living. However, after the second world war and in the

middle of the 20th century, motorized private public transportation modes started to appear. Thus, the people did not need to live near the public transportation stops anymore, which encouraged the cities to expand and get bigger. (European Environment Agency, 2020).

As cities started expanding, transportation within the city became a challenge for people who do not own a private vehicle. So, transit vehicles were introduced, which follow a certain transit line and pass by specific transit stops. By increasing the demand of the mass transit services, and the expansion of the cities, the mobility system had to be categorized into two main services. A main long-distance service that is mainly in form of high-demand buses, railways and/or metro lines which are usually called trunk network. And the other service is a complementary service that tends to connect the commuters to the main service by using modes such as local buses, mini buses, etc. These services are called feeder network systems (Neumann, 2014).

By the end of the 20th century, the information and communication technology (ICT) began being used in developing the mobility system. It started by developing the available travel information of the existing modes into digital platforms instead of the dispersed information on paper. Later, they tried to integrate between the existing modes to have a multimodal travel information. Recently, planners tend to merge multimodal trip planning, booking, payment and ticketing in one digital system in order to facilitate the usage of public transportation for users (Lyons et al., 2019).

Mobility as a Service (MaaS) concept

One of the main integrated systems approaches is called Maas (Mobility as a Service). MaaS tends to offer access to an integration of different transport services such as public transport, ride sharing (car/scooter/bike), active modes and etc. in a digital mobility platform. The MaaS approach was firstly introduced by Nico Tschanz and Hans-Dieter Zimmermann in 1996, who envisioned an intelligent information assistant. It also tries to offer a

multimodal experience for commuters by having it based on active mobility modes and public transportation systems.(UITP, 2019). This aims to encourage the commuters for a transition from owning private transportation vehicles to using shared ones (European Commission, 2011).

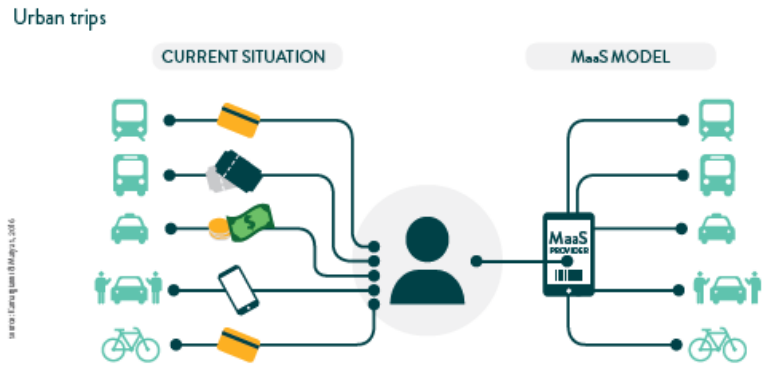


Figure 2: MaaS Model service (Source: UITP, 2019)

MaaS key players

The MaaS approach is mainly based on the existing services and tends to gather them in one platform. Whilst the approach is mainly commuter based and tends to serve the commuter a personalized experience combining the existing modes. However, in order for this to happen, the multiple service providers should collaborate and work together which is a complicated task. Thus, another key-player has to enter the mobility field, the integrator
Thus, the integrator, the service provider and the commuter are the main three key players in the MaaS approach.

The Commuters

MaaS is a user-centric approach, that tends to enable the commuter a personalized experience of navigation, pre-planning the trip, booking, payment and ticketing for a multimodal trip.(European Commission, 2011; UITP, 2019). It also brings all the existing modes and operators in one platform which

enables the commuter to compare and choose the most convenient, suitable, price worthy, customized trip(Kamargianni and Matyas, 2017). Thus, by using MaaS, the user would be able to have a door-to-door commute with a reduced cognitive effort and without needing to own a private vehicle. (European Environment Agency, 2020; Kamargianni et al., 2016)

This will encourage the private car users to use public transportation, however it will not be easy for these users to give up their cars. The modal shift from private cars to public transport would only happen if the Maas system succeeded in offering a high-level quality, convenient, reliable and a relatively low-cost service. Moreover, it should be integrated with real-time travel information and a good brand that can attract private car users. In addition to that, it should avoid some of the disadvantages of using a private car, which are mainly cost and effort exerted in driving, maintaining and parking. These factors combined would encourage the private car users for a shift in their mobility mode choice, leading to a more sustainable mobility system with a reduced number of private cars.

As for the current users of public transportation and shared mobility services, the MaaS system would try to offer them a better commuter experience. That would happen by offering them several mode choices and giving them the option to have better value for money (UITP, 2019).

Generally, one of the most important factors in the MaaS system would be the personalization. The system should be able to adapt to different users' needs and lifestyles and offer them the most suitable services for their case in an easy, user-friendly, transparent and non-discriminatory way (Geier, 2019; UITP, 2019).

The Service providers

The mobility systems have witnessed a noticeable increase in the types of mobility modes by the end of the 20th century. A lot of formal and informal modes found their way to cities. Some of them were based on digital technology

development and relating it to the mobility modes, while others were mainly local solutions to fill some gaps that the available modes were not able to cover. Therefore, MaaS approach tends to gather all the available services in one platform.

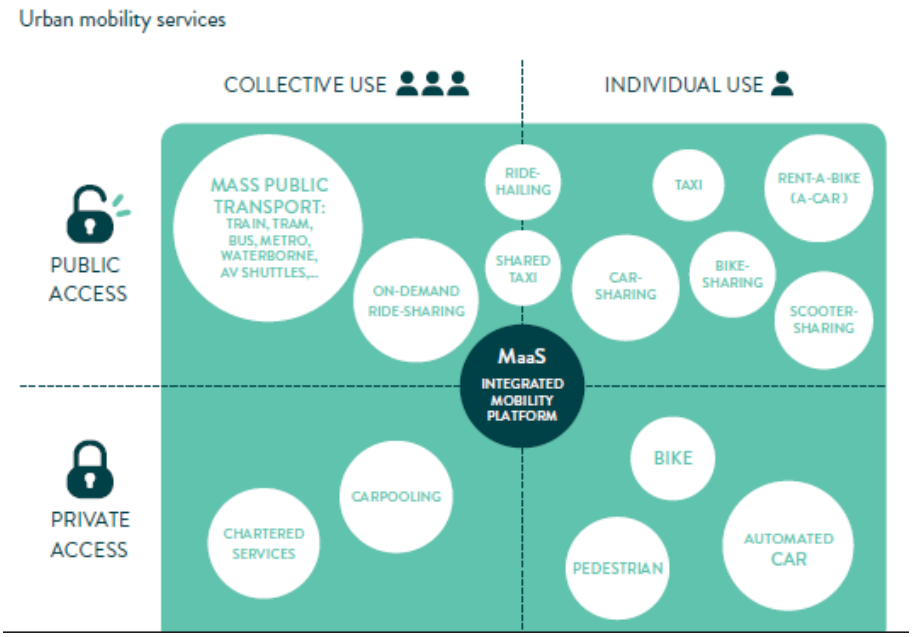


Figure 3: MaaS Integrated mobility platform (Source: UITP, 2019)

The service providers tend to develop through time, and cope with the surrounding circumstances in order to develop a sustainable business model. While shifting to the MaaS approach, they would be able to use of the information and communication technology (ICT) in the MaaS system which also helps the service providers to plan their services more sufficiently. It helps them to develop business concepts that enables them to have the best usage of their capital and vehicles. In addition to that, it helps in utilizing a better infrastructure, and an optimized transportation network, and smooth seamless trips (Kamargianni and Matyas, 2017).

However, MaaS approach triggers some risks to the service providers. Mainly that they will lose their direct contact with the commuter, and the integrator would be the gatekeeper to the relation between the commuter and the provider. Also, the data for their business model would be available to their competitors, and the competition between them would increase to supply the needs of the commuters and attract them as they will be directly compared within the MaaS platform.

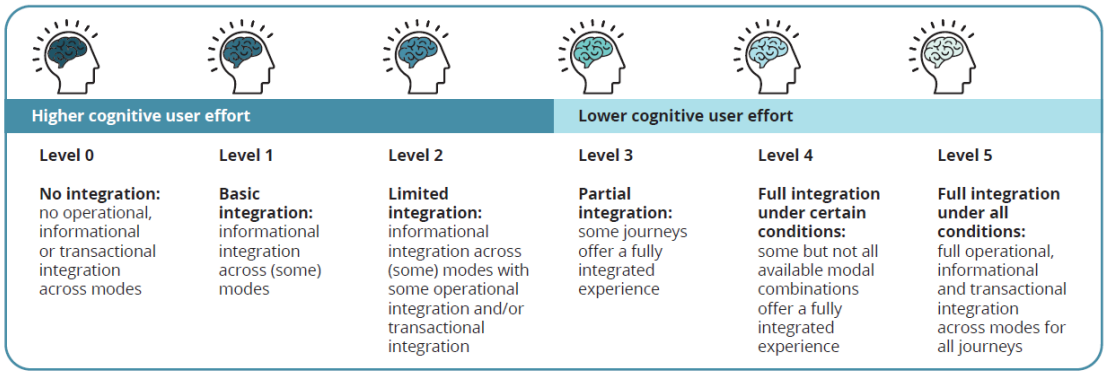
The Integrator

The integrator is the newly introduced key player within the mobility system. The integrator can either be a private firm or a local transportation authority. The choice between them mainly depends on the local context of each city, as well as the capabilities and capital of the local transportation authorities, and the power and development of the private business sector.

MaaS integrator would be the responsible entity for setting up the MaaS platform and creating an attractive business model to attract the service providers in order to attract the commuters. The platform should guarantee neutrality and fairness to the service providers. Also, it should be up to date and include any new services being introduced in the mobility field, whilst being user-friendly and having a strong brand in order to attract the commuter. The complexity of the role of the integrator comes to dealing with all these key players and maintain a good relationship with them both in order to scale up and create a sustainable integrated mobility system. As the system would not succeed if any of the key players (the commuter or the service provider) were not happy about the approach and did not support it (UITP, 2019).

Levels of integration

The integration in a mobility system can take place in several levels. Older approaches tried to have an integrated concept covering several mobility characteristics. Whilst MaaS approach tends to have a fully integrated travel experience with the least user cognitive effort as shown in Figure 4.



Notes: Cognitive user effort: the effort involved in relying upon the mobility system beyond the private car to fulfil mobility goals; operational integration: interchange penalties are low and door-to-door journey experience is 'seamless'; informational integration: journey planning and execution information for available modes is offered through one interface; transactional integration: payment and any required booking and ticketing is offered through one interface.

Figure 4: Levels of Integrated Mobility (Source: European Environment Agency, 2020)

There are several levels and characteristics of integration such as; ticket and payment integration which are one of the very first approaches that planners developed. The integrated payment and ticketing system includes a smart card that can be used in different mobility modes and services. The second is the mobility packages, in which the commuters can pre-pay for their trips either calculated by time or distance or a different model that combines the mobility services. Moreover, there is the travel information integration, where there is a platform in which all the travel information of the different mobility modes and services exist and might allow pre-booking for them (Kamargianni et al., 2016). Several studies have shown the positive impacts of the integrated services on the ridership of commuters. In a case study of the effects of ticket and payment integration in Paris, by offering free transfers between all the existing services,

the public transportation operating expenses decreased by 12% within the year of 1945 and 1975. Moreover, the ridership increased by 33% within the period of 1975 to 1993 (NEA, 2003 in Kamargianni *et al.*, 2016). Furthermore, in Singapore, The commuters at train stations were doubled by only enabling the usage of the different mobility modes with the same ticket and pricing without needing to exit and reenter (Prakasam, 2009 in Kamargianni *et al.*, 2016). As for the mobility packages, it also had several positive effects on the ridership of mobility services. Statistical survey analysis in Switzerland has shown that the mobility packages helped car-users to commute without the need of their cars. Almost 90% of the survey respondents no longer need to use their cars in commuting (Schad et al., 2005 in Kamargianni *et al.*, 2016). Moreover, Season tickets can be included in mobility packages integration. Season tickets ownership in Switzerland positively affected the public transportation ridership (Axhausen et al., 2000 in Kamargianni *et al.*, 2016). In addition to that, the ICT integration in the mobility services has been desired by the commuters at all the trip stages: pre-trip, way-side and on-board stages. This service has succeeded to cover the demand of individual trip planning, real-time route adjustments and multimodal transportation in several case studies in Dresden and Rhine-Neckar in Germany as well as cities in Netherlands (Grotenhuis et al., 2014 ; Eryilmaz et al., 2014; Stopka, 2014 in Kamargianni *et al.*, 2016) Helsinki integrated mobility model tends to be ranked one of the highest. It tends to include all of the previously mentioned factors such as payment and ticketing, mobility packages and ICT integration within a variety of transportation modes. These varieties recently include bike-sharing, car-sharing, car-rental, railways, public transportation buses, taxi services and on-demand transport. In addition to that, several integrated mobility models have also shown success in several cities across the globe but with a fewer offered mobility services compared to Helsinki model such as; Ubigo system in Gothenburg, SHIFT system in Las Vegas, Optimod' Lyon system in Lyon, Smile

system in Vienna, and Mobility Mixx, NS-Buissness Card and Radiuz Total Mobility in Netherlands. (Kamargianni et al., 2016).

Challenges and risks of Maas

The private car users are the main obstacles facing any sustainable mobility approach, as it is always hard to switch the car users into mass transit service commuters. Moreover, the cars development technology these days are driven towards fully automated vehicles. These vehicles would be a great future challenge for any sustainable mobility approaches as it will solve one of the main private vehicles disadvantages which is the driving and parking efforts. Thus, with this technology getting closer, a lot of new mobility services would be introduced and some of them may include mass transit modes that need to be integrated in a MaaS platform(UITP, 2019).
Furthermore, MaaS as an approach would only be applicable if the existing transportation network and mobility modes are covering the city. MaaS mainly depends on the existing services, and tends to have public transportation services as its backbone and the ride-hailing services as an attractor for car owners. So, in case that the existing transportation system is not sufficient and the only services provided are private transportation vehicles, the MaaS system could increase the number of vehicles in the city (Mulley, 2017). Thus, investing in filling the existing gaps and developing the public transportation sector is an obligatory pre-phase for having a successful MaaS system (Hensher, 2019 in European Commission, 2011).

In conclusion, MaaS tends to create a platform with all the available service providers in order to offer the commuters an integrated door to door trip experience, including planning the trip with comparing the various options they have in order to pick the most sufficient trip that satisfies their personal needs. By doing so, it tends to decrease the car dependency as it is the main obstacle facing any sustainable mobility system approach. However, MaaS

system is based on the existing mobility modes. Thus, a well-developed mobility network covering the cities and offering alternative mobility solutions is the foundation of this system. Moreover, any gap in a part of the system will affect the door to door experience offered by MaaS such as the first and last mile issues. If such issues were not solved before the system was introduced, they would be favoring the personal mobility modes such as ride-hailing and car-sharing as they will offer door-to-door experience rather than the mass-transit modes.

2.2. First and last mile trends worldwide

In order to have a sustainable mobility system, the number of vehicles on the streets should be minimal to minimize the environmental effects, as well as the urban effects such as congestion and noise pollution and etc… Thus, urban planners tend to encourage people to use mass-transit services. However, mass-transit services are only organized in fixed routes passing by several stops and hubs. In order to reach these stops and hubs, first and last mile mobility solutions tend to take place (European Environment Agency, 2020). The first mile is the first part of the mobility trip, or it is the trip from the commuter's original location to the mass-transit stop. While the last mile is the last part of the mobility trip, or it is the trip after the arrival from mass-transit stop to the desired destination. Moreover, the only mile is the trip that you can access it directly from your location without the need to merge with a larger trip. The issue of the first, last and only miles are not new, it exists since the beginning of the development of mass-transit services. However, this issue started to arise when the first/last/only miles' trips' length started to increase. This issue happens as the cities expand, or if the mobility system is not developed and has only a few routes that do not cover the city well. The main issue here facing the urban planners and service providers is how to connect the individual pick-up locations of the residents to the city's transportation network or the desired destinations. (Liu and Porter, 2017).

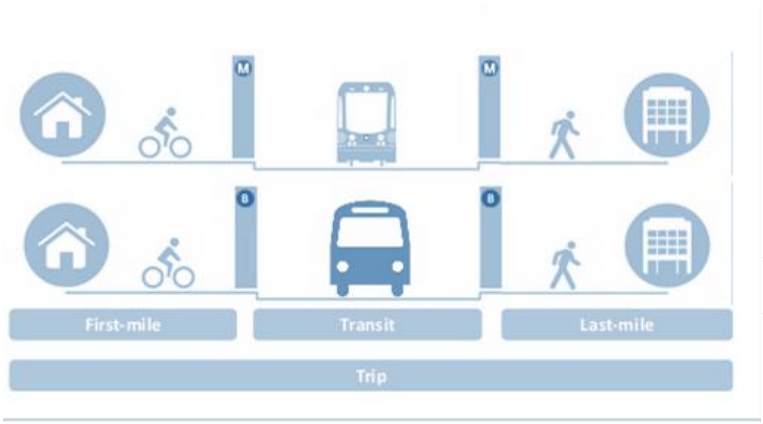


Figure 5: Left: First and Last Mile concept (Source: WRI India Source center); Right: Only Mile concept

First/last/only miles' approaches & modes

The first/last/only miles' trips are strongly affected by the local context of the neighborhoods. Factors such as the urban land-use map, density, distance length and environmental conditions affect the commuters' trip experience. (Krygsman et al., 2004; Özbil and Peponis, 2012).

They also affect the kind of mobility solution to the issue. The mobility solutions for the first, last & only miles' issue can be either approach of the following; active mobility such as walking and cycling, or it can be non-active mobility using motorized or electrical vehicles. It can also be solved by using high technology solutions like mobile applications-based solutions. Furthermore, it can be solved by the usage of a private mean of transportation either car, bicycle or elsewise, or it can be solved by using shared means of transportation such-as car-sharing, bike-sharing, scooter-sharing or likewise services. It can also follow the principle of driving yourself by using your own mode or a shared mode, or it can be solved by modes where the commuter is a passenger and not a driver like ride-hailing and internal shuttle buses services. (European Environment Agency, 2020)

Walking

Walking is one of the main important first and list mile solutions, it is the earliest solution for this issue, and recently several studies states that it is the most used mode as a first and last mile solution. (Chidambara, 2019; Transit Forward RI2040, n.d.). Walking is a sustainable active mode of mobility which does not have any negative impacts on the environment, it also has some positive impacts on the health conditions of its users. Furthermore, walking costs the least compared to other first and list mile solutions.

Moreover, walkability is affected by several factors, one of the most important factors is the distance between the origin of the commuter and the mass-transit stop. U.S studies are often use 0.25 miles / 400 meters' radius as an optimum travel distance for the commuter from his origin to the mass-transit stop, which is almost 5 minutes walking. However, European studies are comfortable by slightly increasing the distances for this trip and it can reach up to 700 meters in some Asian cities which is almost 10 minutes walking. However, all these distances are open for approximation and should not be taken as exact numbers, and they all tend to decrease in case of children, elderly or disabled people. Furthermore, according to (McKinsey, 2017), the walking to mass-transit services tends to decrease up to 90% if the distance to the mass-transit stop exceeds 0.5 mile / 800 m. In addition to that, several studies proved that some commuters tend to walk longer distances for faster mass-transit mode choice like the railways services instead of the bus services. By this mean they tend to reduce the overall duration of the trip by walking a bit longer (Walker, 2011; Yang and Diez-Roux, 2012).

Moreover, the mass-transit distance is also affected by the street network design,

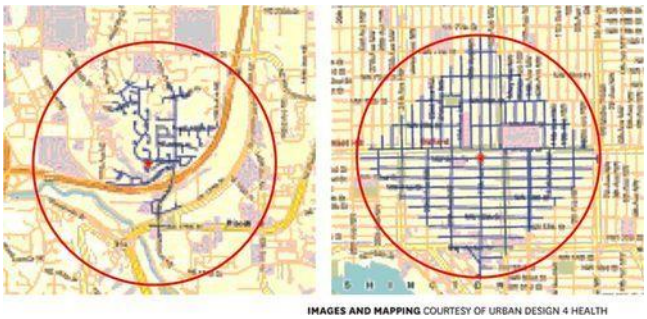


Figure 6: City grid vs organic shaped streets
(Source: Frank et al., in Walker 2011)

as shown in Figure 6, the grid-shaped street network tends to give a better direct walking distance experience than the organic shaped street network. In addition to that, pedestrian infrastructure also affects the commuters' willingness to walk to the nearest mass-transit stops. The pedestrian infrastructure should include footpaths, street crossings, and wayside amenities aside with good quality and conditions of the walking surface that is free from obstacles. Moreover, it should be universally accessible to support disabled users' needs. (Gehl, 2011; Singh et al., 2015). Also, Wayfinding signage visuals are also important to direct the commuters and specially the visitor commuters to the nearest mass-transit stations. It can also include real time information or schedules of the offered services (Thomson and Garanath, 2020)In addition to that, some studies state that the place-making in the urban environment is one of the main factors affecting walkability in neighborhoods. The place-making approach covers safety and security issues of the streets, and creates a livable and active environment with integrated aesthetics elements and architectural buildings (Chidambara, 2019; Rafiemanzelat et al., 2017; Rebecchi et al., 2019).

Cycling

Cycling is the second active mobility mode, and likewise walking, it is a sustainable mode of transportation that has no impact on the environment, yet it has positive impacts on the users' health. In addition to that, cycling is a much faster mobility mode than walking, which enables users to access further places that they would find difficult in reach by walking. On the other hand, cyclists need to exert more efforts to cycle than they would need to walk. However, nowadays the electric bicycles reduced the amount of effort needed to cycle and made the cycling option easier. For these factors, urban planners started to encourage the usage of cycling as a cheap feeder network mode for the mass-transit services. (Flamm and Rivasplata, 2014; Pucher and Buehler, 2009). However, unlike walking, cycling is based on a physical mobility mode

that which is the bicycle. Thus, planners tend to use one of these two systems at the mass-transit stops; park & ride or bike & ride. bikes for the last mile of their trip as well. The park & ride system tends to install bike racks at the mass-transit stations in order to encourage cyclists to use their own bicycles for the first mile of the trip by providing a safe parking service. On the other hand, the bike & ride system tends to enable the cyclist to take their bicycles on board with them. This way, it will enable cyclist to use their bicycles for the last mile of their trip as well. However, not all the mass-transit services would be able to host several bicycles on board, specially buses. Thus, the bike & ride system is more famous at the railways service. While the bus services tend to depend on the park & ride system with a limited accessing to bicycles on board (Tay, 2012).

The average trip distance ranges that can be covered while cycling to transit can range from 2 to 5 kilometers which is from 8 to 20 minutes (Martens, 2004 in Tay, 2012), while (Keijer & Rietveld, 1999 in Tay, 2012; ECF, 1998 in(Department for Transport, 2008) says that the range is from 1 to 3.5 kilometers which takes from 4 to 14 minutes.

Furthermore, cycling to mass-transit stations has several challenges, the users fear of getting sweaty after exerting effort in cycling in the different weather conditions is one of the main challenges (Ravensberge et al., 2018 in Mitra and Schofield, 2019). In addition to that, the safety and the security of the cyclist on the streets is a main challenge, especially in arterial roads (Pucher et al., 2009 in Mitra and Schofield, 2019). In response to that, planners tend to develop solutions for these challenges by developing an adequate cycling infrastructure and solutions for these challenges. The cycling infrastructure encourages cycling in shared streets by enforcing car speed regulations, while also implementing protected bike-lanes in arterial roads to ensure the safety and security of the riders. Also, several approaches and models were implemented to introduce showers and locker rooms in the mass-transit stations in order to

solve the sweaty cyclist issue. These solutions succeeded to encourage larger number of commuters to cycle to transit (Mitra and Schofield, 2019)

Shared active transportation / Shared micro mobility:

The development in the information and communication technology has led to the introduction of new mobility modes beyond the traditional transportation and ownership models. (Sand et al., 2016). The shared micro-transit modes were introduced to solve the first and last mile issues by using technology based sharing systems to provide a short term mode based on the demand of the user. The sharing system might include normal bicycles or scooters or both, as well as electrical bicycles or scooters or both. The system is designed to provide the commuter an easily accessible mode of transportation. Accessing these modes has several typologies; one type is accessing it station-based, in which the user can pick-up the mode from a station and then drop it off in another station after finishing his trip. Also, there are dockless sharing systems, in which the user can pick-up the mode and drop it-off from anywhere within predefined geographical boundaries. Moreover, there are some systems integrating both accessibility solutions by integrating the dockless pick and the station drop-off or vice versa (Shaheen et al., 2020). The main advantage of the shared micro-mobility modes is solving the first and last mile issues by a sustainable mode. In addition to that, they are easy modes that can be used by everyone with a minimum effort. Furthermore, the scale of the used modes is relatively small, so they do not need large parking spaces.

Overall, it tends to decrease the car ownership, as well as the number of trips by private vehicles, thus it decreases the congestion. Moreover, it also benefits the individual health of its users as it encourages the usages of active mobility modes such as bicycles and scooters (SUMC, 2015). However, the micro-transit system is still in the development phase and needs to solve several issues such as; the frequent gathering of the micro-transit modes at specific locations that would need redistribution of these modes within the daytime. (Kaufman and

Buttenwieser, 2018). Moreover, vandalism and theft are one of the main issues that faces micro-transit service providers. The issue is more serious within the small companies that cannot afford repairing these damages. (Garanath and Richert, 2020). Furthermore, cities are still in the development phase in terms of the regulations of operating these services and how to integrated it within the existing modes and existing streets hierarchy. one of the most common micro-transit issues affecting the urban environment is the informal parking of the modes either in station-based stops or dock-less stops. Such users' behavior encroaches larger spaces from the sidewalks and negatively affects the walkability. Moreover, the usage of the micro-transit modes on the sidewalk will endanger pedestrian. Thus, urban planner and city councils have to produce specific regulations that encourage using the micro-transit modes instead of the private vehicles, but they have to produce operating regulations that does not reflect negatively on other modes of transportation such as walkability.

Microtransit

Microtransit is a newly introduced system that tends to fill in mobility gaps using mass-transit services such as via and chariot. Similar to paratransit vehicles in size of vehicles, mostly microtransit uses vans and shuttle buses that are from 7 to 15 seats (Kawaguchi et al., 2017). The main difference between paratransit and microtransit services is the integration of information and communication technology. This technology allows pre-booking the trip as well as online payment. The main advantage of this service is that it is smart solution based and can be adapted based on the existing needs (Transdev, 2020). Moreover, the service can have several operational models such as; on demand routes, that enable the commuter to flexibly choose the pick-up, drop-off destinations as well as the route used, in addition to that it can have fixed routes that enable route deviation for individual commuters' pick-up or drop-off (Shaheen et al., 2020; Transit Forward RI2040, n.d.). This newly

introduced service is being used as a feeder network to connect the individual origin locations of the commuters to the mass-transit stops through a fast, collective and a low cognitive effort mode. Integrating micro-transit with mass-transit station would help reduce the car ownership rates as well as the vehicle miles traveled within cities (SUMC, 2015). However, the main challenge facing this service is the high operational costs that reflects on the pricing system. However, several cities tend to subsidize these services in order to develop the transportation system and increase the public transportation ridership and decrease the car-dependency (Transdev, 2020).

Ride-hailing Services

Ride-hailing services like Uber and Lyft are individual, easy, quick but non-active mobility solution. It offers an information and communication technology based solution to connect commuters to a trip-based driven vehicle. These services can offer a variety of comfort levels in car choices, as well as integrating taxi services throughout its applications. Also, some ride-hailing services may include a motor-taxi as one of the offered modes choices (Shaheen et al., 2020). Generally, the ride-hailing services are favored for their door-to-door mobility experience and enabling elderly and disabled people to move easily with low cognitive efforts. (Tirachini, 2020). Thus, several planners tend to integrate it by the mass-transit services to offer the commuters a direct, fast, easy trip to the mass-transit stop. In addition to that, some cities tend to partner with the ride-hailing service providers to subsidize the costs of the trips from and to mass-transit stations (Sand et al., 2016). Moreover, the responses of a survey conducted in New-Delhi has shown that 66% of the respondents stated that they used ride-hailing for accessing mass-transit services (Ilavarasan et al.,2018 in Tirachini, 2020). Furthermore, ride-hailing services had significant effects on the usage of mass-transit services in Las Vegas(Contreras and Paz ,2018 in Tirachini, 2020). However, ride-hailing services can react as a substitute of mass-transit services in some cities with a

relatively weak public transportation rather than complement it. (Graehler et al. 2019 in Tirachini, 2020) has estimated that the usage of ride-hailing services has decreased the ridership of buses by 1.7% and the railways by 1.3%. Overall, The ride-hailing services tend to substitute the mass-transit services in smaller cities, whilst it tends to complement the mass-transit services in big cities (Hall et al. 2018 in Tirachini, 2020). Furthermore, ride-hailing services may react as replacement for the private car usages. As per (Clewlow and Mishra, 2017) the car ownership has significantly decreased as per the ride-hailing service availability. However, the ride-hailing services have encouraged several people around the globe to buy cars to become ride-hailing service providers (Parrott and Reich 2018; Wells et al. 2018; Agarwal et al. 2019)

Park & Ride system

The park and ride is a non-active mobility solution for the first and last miles' issues that is mainly based on vehicles-ownership. It tends to create parking facilities near a mass-transit stop in order to encourage private car users to use mass-transit services. In addition to that, park & ride system tends to encourage cycling to the mass-transit hubs by providing them a safe and convenient parking spaces. Generally, the park& ride provides multimodal experience by reacting as the interchange location for the commuter and from an individual mode user to a mass-transit user.

Furthermore, the park & ride space can have several forms; it can either be integrated in the street hierarchy, or it can have a specified space just for this service without letting people use it except for the mass-transit users. Moreover, the park & ride service can be integrated within an existing parking lot for other activities such as religious buildings, supermarkets, theaters or etc… (Robert Spillar et al., 1997). In addition to that, the location of the park & ride services should be convenient, and within the first mile of the users and not close to the destination's location in order to be convenient to leave the private vehicle and ride the mass-transit services. As for the financial model of

the system of park & ride, it can either be funded or subsidized by the transportation authorities or service providers in the city, or it can charge the users for the parking fees either by daily usage or by monthly subscription. Most importantly, the system should fulfill the demand of the users by providing the sufficient amount of parking spaces for the vehicles, as well as sufficient waiting services for the users. (Cornejo et al., 2014). The park & ride system is not new, it has been used since the 20th century starting in the United States of America then going to Europe until it spread nowadays to most developed cities in the world (Krasić, Lanović, 2013). The success of the system depends on several factors, one of the main factors is the reliability of the available mass-transit services, including service quality, frequency and waiting experience. (Bos et al, 2003; in Cornejo et al., 2014).Moreover, the safety and security factors are also very encouraging factors for private car users to use the park & ride system (Shirgaokar & Deakin, 2005). Furthermore, other researchers identified that in some cases the total trip duration aside with the total trip costs are one of the most influential aspects in choosing this system from others (Van der Waerden, 2011). Also,

Generally, park & ride system has a significant positive effects on the mobility system as it increases the ridership of the mass-transit services (Florian & Los, 1980; Merriman, 1998). Moreover, it tends to increase the economic activities around its area which significantly affects the vitality and land-uses of the space. (Cairns, 1998). Overall, the system has positive effects on the mobility system within the city by positively affecting the mass-transit services which would decrease the congestion within the city. However, it does not necessarily decrease the travel trips within the city (Parkhurst, 2000), and these individual trips negatively impacts the environment. However, using car-pooling in between family, friends or coworkers who lives within the same neighbor and integrating it with the park and ride system would relatively decrease the general travel trips. In addition to that, some approaches tend to be against park & ride systems as they might need a capital investment to develop it as

well as the land usage. Thus, they prefer investing these capitals in other feeder network systems which are not only exclusive to private vehicles owners (Macbeth, 2019)

Conclusion

In this chapter, MaaS as an international integrated mobility approach was discussed. As well as FLO approaches and trends worldwide. To conclude, MaaS system tend to offer door-to-door mobility services. In order for this to happen, the available mobility modes should be integrated within one platform or application. This application should enable the users several collected advantages for the integrated services such as; pre-booking, online-payment, real-time travel information, comparing between several modes to plan the most convenient personal trip. However, in order to have an integrated system, the offered transportation network should be efficient and covering all the city areas. Furthermore, the commuters' FLO are mostly the weakest links in the city transportation network that needs to be developed before the development of the integrated system. There are several FLO modes approaches depending on the local context. Moreover, one of the approaches tend to enhance and encourage the usage of active mobility such as walking and cycling. While other approaches tend to use shared micromobility modes such as shared bicycles and scooters. Some systems' approaches tend to use ride-hailing services as a FLO mode that can encourage private-car users to travel without the need of their car. In addition to that, park & ride approach tend to encourage the private-car users to use mass-transit services by covering the first or last miles with their private cars.

3. Chapter 3: Mobility systems and modes in Egypt

Mobility is one of the main challenges facing Egyptian cities. On the one hand several mobility systems and modes are being provided, some of them are available especially in Egypt and are not seen worldwide, however on the other hand these systems usually operate independently, without integrating with different stakeholder and the rest of the mobility systems, creating difficulties for the commuters while interchanging and using the network. In this chapter the different mobility systems as well as modes are being represented to give an overview of the provided mobility services and the different stakeholders involved.

3.1. Overview of mobility systems in Egypt

3.1.1. Brief about transport institutional bodies in Egypt & Cairo

The main entities responsible for the urban transportation regulation in Egypt are the governorates, except for the Greater Cairo Metro. Each governorate is responsible for licensing mass transit vehicles, their routes and operating parking lots and terminals. The governorates of Cairo and Alexandria have other specific transport authorities.

The **Greater Cairo Metro** is under the responsibility of the Ministry of Transport through the operation of the Egyptian Company for Metro Management and Operation (ECM). EMC is an independent body that got transformed into a company in 2003, operating, maintaining, and managing the GREATER Cairo Metro. The construction is under the National Authority for Tunnels (NAT), which is responsible for planning and executing tunnels and metro projects, including managing the whole process of the construction. The suburban rail lines are operated and belong to the Egyptian National Railways (ENR), which is responsible for constructing and operating national and regional railways for passengers or freight. (Huzayyin et al., 2009)

The **Cairo Transportation Authority** (CTA) is the primary bus service provider and operator in Cairo. It also licenses the routes of other private service providers which operate minibuses under the supervision of the CTA within Cairo. While being under the umbrella of Cairo Governorate, the CTA also covers the bus network in Giza and Qaliubeya (Huzayyin et al., 2009).

The lead institution for transport planning and regulating in the Greater Cairo Region is Greater Cairo Transport Regulatory Authority (GCTRA). Under the supervision of the Ministry of Transport, GCTRA plans, organizes, monitors,

and evaluates the performance of transportation sector related activities in the Greater Cairo Region (Abd Alla and Ferro, 2017)

Recently, the New Urban Community Authority (NUCA) was granted the right from the Ministry of Transport to license public transportation services within the New Cities. NUCA also plans and provides internal public transportation buses, which are operated by private companies (Al-Aees, 2019)

3.1.2. Public transportation systems in Egypt

The extent to which the means of transportation provides safety and speed of access is an important indicator of civilization, development, and technological progress. It is also a strong contributor to the progress of development, due to its importance in providing the citizens easy and timely access. It is a way to develop and employ thousands of employees in the transportation sector and the contributing sectors (industry, energy, roads etc.) (Zain, 2019).
Despite the importance of mass transit, it has suffered from several problems throughout the years, including the disproportion of the amount of transportation provision with the population density, the low quality of service. In addition, it suffers from the deterioration of transport vehicles, which contributed to the low quality of roads, lack of periodic maintenance, random waiting time, poor traffic control, increased rates of traffic accidents, and the absence of a paved road network covering all regions and governorates. This prompted many to move towards private cars, which exacerbated the traffic crisis (Zain, 2019).

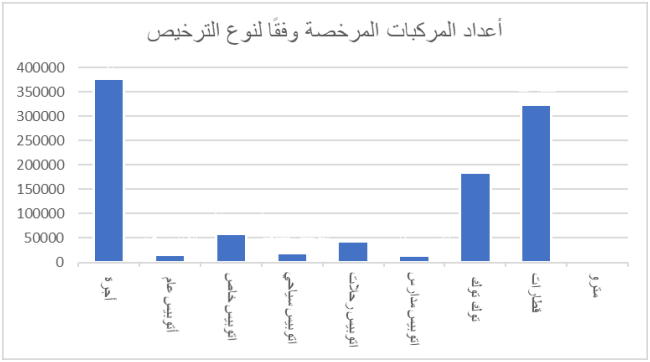


Figure 7: Number of Licensed Vehicles (Source: Zain, 2019)

Railway

The railway is responsible for the mobility between the provinces and their suburbs. The number of operational trains is estimated at 323,332, with a length of 9,566 km. The railways serve approximately 243,152 passengers annually, according to the estimates of the Central Agency for Public Mobilization and Statistics for 2017 (Zain, 2019)**.** Currently, there is a great interest in developing the railways is due to the increase in the number of train accidents. Most of them are in lower Egypt trains, due to the collision of vehicles at the crossing gate (Zain, 2019)**.**

Metro

In 1987, the first city to develop a metro system in Northern Africa was in Cairo. The Metro connects the governorates of Cairo, Giza and Qalyubia. 337 service units are serving 243,152 thousand people, with a crowding rate (average number of passengers per floor / average number of seats) of 10.9 (Zain, 2019). The Metro transports around 2.8 million passengers per day (2012). (Abd Alla and Ferro, 2017)

The Metro consists of three lines, the first line runs from Al Marg to Helwan, passing by downtown Cairo and Tahrir square. It has 35 stations and a length of 44 km. The capacity of line 1 will be increased by 40% as a result of the reduction of headway, with a 205-million-euro loan from the European bank of

Reconstruction and Development (EBRD). (Egypt Today, 2018 in (Hegazy et al., 2019) The second line connects ElMonib with Shubra, with two interconnections with Line 1. It consists of 20 stations and 22km length system. The third line is partially operational since 2012, connecting Attaba to Al Shams Club, the rest of the line aims to connect from Imbaba to the Cairo airport. In addition to that, three more lines are planned to be implemented in the future, as explained in the upcoming projects section below (Abd Alla and Ferro, 2017).

Public Buses

The main public bus provider in Cairo is the CTA which is responsible for operating public buses and supervising private minibus service providers. Like many other mass transit services in Cairo, the network suffers from lack of funding, which leads to a lack of maintenance, a decline in service quality and frequencies and overcrowding. Besides the regular busses, the CTA provides some profitable services such as air-conditioned buses, natural gas buses and double-decker buses (Abd Alla and Ferro, 2017).

The number of public transport buses operating in the system is estimated at 3810 buses (637 air-conditioners, 3173 normal), with a total of 2268 lines and a length of 273931 km. With an average operating efficiency of 72%, it serves 824,235 thousand riders annually and achieves total revenues of 13,134,430 thousand pounds. The crowding rate is estimated at 3.3, according to estimates by the Central Agency for Public Mobilization and Statistics (Zain, 2019).

As for the minibuses licensed by the CTA, there are 16 licensed private operators ((Hegazy et al., 2019), with a number of the buses operating in the system and belonging to the public sector of 1022 minibuses (387 air-conditioned, 635 normal). Their presence is predominantly in the governorates

of Upper Egypt and Lower Egypt compared to the number of public transport buses (Zain, 2019).

For both the CTA buses and the licensed minibuses, the frequency of trips across the different routes has no standard departure times and thus varies from 24 – 30 minutes for the CTA buses and an average of less than two trips per hours for the minibuses. (ACE Consulting Engineers and COWI 2016 in (Hegazy et al., 2019)

Mass transit companies project

This project provides mass transport services under the supervision and control of the Cairo Transportation Authority by authorizing companies whose activities include mass transport activity to operate vehicles under the license of public buses in Cairo (Cairo Governorate, no date).

The aim of this project is to achieve a level of coordination and integration between the various means of mass transportation in Cairo. It also gives the opportunity for the private sector to enter the field of mass transport by operating licensed minibuses (Cairo Governorate, no date).

This helps in providing a suitable long-term alternative to solve the problem of paratransit (service) through organized entities and under the full supervision of the authority. Routes can be controlled, and the operation can be monitored to achieve an adequate service for commuters as well as integration with other means of transportation, while determining the appropriate tariff for passengers (Cairo Governorate, n.d.).

Along providing new job opportunities, this project enables obtaining a percentage of operating revenues, of which the expansion of the current mass transit network of the Cairo Transport Authority will be possible. It also opens up the possibility of extending the service area of these companies to include new urban areas or serving other purposes or other activities deemed by the administrative authority to achieve the services of mass transportation for

passengers in Cairo, whether by minibus cars or buses or other means. Moreover, it will provide new job opportunities for those who will work in these companies with various specialties (Cairo Governorate, n.d.).

The Cairo Transport Authority and the management of the mass transit project have set new requirements for granting licenses to add minibuses to the private sector in Cairo, on top of which is reliance on smart transportation (Ismail, 2019).The intelligent transportation systems in the buses are considered: "air conditioning, Wi-Fi, electronic payment, station display screens, in addition to daily and periodic maintenance of buses, and placing advertisements according to specific designs." (Ismail, 2019).The purpose of these conditions is to improve the services provided to the citizen and keep pace with advanced transportation systems. In addition to the fact that the current system is sufficient and does not need expansions in the current form, especially as it will negatively affect each other in revenue ratios.

The number of companies operating at the present time under the umbrella of the mass transit project within the scope of Greater Cairo is 18 local companies, with a fleet exceeding 1109 vehicles, on 122 lines, connecting new cities such as Sheikh Zayed, transit and sunrise, to the capital (Ismail, 2019).

New Urban Community Authority (NUCA) Buses

NUCA launched a project aiming to provide internal public transport system in the New Urban Communities. These networks are available in almost all New Urban Communities (NUCs). The internal transport system operates under the supervision and control of the city authorities. They are minibuses planned and provided by NUCA, while being operated by private companies, such as Mwaslat Misr, in East of Cairo NUCs and Mandolin, in West of Cairo.

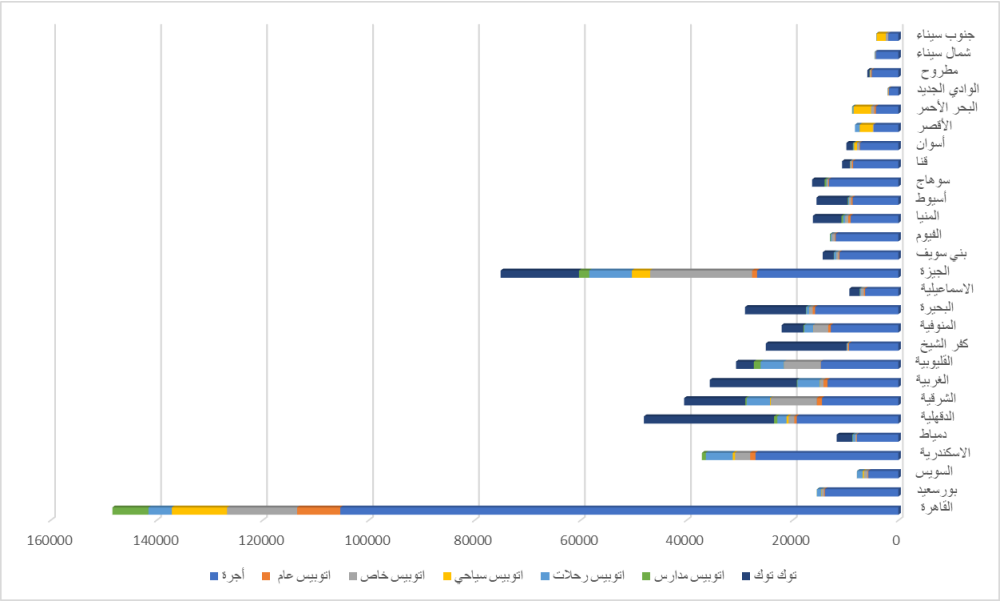


Figure 8: Percentages of Licensed Vehicles Across Governorates (Source: Zain, 2019)

In Figure 8, it is noticeable that bus licenses do not exceed 25% of the total vehicles, with the exception of the tourist governorates such as (Giza - Luxor - Red Sea - South Sinai), which are mostly tourist buses. This percentage is totally incompatible with motion eliminating traffic congestion. As a result, a recent approach of refusing to license more taxis, working to diversify the quality and prices of services provided by mass transit, fitting all social groups, has been taken. This is to reduce dependence on taxis and private cars (Zain, 2019).

Upcoming projects

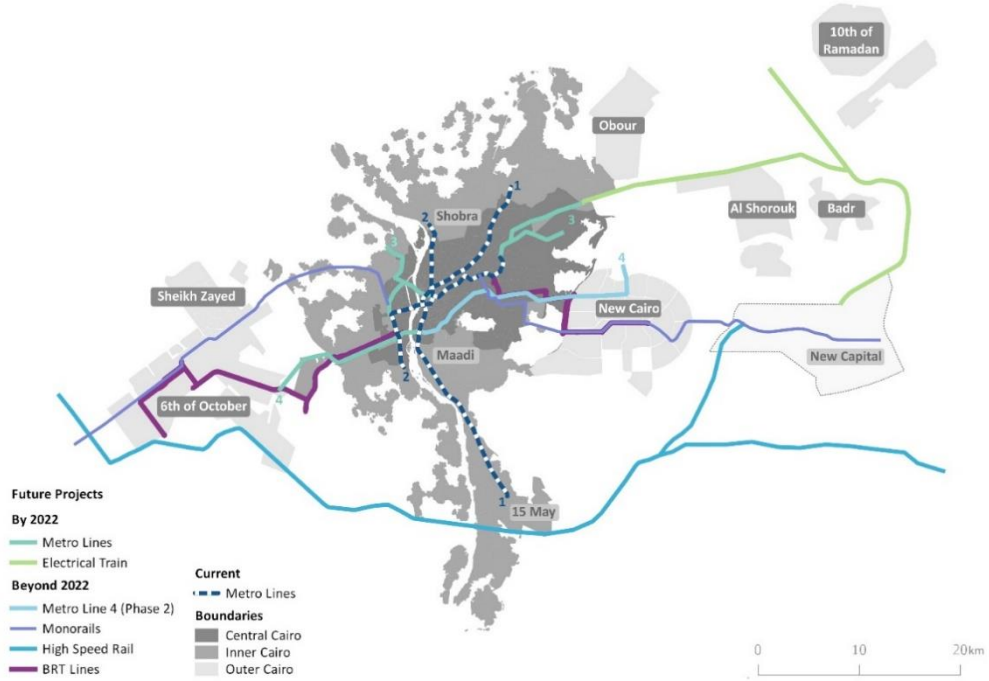


Figure 9: Future Transportation Projects (Source: Hegazy et al., 2019)

Metro lines 4, 5 and 6

Three more metro lines are to be established in Cairo. Line 4 extending from the Ring Road next to Dreamland and Haram District to New Cairo, connecting the West and East of Cairo, will be implemented in two stages., work has already begun on the first stage. ((Hegazy et al., 2019). The fourth line will have a total length of 24km. The fifth line with 17 stations, extending from Nasr City to Al Sahel area, with a length of 20 km and a total number of 17 underground stations.

Line six with a length of 30 km and 24 stations (four elevated and 20 underground) extends from Al Khosos to El Sayeda Zainab and then New Maadi. This is to reduce the burden on the existing lines and serve the densely

populated areas that are not served by any of the metro lines (Zain, 2019). The Greater Cairo Metro network capacity is expected to reach 8.9 million passengers / day (Abd Alla and Ferro, 2017)

Figure 10: Ridership Capacity of Cairo Metro Lines (Source: Zain, 2019)

Monorail

There are two parts of the monorail project. One in the west and one in the east of Cairo. The west of Cairo Monorail will connect 6th October city with several parts of Giza Governorate, spanning a length of 35km and terminating at Cairo University station at the end of Line 3 of the metro ((Hegazy et al., 2019). The monorail will be implemented and administered jointly by the government and the Canadian Company Bombardier, which will provide the rail vehicles and the control and signaling equipment. The aim of the project is to support the economic and housing projects as well as facilitate transportation and ease congestion (Abd Alla and Ferro, 2017)

The East of Cairo Monorail is one of the fast means of transportation, which is expected to transport 350 thousand passengers per day (60 thousand

passengers per hour). It is being constructed at a cost of $ 461 million, and its length is 74 km, along a route parallel to the Cairo-Ismailia Road, with a total of 12 stations, reaching the International Medical Center, and then branching north to the tenth of Ramadan city, and south to the new administrative capital (Zain, 2019).

Electric Train

A light rail train connecting the New Administrative Capital with Cairo will be implemented. This electric train will start from the third metro line at Salam City, connecting Al-Obour, Al-Shorouk, Badr and 10th of Ramadan City with the New Capital. ((Hegazy et al., 2019) The railway extends about 66 km, including 11 stops. The aim I to provide a sustainable and safe mode of transportation for commuters and for goods. It is expected to be operated by the China Railway Engineering Corporation (CRECG). ((Hegazy et al., 2019)(Abd Alla and Ferro, 2017)

Bus Rapid Transit (BRT)

A pre-feasibility study to implement a BRT system in Cairo was conducted by UN Habitat and Institute for Transportation and Development Policy (ITDP) in 2015. The first phase of this project is a 50km BRT route to be built in Giza and New Cairo, with 240 buses. The aim is to connect the New Urban Communities with inner Cairo. ((Hegazy et al., 2019)(Oxford Business Group, 2018)

High Speed Rail (HSR)

A high-speed rail to be implemented aims to connect Ain El Sokhna to El Alamein City. The first phase is to connect 6th of October to the New Administrative Capital, with a length of 122km. The second phase connects 6th of October with El Alamein City through a 320km extension. The last phase will connect New Administrative Capital to Ain Sokhna, with 92km. ((Hegazy et al., 2019)

3.1.3. Private Mass transport system

Private Mass Transit Buses

The first and main private mass transit buses are the busses operated and owned by Mwaslat Misr. Mwaslat Misr recently joined the smart transportation sector in Cairo. It was established in 2011, with a capital of 32 million Egyptian pounds. Its routes serve Greater Cairo, through which Cairo has become the first city in the Middle East and Africa to put buses routes on Google. (Zain, 2019).

Mwaslat Misr Company, a subsidiary of the Emirates National Group, the pioneer in the field of mass transit in the United Arab Emirates, in cooperation with the Cairo Governorate and the Public Transport Authority, aims to provide a civilized means of transport in Egypt and provide safety and comfort for passengers. It also aims to provide a practical and civilized alternative suitable for Egyptians, to represent an attractive option for private vehicle drivers to shift to public transport (Hassan Osman, 2018).
The service consists of several elements to enable a safe and comfortable experience for the commuters. Most notably are the trained drivers at professional level, smart air-conditioned vehicles and the electronic payment system through smart cards. Mwasalat Misr is the first company in Egypt to offer this service through the “Mwasalati” prepaid card in in cooperation with Misr Tech (Nogoum FM, 2018). Another element is the smart application that is applied for the first time in Egypt to plan the trip and determine the commuter’s route and the arrival dates. The application has been provided with all the data of the routes to make them available to the user (Nogoum FM, 2018).

In addition to that, the first smart electric bus system has recently been launched in Egypt by Mwaslat Misr, in alliance with the Arab Organization for Industrialization with Chinese Wanxiang International Company and United Investment Company (Zain, 2019).

Mwaslat Misr targets to serve 8 million passengers. The project is expected to accommodate about 3600 workers, engineers, and drivers with an average monthly income of 4,000 pounds and it is expected to provide 52 routes at the level of Greater Cairo by linking parking spaces to metro stations Tunnels (Taher, 2017).

Peak only Buses

Among the strongest examples of private mass transportation services are the peak only buses. Currently there are several entities competing in peak only transport services, such as "Buseet", "Swvl" and Uber Bus. The local market is witnessing fierce competition between smart mass transport companies over price competitiveness, quality of service provided to the customer. These peak-only services operate self-determined routes targeting higher social class citizens. Their network includes several origin and destination pairs to be booked through an online application. This service is highly competitive with the private cars and might represent a threat to public transport based on the perspective of travel time. Nonetheless, these services operate at specific timings in the day, usually in peak period and offer limited number of trips ((Hegazy et al., 2019).

Cairo has seen an increase in the number of lines and geographical network expansion during the current year. SVWL, for example, has already more than 100 unique routes and over 100000 rides per month ((Hegazy et al., 2019). While providing services for the commuters, they also provide job

opportunities. The number of drivers for these companies exceeds two million drivers (Al Borsa, 2018).

3.1.4. Informal public transport system

Paratransit

Paratransit includes informal public transportation that consists of vehicles dedicated to transporting passengers, with the number of passengers not exceeding 14 passengers (Zain, 2019). The most common types of paratransit are microbuses, with 14 passengers and Suzuki vans with 7 passengers. These services are provided by individual operators and are usually not planned and are regulated in a flexible way, which makes it a demand-responsive mode that is heavily used. More than half of Cairo's population uses paratransit (Hegazy video), which made them become a crucial part of the mobility system of Cairo. (Abd Alla and Ferro, 2017)It is one of the most affordable public transports, however not always a reliable one, as part of being demand responsive, routes can appear and disappear from one day to another to accommodate different sensed needs or demands of the society. Nonetheless, it contributes to reducing the journey gap between public transportation and private cars. Thus it should be considered as a solution where possible and get integrated in planning and any future integrated mobility system (Mostafa, 2015) (Hegazy et al., 2019)

Service Project

The mass transit service project in Cairo Governorate is considered one of the governorate's economic service projects and has its own budget. It was established 1992 by the Executive Council of Cairo Governorate.The aim is to provide mass transport service to under the supervision and control of the Cairo Transport Authority that suits the civilized face of the capital, by authorizing companies whose activities include a mass transport activity for passengers to operate cars bearing traffic plates for the Cairo public bus.

The project provides:

- Establishing, planning, and developing parking lots for mass transit vehicles within the boundaries of the Cairo governorate in coordination with the General Administration of Cairo Traffic and the General Administration for Urban Planning in the governorate
- Organizing the parking lots and following up their workflow to improve the service performance of passengers and car drivers
- Determine and monitor the implementation of passenger tariffs for project vehicles.
- Eliminate the operations of collecting any sums from the vehicles other than contributions and the proceeds of fines for violations that are paid to the project management (Cairo Governorate, n.d.).

3.1.5. On demand transport services

Taxi Services

In Cairo there were three types of taxis. The ordinary black and white taxi, its update the white taxi and the yellow taxi operated by private companies such as Cairo Cab (Huzayyin et al., 2009).The black and white taxis were gradually replaced by the metered white taxis, which are also offering a higher quality and service. The yellow taxis faded by time and eventually disappeared. Currently the main taxi service is provided by the white taxis, while some old black and white taxis can be found in some areas of Cairo.

Officially taxi licensing includes any car licensed to transport passengers, without a predetermined route. It was estimated at 376,456 cars by the end of 2018 (Zain, 2019)**.** Thus, mass transit such as Suzuki vehicles are considered shared taxi services and usually have the license of taxi services.

Toktok

The TokTok is a three-wheeled vehicle used to transport people in popular areas and villages. It began to appear around the year 2006, as an alternative to taxis because they can reach narrow streets. Recently they began spreading even in more cities and district neighborhoods, such as 6th of October and Maadi.

Unfortunately, they do not adhere to traffic rules, and are often driven by children as most of them are not licensed. They have also no specific fare tariff. Estimates of the number of tok-toks in Egypt reach 5 million vehicles, but what is licensed is estimated at 183884 TokToks.

In 2019, the government announced its intention to ban TokToks on Egyptian streets and replace them with licensed mini-vans within three years (Zain, 2019)**.** The aim is to provide safe and civilized mode of transportation as well as provide job opportunities (Ahram Online, 2019).

Ride hailing

Following the global trend, ridehailing services expanded in Egypt over the past years, taking advantage of the urbanization, the large population and the increasing smartphone distribution among the society.

Ridehailing services are door to door services like taxis, except they get booked through an online application. The emerge of ridehailing services in Egypt provided comfortable mobility options for people who cannot afford to buy a car nor can rely on the public transportation. Ridehailing services also prevent several issues faced when taking a taxi, such as harassment, refusal to take the ride and rigged meters. With the booking being online, it is convenient especially in underpopulated areas like the New Cities where taxis do not pass in inner streets (Mostafa, 2015) . However, with the emerge of these ridehailing services, like Uber and Careem, several legal battles were triggered from traditional taxi drivers, opposing this service. In 2018, Egyptian authorities

launched a new regulating law for all ridehailing operators in Egypt. Eitherway, Egypt has become one of the most significant markets for ridehailing businesses. On the one hand it provides a mobility service but on the other hand it also provides job opportunities. Uber for example, began in 2014 and reached in 2018 around 90000 drivers (Oxford Business Group, 2018) .

3.1.6. Integrated mobility approaches in the GCR

Integrated ticketing

A smart card ticketing project is to be launched in Egypt. The project has great importance due to its great return at the state level, transport service operators and citizens, improving the level of service provided in various modes of transportation, and enhancing the competitive advantage of the transportation system. It will also contribute to the ease of movement of citizens and avoiding the need to queue in front of the ticketing windows at the stations. In addition to that, it will strengthen the emergence of the transport sector and its contribution to the gross national product (Hamdan, 2020).

The smart card system will include linking the three metro lines, the electric train, superjet buses and 1600 public transport lines. The project also includes connecting buses of private mass transit companies. Eventually, it will include all means of transport in the country (Hamdan, 2020). The introduction of the railway and monorail to the system was also discussed so that there would be a card for all means of smart transport and a unified ticket.

Kamel Al-Wazir, Minister of Transport, announced the formation of a committee to run the smart card project for the mass transit system and issue a

unified ticket headed by the Domestic and International Land Transport Regulatory Authority as the owner of the project (Hamdan, 2020).

The success of the project is based on the operating system and technical support for the project, which is assigned to Trans IT Company. Currently, the components of the project system, which include ticketing channels, means of dealing and integration with service operators and the main data center, as well as applications supporting the operation is being reviewed. Moreover, the full cycle of supplying, configuring and issuing cards to users, and the system of financial settlements between the various parties are being discussed, as well as, the scheme for managing and operating the project. (Hamdan, 2020).

Sustainable Transport Project

The Sustainable Transport Project (STP) was launched in 2009. The UN Development Program and the Global Environment Facility envisioned to introduce pilot projects in sustainable transport on high-quality transportation, demand management and cycling. The project's objective is to create enabling policies and institutional environment as well as provide financial resources to develop a sustainable transport sector, encouraging public-private partnerships. The execution agency of the project is the Egyptian Environmental Affairs Agency (EEAA). One of the main aims of this project is to create integrated high-quality public transport services for the Greater Cairo Region. This way, the higher income citizens will be encouraged to leave their car and shift to public transportation. Five high-quality bus corridors were established in 6th of October and Sheikh Zayed connecting them to the Cairo Metro, specifically to Cairo University and Abd Elmoniem Riad Square. These buses are operated by Mwaslat Misr with the goal to extend the network in the future. The project also aims to provide parking areas to act as a Park and Ride service at the bus terminals for private car users to leave their car and use the bus service (Abd Alla and Ferro, 2017).

CREATS Master Plan 2022

An approach towards implementing an integrated transportation system was done by the Japan International Cooperation Agency (JICA) and the Higher Committee for Greater Cairo Transport Planning when they published the Transportation Master Plan and Feasibility Study of Urban Transport Projects in Greater Cairo Region in the Arab Republic of Egypt (CREATS – Cairo Regional Area Transportation Study) in 2002 (Abd Alla and Ferro, 2017). This master plan presented the transportation achievements to be implemented by 2022. The plan aimed at introducing approaches to mitigate urban transport problems, contributing to the sustainable development of the Greater Cairo Region. The strategy aims to shift from the present shortcomings to a sustainable and integrated transport system. It addresses three main aspects (Abd Alla and Ferro, 2017):

1. Planning and preparing for an integrated multi-modal transport master plan to be implemented by 2022
2. Identify high priority projects to be implemented in the short term via feasibility studies
3. Implementing a productive and effective technology transfer program with Egyptian counterparts

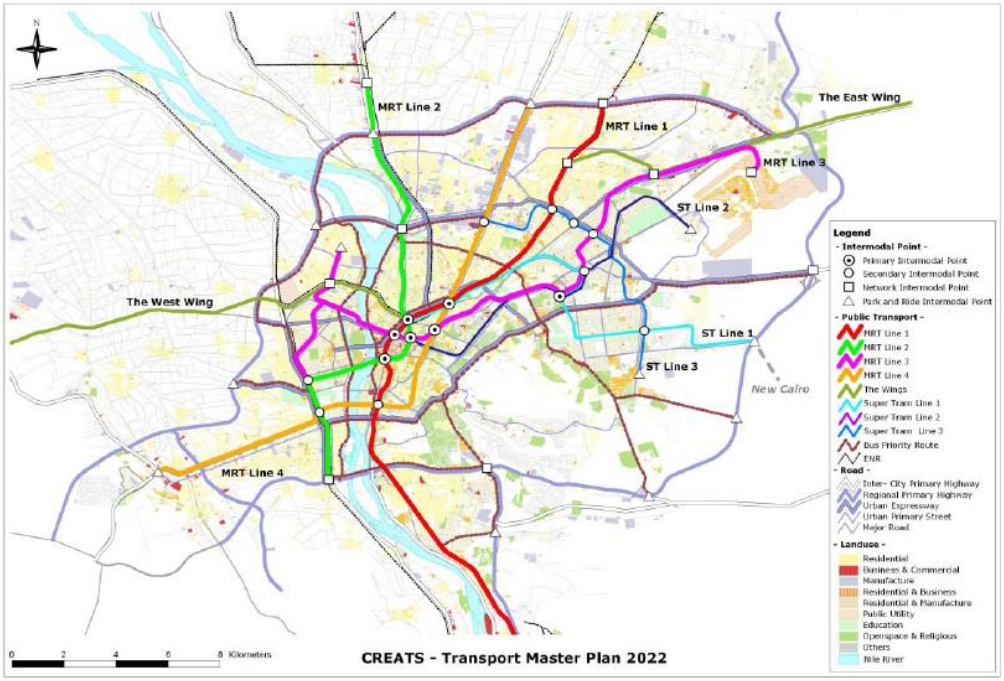


Figure 11: CREATS Transport Master Plan 2022 (Source: Abd Alla and Ferro, 2017)

Conclusion

After looking at the different mobility systems and the modes belonging to these systems in Egypt, the variety of service provision is highlighted. The range of mass transit services cover from public to private as well as private-public partnerships. They also include varieties of services such as rail and high speed transportation services as well as flexible on demand bus networks. Although several plans were made to achieve an integrated mobility system in Egypt, that combines and integrates all these services together, till now only limited approaches are implemented. Nonetheless, there are several mega transportation projects as well as mobility plans that envision a promising future towards integrated mobility system in Egypt.

Part III: Methodology

4. Chapter 4: Methodology

In this chapter, the methodology of the research is being presented. The approach used in this study varies from qualitative to quantitative approaches. The qualitative approach is consisting of analyzing the current transport network in New Cairo, mapping the FLO services and getting more insights on how service providers plan their network and their standpoint on the FLO concept. The quantitative approach aims to analyze the mobility patterns as well as identify the potential impacts of the FLO on the ridership. Methods such as mapping, interviews and survey are being used for the data collection, while methods such as statistical and qualitative approaches are being used for the analysis.

4.1. Introduction to the case study

The first, last & only mile's challenges exists throughout the whole mobility system, whether it is in a high-dense, middle-dense or low dense neighborhood. However, the researcher chose to base the research on low-dense satellite cities, as these cities are under-occupied and its car-dependent mobility system is one of its main reasons. While this problem tends to be less in medium dense

or high dense neighborhoods due to the shorter distances and the increased demand of diverse mobility options, which resulted in the introduction of several solutions either formal or informal.

Choice of the case study

New-Cairo is one of the most important satellite cities, due to the massive expansion of the GCR towards the east and due to the New Capital being right next to it. As a result, New-Cairo will play a huge role in connecting Cairo's downtown and old cities to the New Capital. This was the main reason of choosing New Cairo City out of the rest of satellite cities.

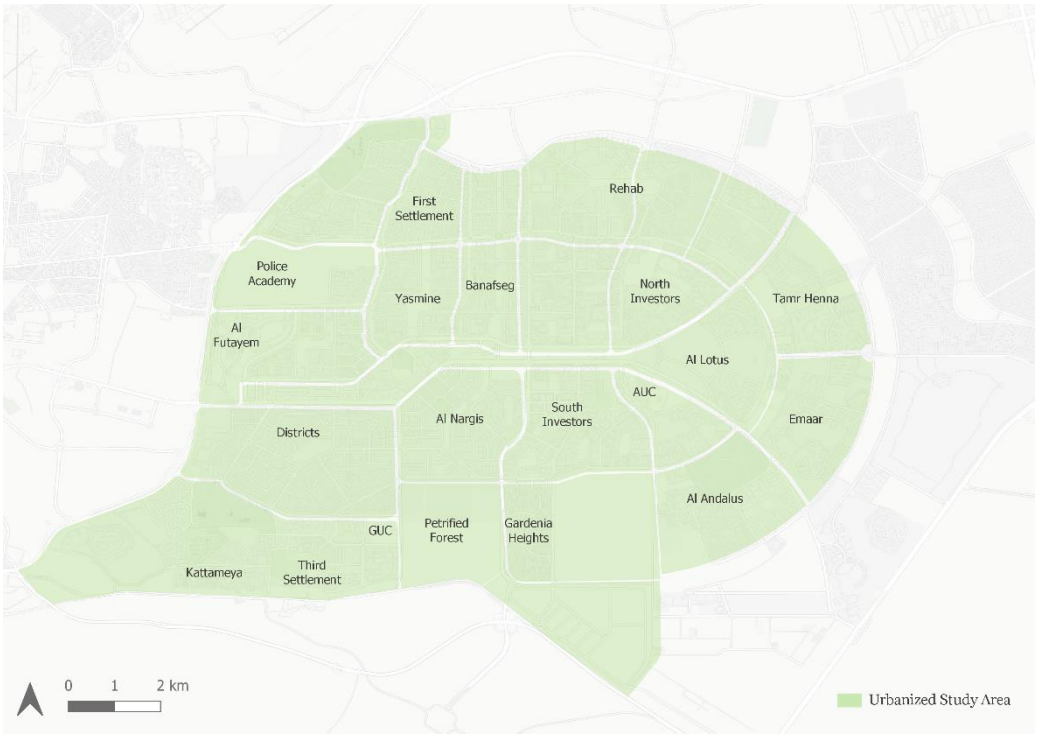


Figure 12: New Cairo Study Area (Source: Author)

General information about the area

The establishment of the city started in the year 2000 by presidential decree. Its main goal was to decrease the congestion from downtown Cairo and expand the capital towards the east edge. It is covering an area of around 500 km2 and was planned to host almost 5,000,000 residents. However, the existing residents are nearly just 300,000 residents in the year 2020 (New-Cairo authority). Controversially, according to New Urban Community Authority (NUCA) the residents are around 2,000,000 already and are expected to reach 3,000,000 by the year 2030.

4.2. Quantitative Methodology

4.2.1. Online Survey

Data Collection Approach

Survey aim

The survey aims to understand the current mobility patterns of the New Cairo residents and to collect the New Cairo residents' views on the international trends of first and last-mile solutions, while exploring possible first and last-mile solutions that might encourage them to use mass transit services.

Survey structure

The survey is based on two different methods, the revealed preferences method and the stated preferences method. The aim of the revealed preference method is to understand the current mobility patterns of New Cairo residents, and analyze the first, last and only miles' mobility solution that subsequently reflects on the mobility patterns of its residents within the city. In addition to that, the stated preference method aims to analyze the willingness of the

residents to ride mass-transit services more frequently if the first, last and only miles' issues were solved with any of the international solutions.
As the residents' mobility behaviors are different. the survey's questions are divided into three different branches based on the users' main mobility mode. The first branch is for the mass-transit users, while the second branch is for the ride-hailing and taxi-services riders, and the third branch is for the private vehicles riders.
However, the three branches follow a similar structure, but the division helps to have more specific questions and answers for each group. The structure of the survey mainly consists of five main sectors.
The first section's questions are mainly about the demographics of the user, asking about the age, gender, average monthly income, residence type, main mobility mode, most common destinations as well as the average monthly expenses for mobility and the average daily time consumption during his trips. The second section is mainly about evaluating the chosen mobility mode in terms of advantages and disadvantages. While the third section asks about the user's first & last mile trip to the nearest mass transit station. It mainly asks about the distance from the residence to the stop, the available modes within this stop, as well as the quality of this trip in terms of walkability and cycling. Moreover, the fourth sector is focusing on the only mile trips, mainly asking about the distance between the residence to the surrounding services and how the respondent accesses these services. The last section is questioning the willingness of the residents to change their main mobility mode if the issue of the first and last mile of their trips was solved.

Sample size

The sample size for the survey is calculated based on the population of New Cairo residents, which is either 2,000,000 as per the estimations of (NUCA, 2020) or 300,000 residents as per the estimations of New Cairo authority 2020. However, to ensure a 95% confidence level and a 5% margin of error in

the overall survey; the research was based on the higher estimation of population. So, the aimed minimum sample size is 385 respondents.

Data Analysis Approach

The survey will be analyzed in a quantitative approach using pivot tables and multi nominal logit models. Then the output data from these methods would be presented in charts and diagrams. The chart and diagrams will help in visualizing the results and comparing between the three main transit users' respondents that are; Private car, ride-hailing, and mass transit users. Moreover, the analysis of the data will follow the survey's previously mentioned structure. Starting with the demographics and their relation and effects on the resident's main mobility mode choice. While the second section focuses on analyzing the users' satisfaction level of their chosen mode of mobility in terms of advantages and disadvantages. As well as reasons behind not using mass-transit services. Furthermore, the third section would analyze the first and last mile options for the respondents. The analysis will include the distances needed to arrive to the nearest mass-transit station as well as the services passing by this stop. Furthermore, these data would be compared based on the main mobility mode show how different users perceive the first and last mile trip. In addition to that, section four would be focusing on the only miles' trips. In this section the different respondent's travel behaviors within the only mile in New-Cairo would be analyzed based on their responses and compared to each other based on their main mobility mode used within the city. The last section is analyzing the respondents' willingness to shift their main transportation mode. The transportation mode shift is divided into two parts; one part regarding the private car and ride-hailing users shift towards mass-transit services by developing some future FLO modes. While the other part is regarding the mass-transit and ride-hailing users' willingness to shift to private car usage.

4.3. Qualitative Methodology

4.3.1. Mapping of the current transportation network

Data Collection Approach

The first step in identifying an issue and proposing a solution is to map and analyze the current situation. Thus, the first step in the qualitative approach is mapping the existing public transportation network of New Cairo. The data of the current network is taken from Transport for Cairo (TfC) (Transport For Cairo, 2018); a company which works in the field of transportation in Africa. One of their major projects was mapping the public transportation network of the Greater Cairo Region, with all its transportation modes. The data is in GIS format and consists of the routes of public transport network collected in 2018. The public transportation modes include CTA buses, Mwaslat Misr buses, NUCA buses, microbuses, and Suzuki buses. In addition to that, it contains the locations of the main terminals in New Cairo.

Data Analysis Approach

The aim of this mapping approach is to process the data taken from TfC and produce a map for each transit mode. Each map will act as a heat map, showing the areas where most of the transit lines path through, as well as the most prominent terminals used by these modes. In addition to that, the data for all these mass-transit services will be merged in a general map that includes the available mass-transit bus routes. Furthermore, a coverage area for these routes will be calculated for two coverage ranges; the 400-meter radius that is almost 5 minutes walking distance, as well as 800-meter radius that is almost 10 minutes walking distance. These ranges are chosen to represent catchment areas for the network that enable active travel as the first and last mile option.

Then, these coverage areas will be compared to New-Cairo's area in order to identify the percentage of the areas which are covered by the mass-transit systems.

4.3.2. First and last mile mapping

Data Collection Approach

For a better understanding of the FLO miles the trip experiences of the users will be collected and analyzed. Several interview will be conducted in order to have qualitative data for the FLO miles trip experiences besides the quantitative data collected by survey responses. The interviews will be structured interviews, asking mainly about their most common origin and destination locations, as well as their main mobility mode to travel across GCR. After knowing the trunk network service, the exact pick-up or drop-off location will be asked in order to identify the first and last (FL) miles of their trips. Furthermore, the interviewees will be asked about their FLO trip mode and its price, duration and comfort level. In addition to that, they will be asked to describe the FL trip into keywords that should include the advantages and the disadvantages of this mode.

Data Analysis Approach

The analysis of the interviews will be divided based on the FLO mode choice. The answers of the interviewees within each FLO mode will be combined in order to have a collective commuters' feedback on their used mode. In addition to that, maps will be created for each FLO modes to show the origin and destination of each commuter. These maps will be used for creating an overview of the spatial distribution of the FLO used modes, as well as the length of these FLO trips.

4.3.3. Understanding Service Providers

Data Collection Approach

Interviews will be conducted with service providers operating mass transit services in New Cairo, as well as service providers tackling and/or have the potential of tackling the first and last mile solution in Cairo. The aim of these interviews is to understand the different mass transit providers' systems, services, and how do they plan the routes and if they include in the planning process the FLO miles' issue. It is also a way of exploring different possibilities of potential FLO services that might be provided by those companies or supported by them through cooperation. The interviews are designed as semi-structured interviews to give enough space to explore and discuss several aspects such as; their vision, the main target audience, type of service, route planning models, stop and stations choice criteria, challenges and opportunities, as well as their response to the FLO mile issue.

Data Analysis Approach

The service-providers' interviews analysis will follow a qualitative analysis method through drawing conclusions from the discussion conducted in the semi-structured interviews.

Conclusion

The approaches and methods explained in this chapter will be the guide for the coming steps of the study. In the following chapter, the implementation of these approaches are being discussed along with the output of the data collection and analysis.

Part IV: Findings and Analysis

5. Chapter 5: Quantitative Analysis

The quantitate analysis was done by using an online survey method. The survey was launched on the 8th of June for 13 days until 25th of June 2020. In this chapter, we will discuss the findings of this survey as well as analyzing it. The analysis was done by a statistical analysis approach by using multinomial logit model and pivot tables.

5.1. Online Survey

5.1.1. Findings

Distribution & validity

The survey was launched as an online survey. Moreover, to ensure a representable sample, the survey was shared in more than 100 social media groups consisting of residents of most the neighborhoods within New Cairo. The survey managed to collect a total of 563 responses with relatively balanced

and diverse demographic groups. Thus, it achieved a confidence level of 95% with a 4.3% margin of error for the general survey's questions. However, due to the branching of the survey, each branch received a different amount of responses. According to the mobility modal share answers collected in the survey, mass transit users represent 10.8% of the residents. With the number of responses collected, 61 responses for all the mass transit modes, a confidence level of 90% and a margin of error of 11% was achieved for the mass transit specific branch questions. As for the second branch, grouping the ride-hailing users and the taxi services users in one branch, 87 responses were collected, representing 15.5% of the residents. So, a confidence level of 90% and a margin of error of 9% was achieved for this branch specific questions. The responses collected for the private car users were 415 responses, which represents 73.7% of the residents, thus a confidence level of 95% and a margin of error of 5% was achieved for these specific branch's questions.

Demographics & Characteristics

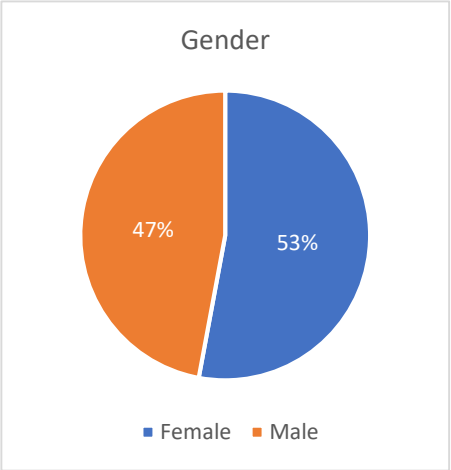


Figure 13: Gender Distribution (Source: Author)

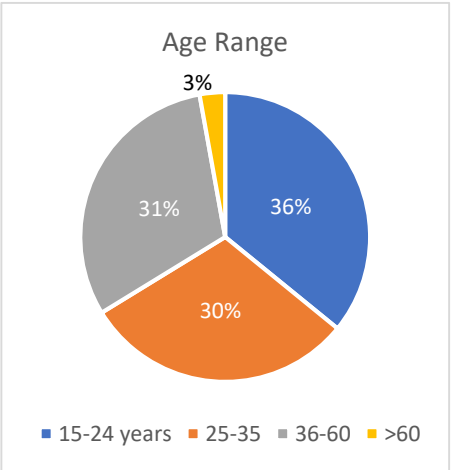


Figure 14: Age Range (Source: Author)

Gender & Age

The gender ratio in Egypt is nearly similar, with 51% males and 49% female of the whole population. While 33.38% of the population are below the age of 14 years, and 18.65% are between the age ranges of 15-24 years, and 37.71% between the age range of 25 to 54 years old, and 10.27% of the population are above the age of 55 years (Indexmundi, 2019). Going to the survey results, 298 females answered the survey with an overall percentage of 52.9%, while the male's overall percentage was 47.1% with a total of 265 responses. Furthermore, the survey was answered by 202 people within the age range of 15-24, while the people within the age range of 25-35 years had 171 responses. Also, 174 responses were by the people within age range 36-60, and the rest of the responses were by people aging more than 60 years with 16 responses.

Monthly income

The minimum wage for state employees in Egypt is 2,000 EGP per month. (Al-Ahram 2019, n.d.). As for the monthly income level for the survey respondents, 118 responses preferred not to mention their income level. While 65 responses

had the income of 2000 EGP or less, and 112 responses were collected by people with income between 2001-4000 EGP. Moreover, 115 responses with an income range between 4001-8000 EGP and 69 responses with an income range between 8000-15000 EGP and 84 responses with an income range above 15000 EGP.

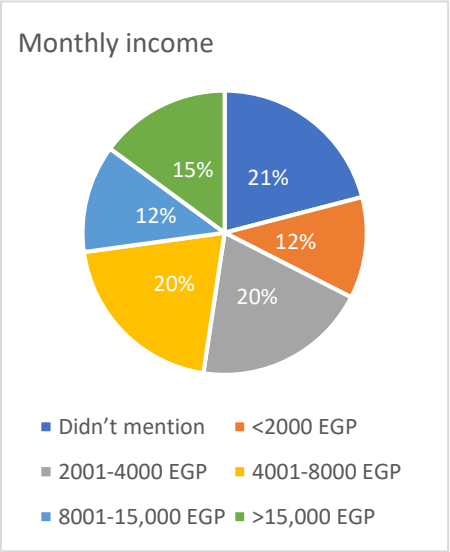


Figure 15: Monthly Income (Source: Author)

Residence type

Moreover, as for the residence type for the respondents; 149 Reponses were from buildings complex residents. While the private/shared villa complexes residents had 214 answers. Also, gated community residents whether they live in a building complex or a private/shared villa had 179 responses. As for the youth residence, 21 resident answered the survey.

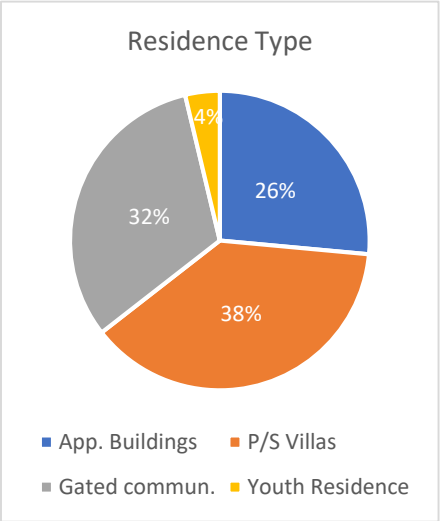


Figure 16: Residence Type (Source: Author)

Most common destinations

The survey gave the respondents the option to choose a maximum of 3 most commonly visited destinations. Based on the survey's findings, the most common destinations for New-Cairo residents within the GCR are as follows: New-Cairo is the most common destination with 85.8% of the respondents, Followed by Nasr-City with 47.2% of the respondents, Maadi is the third most common destination for New-Cairo

residents with 14% of the respondents, followed by Downtown with 11.7% of the respondents. Obour and Sherouk came in fifth with 10.1% of the respondents. Moreover, 7.1% of the residents chose Zamalek, Mohandeseen & Dokki, as well as 7.1% of chose 6th of October and Sheikh Zayed as their most common destinations. Furthermore, 5.5% of the respondents chose Mokattam, and 5% of the respondents chose Heliopolis. Also, 2.1% of the respondents chose Faisal/Haram/Giza, and 2.1% of the respondents chose Abbaseya/ Ain-Shams. Imbaba/ Rood Al-Farag was chosen by 1.2% of the respondents, while Helwan, Al-Marg, and Al-Salam were chosen by 1% of the respondents for each destination respectively.

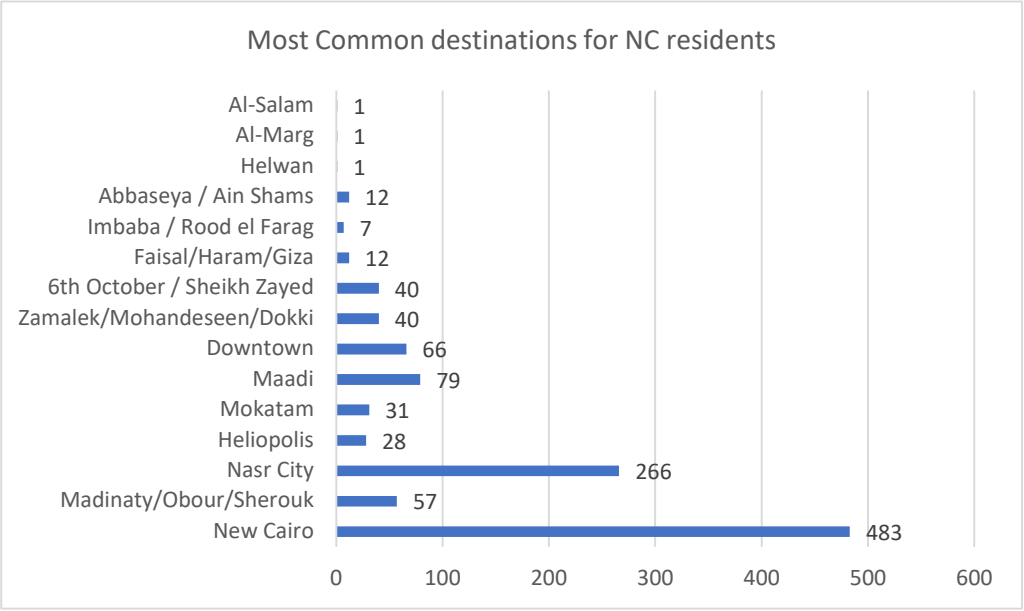


Figure 17: Most Common Destinations for NC Residents (Source: Author)

Travel time and costs

The majority of New-Cairo residents travel about 1-2 hours per day with 303 survey responses which represents 54% of the survey's responses. While 163 responses said that they travel for less than an hour per day with an overall percentage of 29% of the survey responses. Moreover, 15% of the responses travel for a range of 2-3 hours per day with 86 survey responses. And 10 residents travel for more than 3 hours per day which represents 2% of the survey responses.

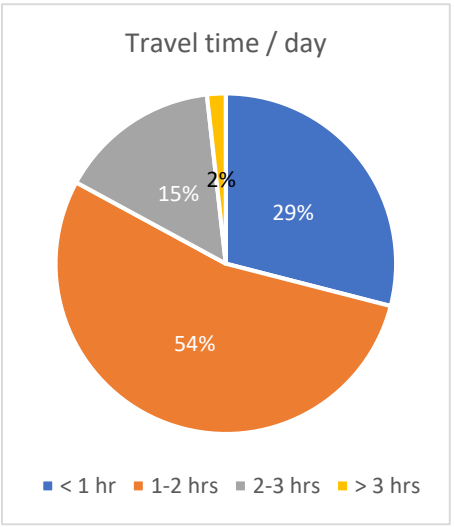


Figure 18: Travel Time per day (Source: Author)

Furthermore, while the minimum income for Egyptians is 2000 EGP, 31% of New-Cairo residents spend an average of 500-1000 EGP per month with a total of 176 survey responses. While in second place 25% of the responses were between 1001 – 1500 EGP per month with a total of 142 survey responses. Moreover, in third place, 122 responses were spending more than 1500 EGP per month which represents 22% of the survey responses. In fourth place were 108 responses representing a total of 19% of the survey responses spending an average of 250-500 EGP per month. And in last place,

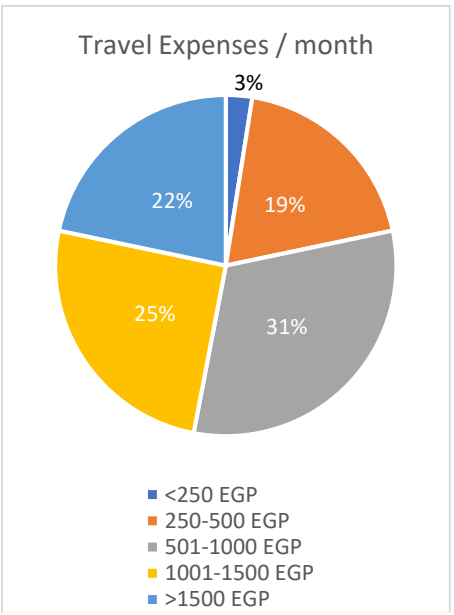


Figure 19: Travel Expenses per month (Source: Author)

just 14 responses and 3% of the overall survey responses spend less than 250 EGP per month.

Main mobility mode

The main mobility mode used by the residents to move within the city responses has highlighted a huge problem. The car dependency was the most dominant mobility choice with 415 responses which represents 73.7% of the total responses. Ride-hailing came in second place with 85 responses representing 15.1% of the responses modal share. The mass transit options came third with 10.9% of the total survey responses which is 61 responses. The mass transit options were divided into three main systems, First, the governmental public transportation (CTA) supported by the microbuses which had 29 responses and an overall 5.2% from the responses' modal choice. Secondly, was the privately owned public transportation system Mwaslat Misr (MM) which received 19 responses and an overall 3.4% from the responses modal share. Moreover, in the third place were the peak only public transportation services (SWVL, UBER bus, Buseet, etc…) with 2.3% share in the overall modal share with 13 responses. The least responses were for the taxi services. It has shown a real failure to compete with the other modes by having only 2 responses and a 0.4% from the overall survey responses.

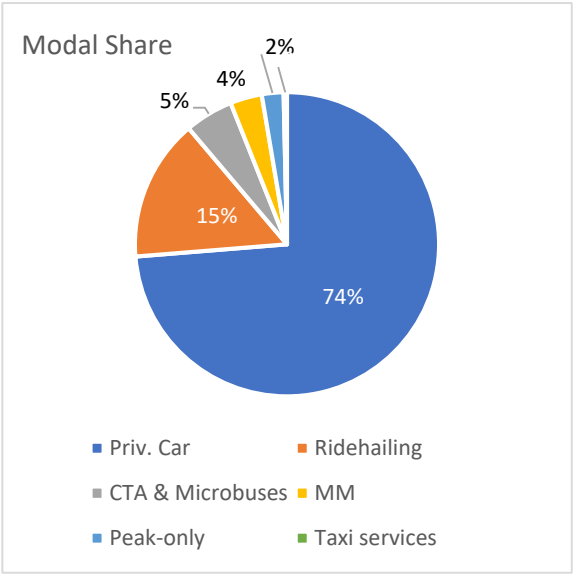


Figure 20: Modal Share of New Cairo Residents (Source: Author)

5.1.2. Analysis

Main mobility mode choice

The primary analysis for the responses for this question has shown a total dominance in the car usage preference for New-Cairo residents. It also highlighted the role of the integration of information and communication technology (ICT) within the mobility services and its effects on the modal choice. The ride-hailing applications came as the second preference in the modal share, in which they mainly depend on ICT to provide their services. Also, MM and the peak-only mass-transit services tend to use the ICT in their mobility services which helped them to compete and have a good share in the mobility modal share even though they are newly introduced in the system for only a few years. Moreover, it shows the failure of the traditional taxi services within New-Cairo.

Demographics effects on the mobility modes' choice

Furthermore, to investigate the factors affecting the residents' responses to this question, a multinomial logit model and pivot table analyses were conducted. The analysis analyzed the choice of the main mobility mode within the city to the demographics data which are the gender, age range, monthly income, residence type and main destinations' locations.

Gender & mobility modes' choice

The multinomial logit model has shown that the gender is a highly significant factor in the choice of the main mobility mode. As also shown in the pivot table diagram in Figure 21; Females tend to use ride-hailing services much more than males. Which is a noticeable change throughout the years as previously females were not encouraged to ride individual taxi services due to social and

cultural limitations. However, recently as per the survey responses, females would choose ride-hailing services rather than mass-transit services. This might be related to the increasing harassment of females in the streets, so, they tend to choose a private transportation mode due to this safety issue. However, both genders tend to mainly depend on the private car usage with a slight increase in the males' ratio compared to the females'.

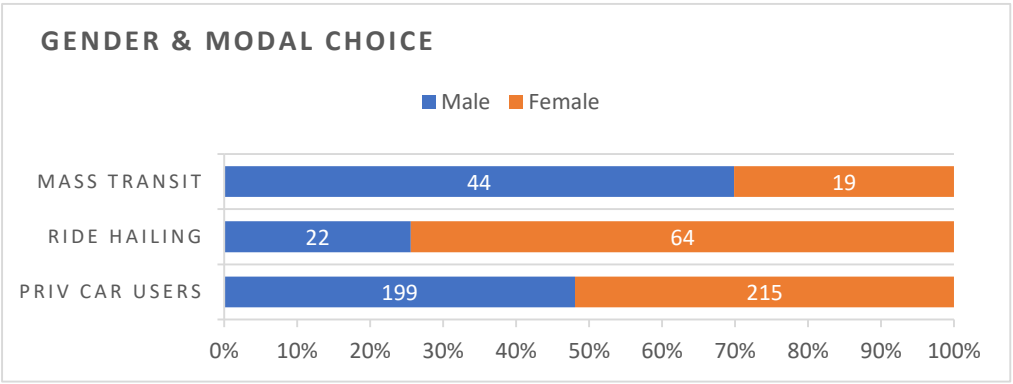


Figure 21: Relationship between Gender and Modal Choice (Source: Author)

Age ranges & mobility modes' choice

Moreover, the SPSS model has shown that the age factor is not significant enough in choosing the main mobility mode except for the age range of 15 to 24 years. Furthermore, The relation between them are shown in Figure 22 and it shows that the age range 15 to 24 years tends to use private cars less than the other age ranges. While also the 15 to 24 years' age range had the highest percentage of using ride-hailing services.

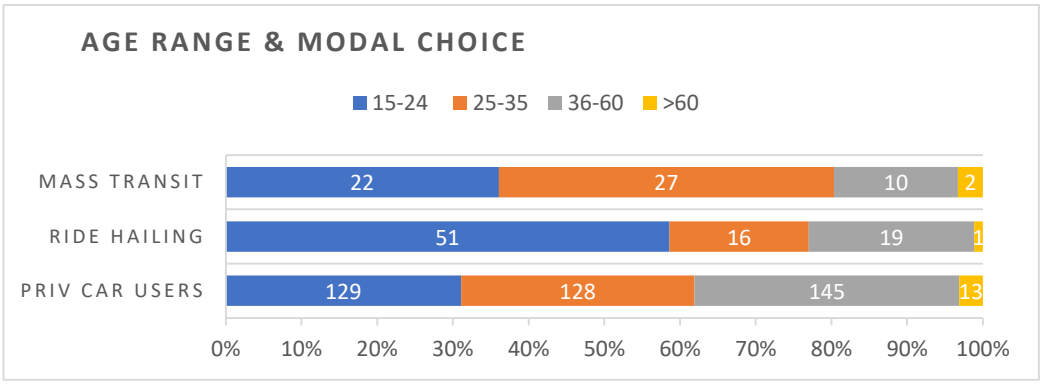


Figure 22: Relationship between Age and Modal Choice (Source: Author)

Residence Type & mobility modes' choice

The residence type was a highly significant factor in choosing the main mobility mode in the SPSS model. The residence type is mainly affected by the urban planning of the city, which reflects back in the mobility system. Figure 23 shows the relation between the residence type and the mobility modal choice of the residents. As shown in the diagram, the gated community is the least factor using mass-transit services which might be mainly due to its enclosure from the city. On the other hand, social housing has the highest percentage of using mass-transit services which might be either due to their social status and

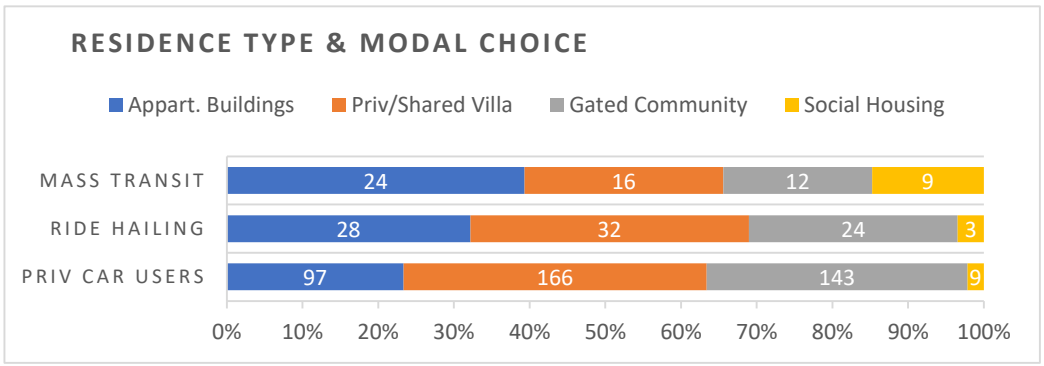


Figure 23: Relationship between Residence Type and Modal Choice (Source: Author)

income level or because of its integration in the public transportation network specially the CTA buses.

Monthly income & mobility modes' choice

As per the SPSS multinomial regression model, the monthly income which is less than 2000 EGP is highly significant in the choice of the main mobility mode. While other income ranges are less significant.

The relation between the residents' monthly income and their modal choice is shown in Figure 24.

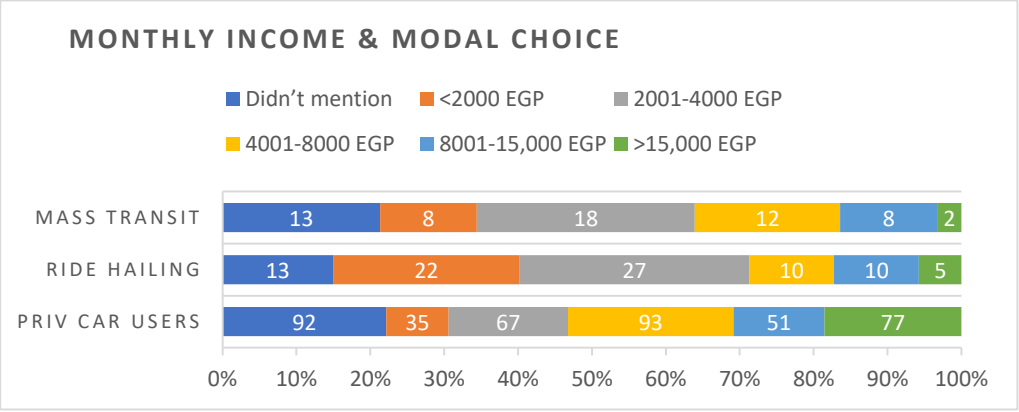


Figure 24: Relationship between Monthly Income and Modal Choice (Source: Author)

Daily commuting time & Monthly commuting expenses & mobility modes' choice

The daily commuting time and the monthly commuting expenses are dependent on the mobility mode choice and the commuting distances.

Figure 26 shows the relation between daily commuting time and the mobility mode and Figure 25 shows the relation between monthly commuting expenses and the mobility mode.

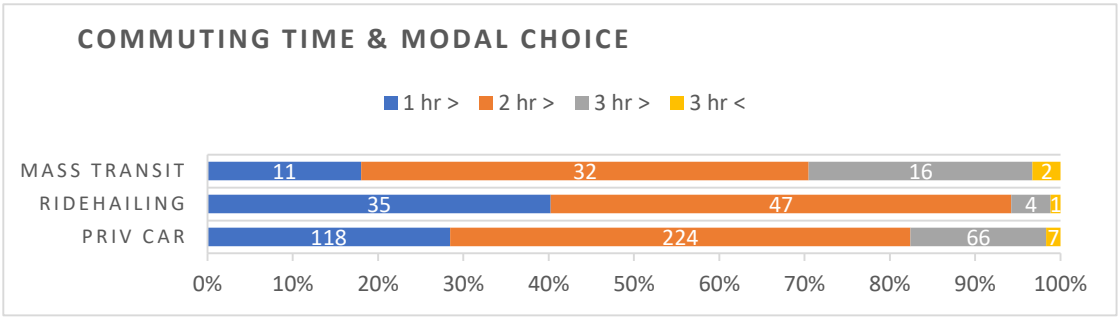


Figure 26: Relationship between Commuting Time and Modal Choice (Source: Author)

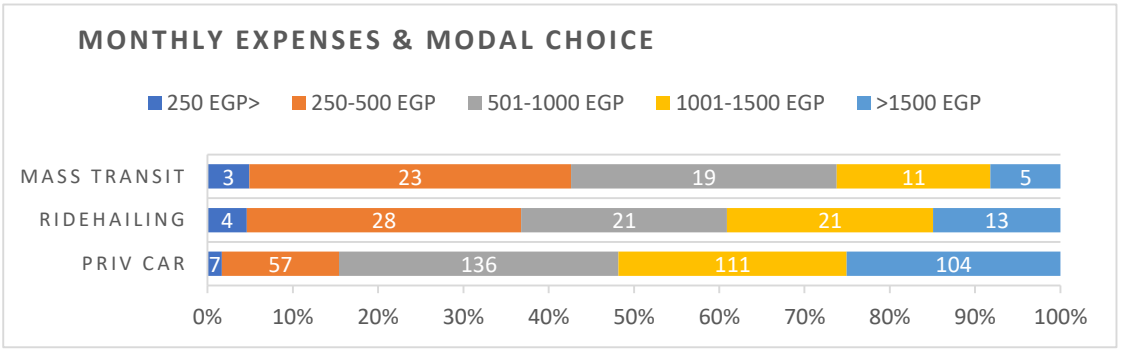


Figure 25: Relationship between Monthly Expenses and Modal Choice (Source: Author)

Commuters' satisfaction of their mobility modes

Following up on the demographics' analysis and its effects on the residents' modal choice, in this section, the advantages and disadvantages of the mobility modes will be discussed based on their users' responses. As well as the reasons that made the private car and ride-hailing users refrain from riding mass transit. The survey gave the residents the option to choose a maximum of three choices from multiple answers with an option to write your answer if it is not mentioned within the choices.

Private car users

Private car ownership and usage is the main challenge facing any sustainable mass transit approach. The qualities and advantages of using private vehicles are really tempting to their users. However, it also has several disadvantages. Between its advantages and the disadvantages, the mass-transit service providers tend to develop a sustainable attractive alternative system that can compete with the private vehicles.

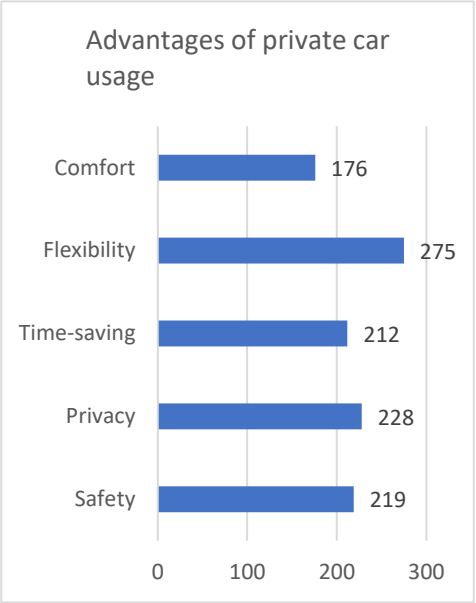


Figure 27: Advantages of Private Car Usage (Source: Author)

As previously shown in the modal share analysis, the private car usage is the most dominant mode in New-Cairo with an overall 73.7% from the whole system with 415 survey response. The residents tend to prefer this mode for mainly five advantages which are; safety, privacy, time-saving, flexibility and comfort. Flexibility was the most common advantage with a total 275 responses and 66.2% of the responses. While privacy came in second place with 228 responses and 54.9% of the responses. After that came the safety advantage, with total

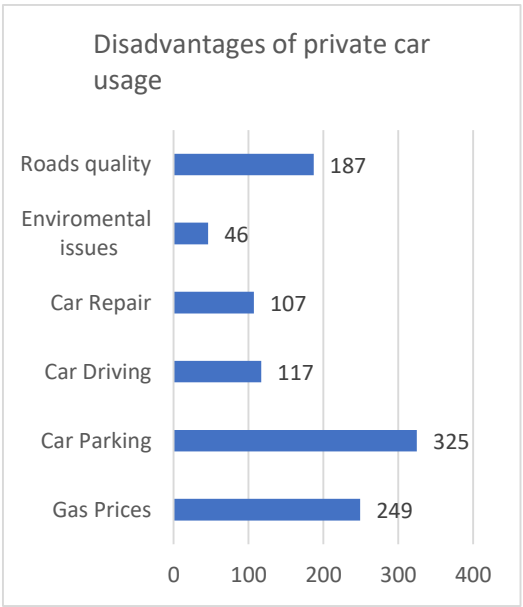


Figure 28: Disadvantage of Private Car Usage (Source: Author)

of 219 responses which represents 52.7% of the responses. Then came Time-saving advantage with 51.1 % of the responses which are 212 responses. The least chosen advantage was comfort with 176 responses which represents 42.4% of the responses.

Going to the disadvantages, the main disadvantages that the residents mentioned were; Gas prices, car parking, car driving, car repair prices, environmental issues, and road quality. The most common disadvantage was the car parking issue with 78.3% of the responses. In second place came the gas prices issue with 60% of the responses. Road quality came in third place with 45.1% of the responses. After that came the effort of car driving issue with 28.2% of the responses. While the environmental issues came as the least chosen disadvantage with just 11.1% of the responses

Moreover, their main issues behind not using mass-transit services were the following; safety, comfort, reaching the stops, pricing, availability and frequency of buses, and the trip duration. The most common issue in the responses was the availability and frequency of buses with 71% of the responses. While the second most common issue was reaching the stops with 64.8% of the responses. In third place came the comfort issue with 41.7% of the responses. Moreover, the trip duration came as the fourth most common issue with 39.5% of the responses. Following that

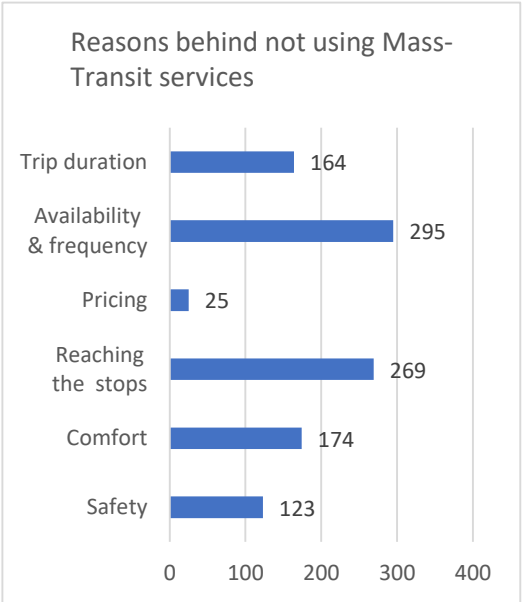


Figure 29: Reasons behind not using Mass Transit Services (Source: Author)

came the safety issue with 29.7% of the responses. And as the least chosen issue was the pricing with just 6% of the responses.

Ride-hailing users

The ride-hailing services are a middle option between the mass-transit sustainability, and the private car comfort. Also, as shown in the modal share responses, the ride-hailing & taxi services were in second place with 87 responses representing 15.5% of the modal share modes for New-Cairo residents. Moreover, 32 responses representing 36.8% of ride-hailing users has private cars but they preferred commuting with ride-hailing services.

Starting with the advantages of this service from the point of view of its users, the most common reason was its availability and flexibility with 75.9% of the responses. While in second place came comfort with 60.9% of the responses. Safety came in the third place with 44.6%, and reaching mass-transit stops came forth with 8% of the responses. Moreover, the pricing reason had 3.4% of the responses, while just

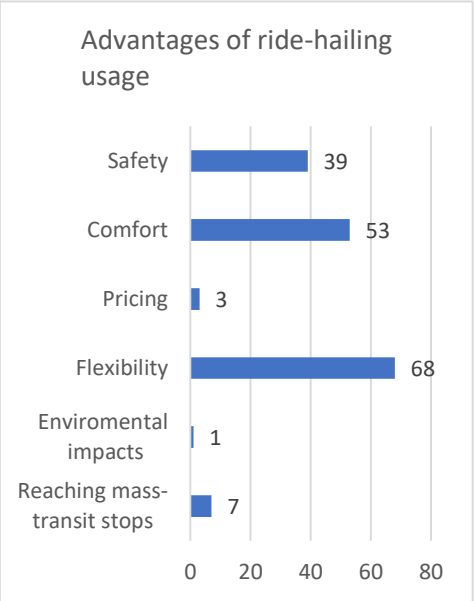


Figure 30: Advantages of Ride-hailing usage (Source: Author)

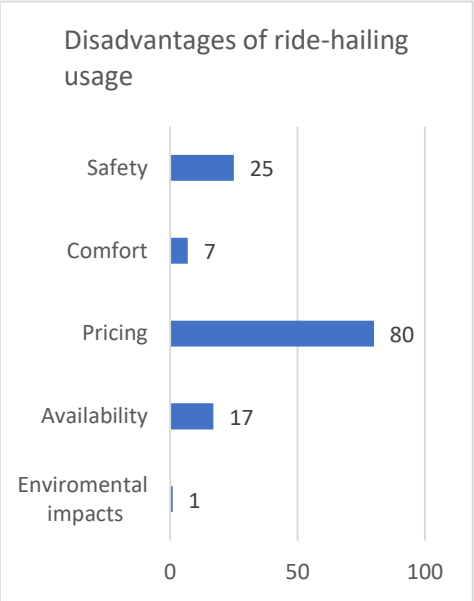


Figure 31: Disadvantages of Ride-hailing usage (Source: Author)

1.1% of the responses was for its environmental impacts.
Moreover, the main disadvantages were as follows: safety, pricing, availability, comfort, and environmental issues. The most dominant disadvantage was the pricing with 92% of the responses. Safety came in second with 28.7% of the responses. While availability came in third place with 19.5% of the responses, followed by 8% of the responses for comfort. The environmental issues came in last with only 1.1% of the responses.

Furthermore, the main issues of not using mass-transit services for the ride-hailing users were similar to the private car users' reasons. Which are the following: safety, comfort, reaching the stops, pricing, availability and frequency of buses, and the trip duration. The ranking of the reasons was similar to the private car users' ranking. The main issue was the availability and frequency of buses with 77% of the users' responses. While 59.8% of the users had the problem of reaching the mass transit stops. The third issue was comfort facing 35.8 % of the users. The safety issue is facing 28.7 % of the users, likewise is the trip duration with 28.7 % of the users' responses. The least issue was the pricing with 1.1% of the users' responses.

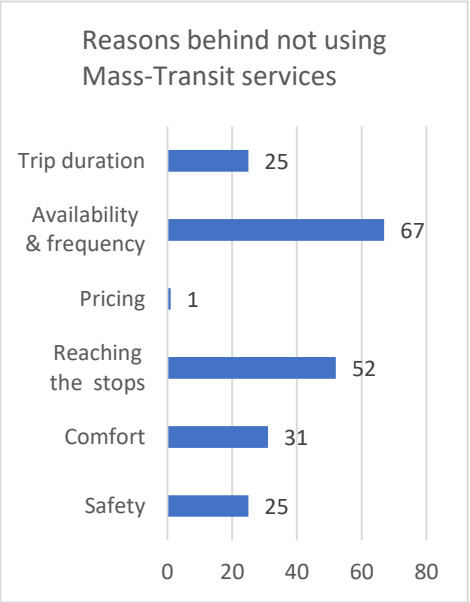


Figure 32: Reasons behind not using Mass Transit Services (Source: Author)

Mass-transit users

Sustainable mobility aims to increase the usage of mass-transit modes instead of any other mode. However, as per the survey responses, mass-transit modes are the least chosen mode by the residents with only 61 responses which represents 10.9% of the survey responses. Furthermore,18 survey responses representing 29.5% of mass-transit users said that they own a private car but they preferred to commute with mass-transit services. Going to the advantages of mass-transit services from the opinion of its users, the pricing was the most common advantage within the users with 78.7% of the users' responses. Availability came in second place with 52.5% of the users' responses. Moreover, safety came third with 29.5% of the users' responses, followed by comfort with 26.2% of the users' responses. The least chosen advantage was the environmental impacts with only 9.8% of the users' responses.

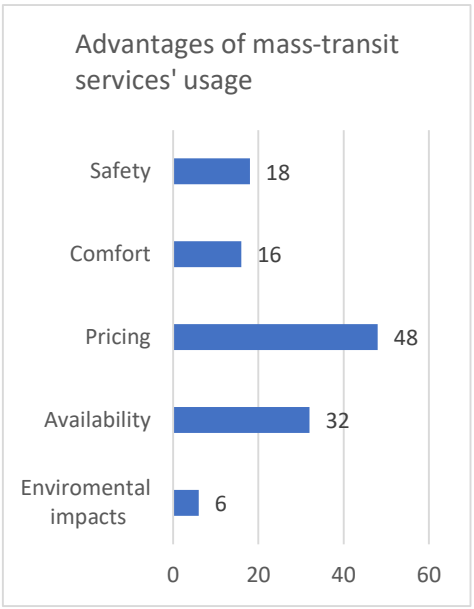


Figure 33: Advantages of Mass Transit Services (Source: Author)

As for the disadvantages, the availability and frequency of mass-transit modes was the most common disadvantage by 88.5% of the users' responses. While reaching the mass transit stops and the trip duration came in second place with 52.5% of the users' responses for each issue. Moreover, the issue of comfort came in fourth place with 29.5% of the users' responses, followed by safety issue with 11.5% of the responses. The least chosen disadvantage was the pricing with 9.8% of the users' responses.

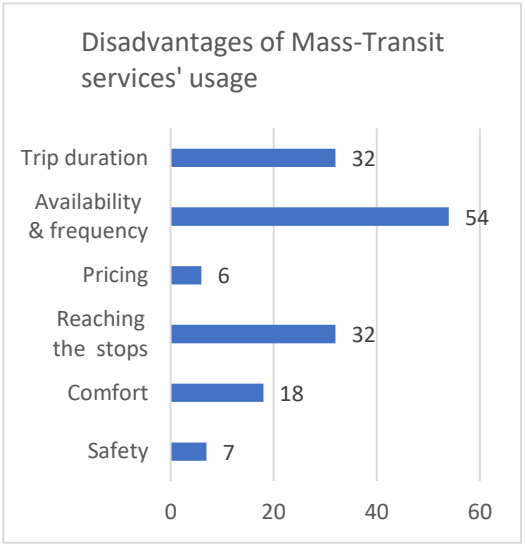


Figure 34: Disadvantages of Mass Transit Services (Source: Author)

Generally regarding their trips main issues, the mass-transit users' responses in the survey stated that the first mile was their main challenge in their trips. 30 responses chose the first mile as their main challenge that needs development within their mobility trip. The interchange of the modes trips came in second ranking with 14 responses, while the last mile of their trip had 10 responses, followed by only 7 responses for the main trunk trip.

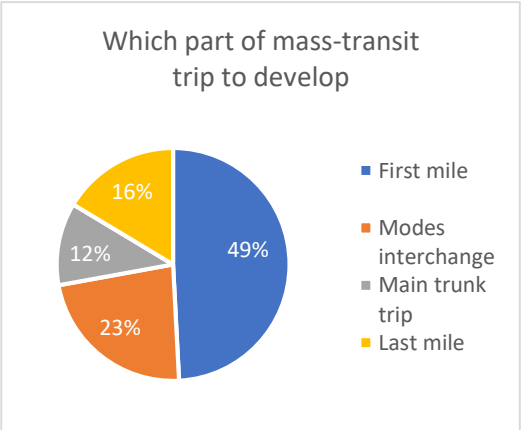


Figure 35: Parts of Mass Transit to be developed (Source: Author)

First and Last Mile

In this section, the first, last and only mobility miles of New-Cairo would be analyzed based on the residents' responses. Mobility within the same district is

different than mobility within the whole city. Thus, in these questions the residents were asked to pick their used modes to move within New-Cairo with the possibility to pick several modes. As shown in Figure 36 active mobility was the least used method to travel across New-City which might be due to its large area and the long distances between its districts. The mass transit was still in the third ranking of used modes, however, the percentage of users using it decreased compared to mobility across Cairo. While ride-hailing services was the second most used mode with a recognizable increase in its users, to move across the city. Furthermore, the private car was still the most dominant mode of mobility used to move across New-Cairo.

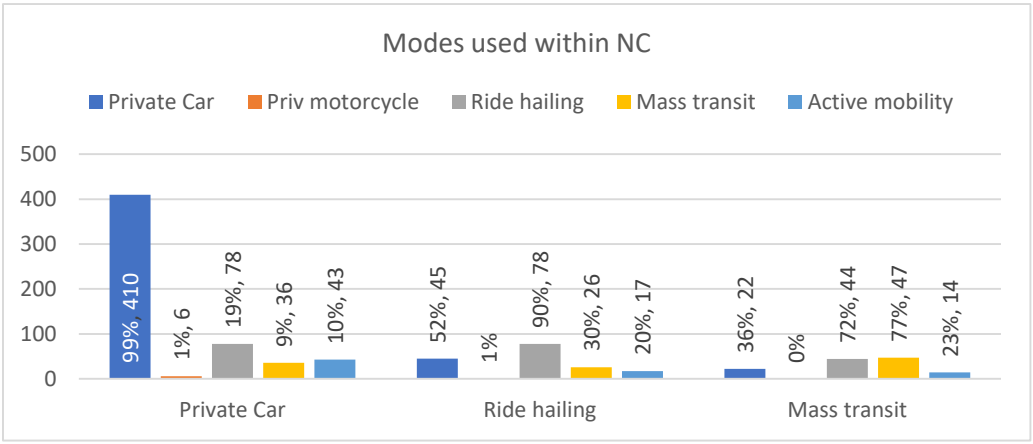


Figure 36: Modes used within New Cairo (Source: Author)

Walkability

Going to the users' experience of their trips in the first mile, the residents were asked about the active mobility experience. Starting with the walkability, the users were asked to rate the walking experience in New-Cairo from the following aspects; safety, comfort, continuity, shading and leisure. The rating was from the score of 5, having 1 as very bad, 2 as bad, 3 as neutral, 4 as good and 5 as very good. The highest rating was for the continuity of the sidewalk with a general rating of 3.08. The safety came in second with a rating of 3.06,

followed by comfort with a rating of 3. The leisure and enjoyment of the walkability came in fourth with 2.66 rating. While the shading of the sidewalk had the lowest rating with 2.16. These rankings summarized together would result in a below average walking infrastructure, thus it does not encourage people to walk more and leave their cars or use the other mobility modes.

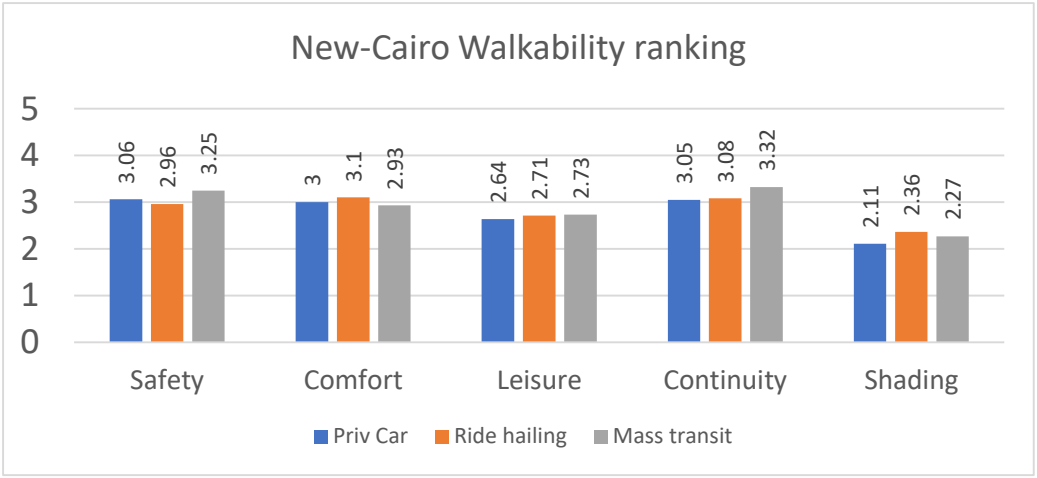


Figure 37: New Cairo Walkability Ranking (Source: Author)

Cycling

As for cycling, the residents think that parking facilities are the main issue facing cycling in New-Cairo with 66.43% of the residents' responses. The second issue is the rider's safety with 59.86% of the resident's responses, followed by roads design with 48.85 % of the residents' responses. Furthermore, the forth issue is the roads' quality with 48.31%, then the weather conditions with 42.45% of the residents' responses. The long distances issue was the least chosen with 31.97% of the residents' responses.

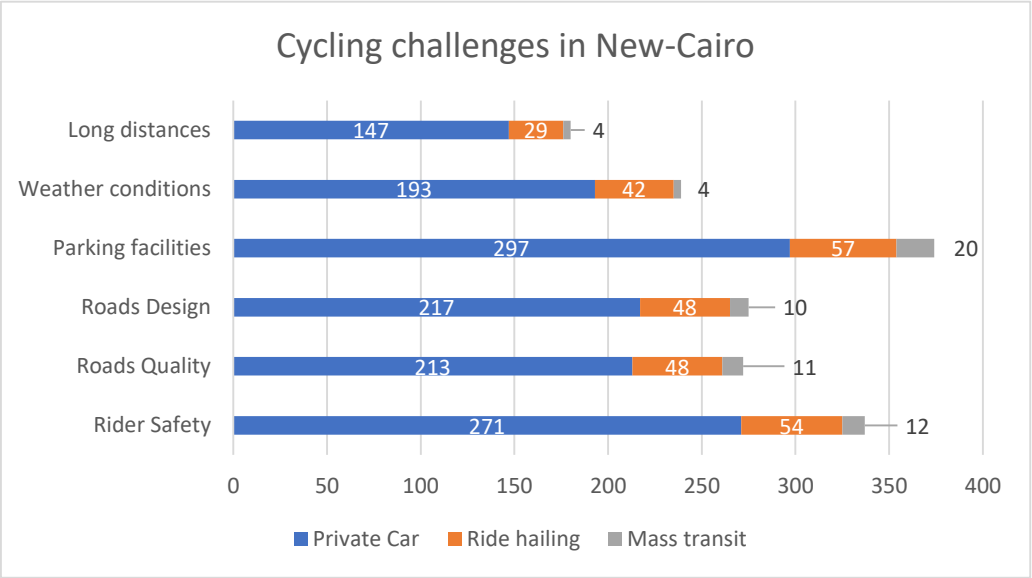


Figure 38: Cycling Challenges in New Cairo (Source: Author)

First mile

Moreover, to understand the length of the first mile, the residents were asked about distance from their residence to the nearest mass-transit stop. As per the responses shown in Figure 39, almost 18.4% of the ride-hailing services users and 13.25% of the private car users did not know where is the nearest mass-transit stop near their residence. Thus, the first problem in the first mobility mile is that the mass-transit stops are not recognizable to some residents living near it. The second issue would be the long distances. Only 26.11% have a mass-transit stop around 1 Kilometer or less from their residence, which is almost 10 minutes walking or less. While 22.2% of the residents have a mass-transit stop from 1 to 2 Kilometers around their residence which is almost from 10 to 20 minutes walking. Furthermore, 12.25% of the residents have the mass-transit stop from 2 to 3 Kilometers away from their house. Also around 11% of the users do not have a mass-transit stop near their house except by a 3 Kilometers distance or more.

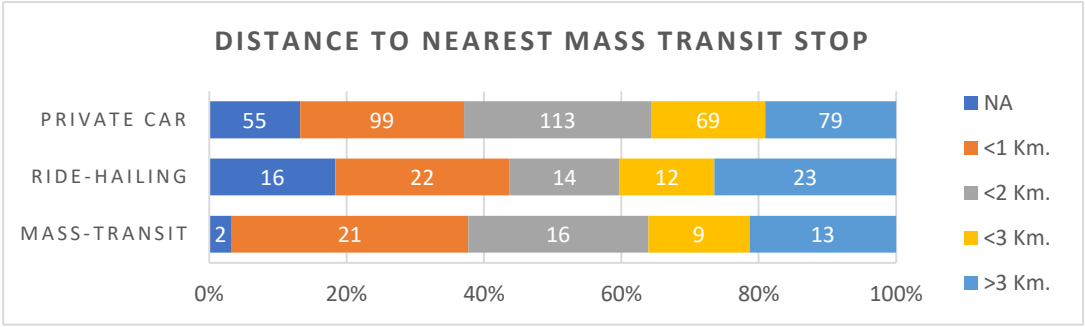


Figure 39: Distance to the nearest Mass Transit Stops (Source: Author)

As for the mobility modes passing by these stops, almost 18.5% of the private car users and 23% of the ride-hailing users did not know the modes passing by

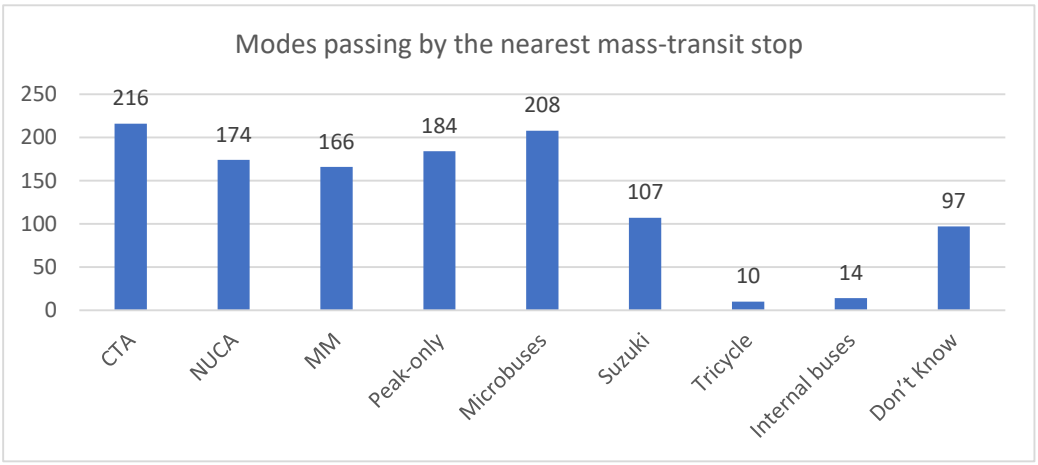


Figure 40: Modes passing by the nearest Mass Transit Stops (Source: Author)

the nearest mass-transit stop. While the CTA buses were the most recognizable modes to the residents, with 38.37% of the residents knowing that they pass by the nearest mass-transit stops. Microbuses buses came second with 36.94% of the residents' responses, while the peak-only bus services came third with 32.68% of the residents' responses. Surprisingly, NUCA buses which are planned to serve the need of moving within New-Cairo came forth by 30.91% of the residents' responses. Mwaslat Misr buses came in fifth ranking by 29.48%

of the residents' responses. Moreover, Suzuki buses had 19.01% of the residents' responses, and the gated communities' internal buses had 2.49% of the residents' responses. While the tricycle came last with only 1.78% of the residents' responses. Figure 40 shows the distribution of these modes from each users.

Furthermore, the mass-transit users were asked about how do they mainly go to the mass-transit stops, with the option to choose multiple options. The most used option reach their nearest mass-transit stops was walking with 40 responses which represents 65% of the respondents'. While ride-hailing was the second most chosen mode with 23 responses representing 38% of the respondents. Furthermore, 18 respondents which is 29.5% of the respondents used their private cars. While only 1 respondent used NC buses, and none of them used cycling.

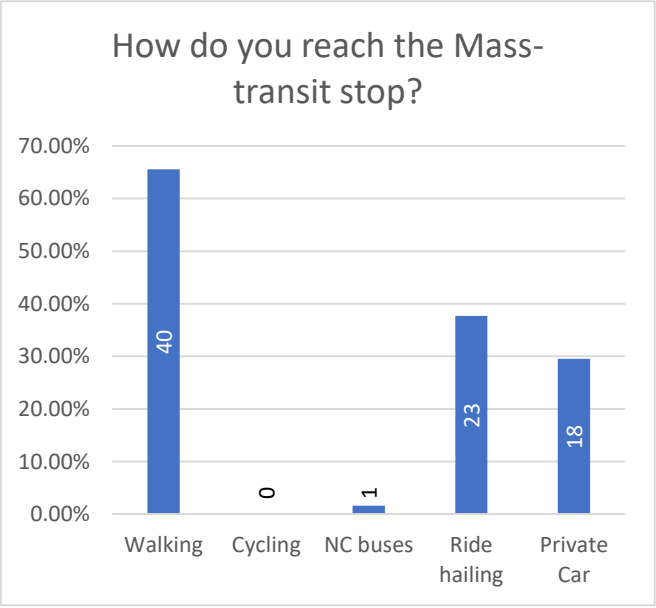


Figure 41: Modes to reach Mass Transit Stop (Source: Author)

Only mile

The only mile mobility is affected by two variables; the distance of the services or destination, and the availability of mobility modes. In this research, the weekly household needs were taken as an example of only mile mobility to the residents, and the results were as follows; only 26.11% of the residents have a services shop within a 1 kilometer radius. While 22.2% of the residents have the services shops between 1 to 2 kilometers, and 12.255% of the residents have the services shop between 2 to 3 kilometers. While 11% of the residents do not have

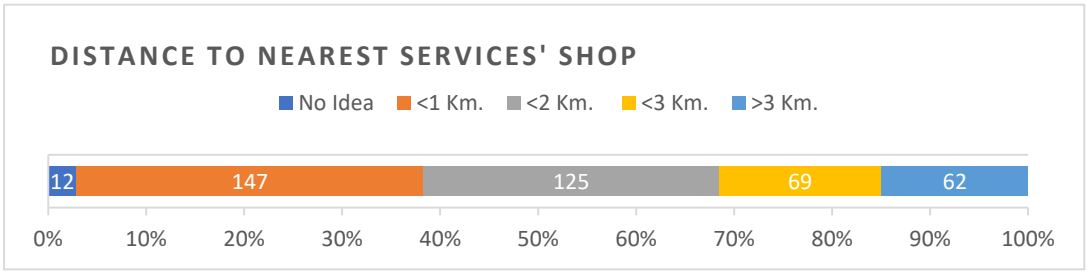


Figure 42: Distance to nearest Services (Source: Author)

any service shops except farther than a 3 kilometers distance. Moreover, 1.2% of the residents have no idea where their nearest shops are as shown in Figure 42.

As for the mobility modes used for the household needs, the private car usage is also dominant with 80.28% of the residents using it. While 42.27% of the

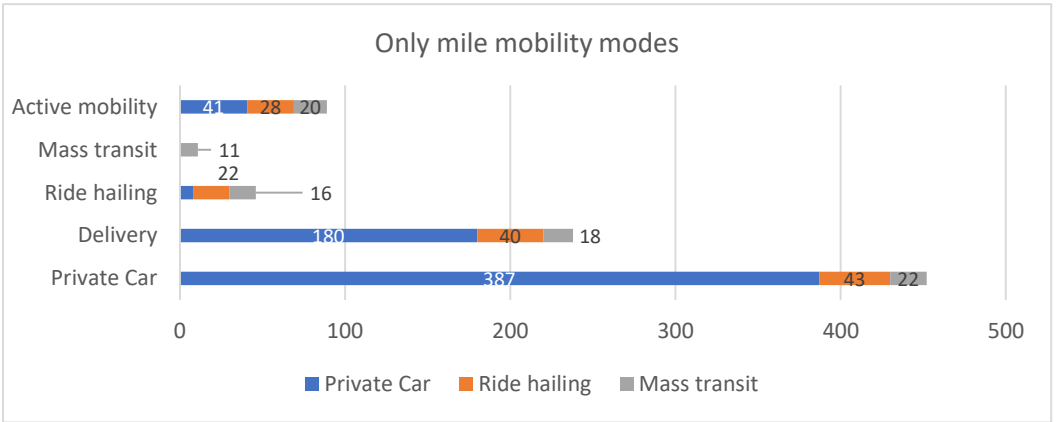


Figure 43: Only Mile Mobility modes (Source: Author)

residents are using delivery services. Moreover, active mobility modes come in third place with 15.81% of the residents, followed by 8.17% of the residents using ride-hailing services. Furthermore, mass-transit services were the least used mode with only 1.95% of the residents. Figure 43 illustrates the ratio between the used modes.

Willingness to shift:

Sustainable mobility approaches tend to encourage shifting in modes from private vehicles into mass-transit services. Moreover, these approaches should also exert efforts to encourage the mass-transit services users to continue using them to avoid a negative shift backwards. In this section, New-Cairo residents' willingness to shift modes is discussed, either from the private car usage towards ride-hailing and mass-transit users or vice versa.

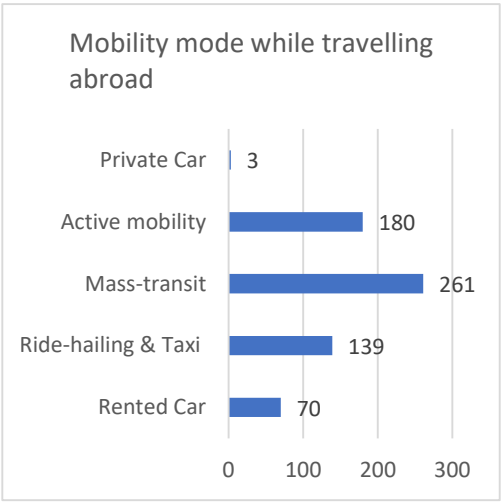


Figure 44: Mobility mode while travelling abroad (Source: Author)

Furthermore, service providers and mobility planners should exert efforts to encourage the private car users towards a sustainable shift. In the survey, the private car users were asked about their mobility modes when they travel abroad, and mass-transit services was the most dominant response with 68.9% of the users as shown in Figure 44. This might give some hope that the private car users of New-Cairo might be willing to shift in case the mass-transit system developed and met their needs.

Willingness to shift based on FLM solutions

Furthermore, the first, last mile is the most dominant issue in the mass-transit system as per the responses of its users. Also, reaching the mass-transit stops

were the second most chosen reason for avoiding mass-transit services for the private car and ride-hailing users. In addition to that, the survey gave the residents the options to choose the most suitable solutions for the first and last mile options and the responses were as follows; the most chosen solution was developing bike-lanes and bike sharing system with 370 responses which represents 66.6% of the survey respondents. While developing the pedestrian infrastructure to enhance walkability was the second most chosen solution with 370 response representing 65.7% of the respondents. In third rank was developing park & ride systems in the mass-transit stops with 299 responses which represent 53.11% of the respondents. Inter-city shuttle buses came in fourth ranking with 281 responses which represent 49.9% of the respondents. While introducing E-scooter sharing system was in fifth ranking with 25.9% of the respondents which is 146 responses. Furthermore, only 13 responses thought that none of these solutions would be suitable which represent 2.3% of the survey's respondents.

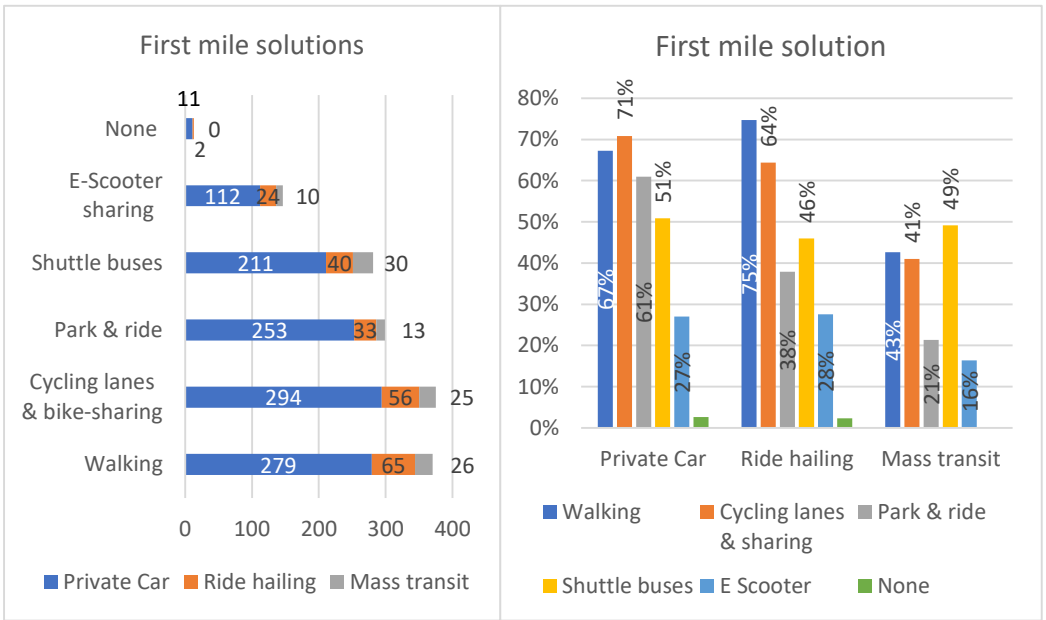


Figure 45: First and Last Mile solutions based on user group (Source: Author)

Willingness to shift towards sustainability

By developing these modes, the willingness of the private car and ride-hailing users to shift to mass-transit services increase. 60.9 % of the ride-hailing users, and 56.4% of the private car users would be willing to shift. While 37.6% of the private car users and 35.6% of the ride-hailing users would be willing to shift sometimes. Moreover, only 6% of the car users and 3.5% of the ride-hailing users would not be willing to shift as shown in Figure 46.

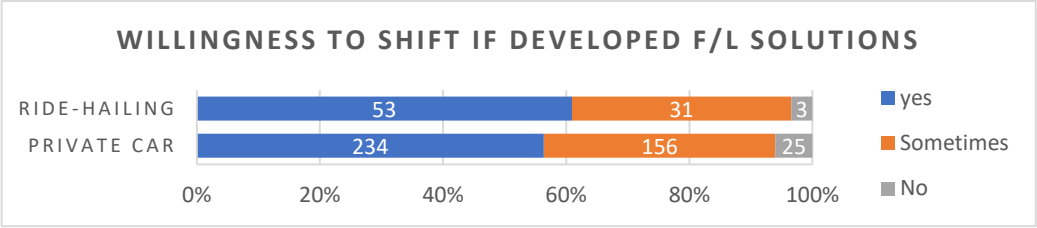


Figure 46: Willingness to shift if First and last mile solutions got developed (Source: Author)

However, these users are used to a certain level of service that provides them several advantages that they will not compromise easily. As for comfort, 52.5 % of the private car users and 57.5% of ride-hailing users would be willing to compromise some comfort in order to save money and use mass-transit services. Moreover, 32% of private car users and 35.6% of ride-hailing users may be willing to compromise some comfort. While 15.5% of private car users and 6.9% of ride-hailing users will not accept any compromises regarding their comfort.

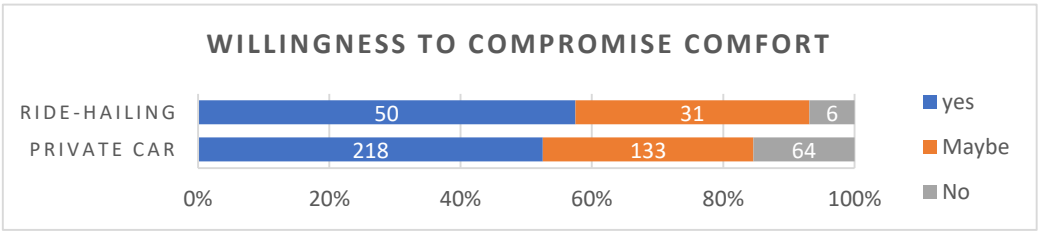


Figure 47: Willingness to compromise comfort (Source: Author)

Moreover, 47% of the private car users and 52.9% of the ride-hailing users will not compromise any extra time in order to ride mass-transit services. With only 20.5% of private car users, and 16% of ride-hailing users willing to compromise some time, and 32.5% of private car users and 31% of ride-hailing users that may be willing to compromise some time. As shown in the results illustrated in Figure 48.

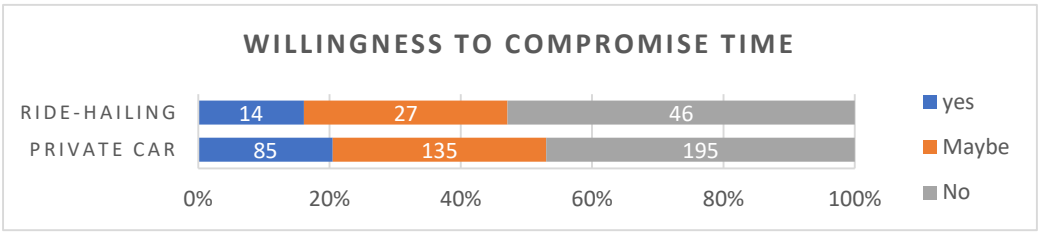


Figure 48: Willingness to compromise time (Source: Author)

Undesirable Willingness to shift

As for the unsustainable shift, by asking the users of the mass-transit and ride-hailing services their willingness to shift to car usage if they could own, the responses were surprisingly unsustainable. 57.5% of the ride-hailing users, and 39.3% of the mass-transit users have shown their willingness to shift to private car usage if they can own it. While 37.9% of the ride-hailing users and 31% of the mass-transit users have said that they might use the car sometimes but not on a regular basis. While only 4.5% of the ride-hailing users and 11.5% of the mass-transit users have rejected shifting to private car usage even if they can own one. Figure 49illustrates the comparison between these opinions. These responses highlight a huge problem, thus, mobility planners and service

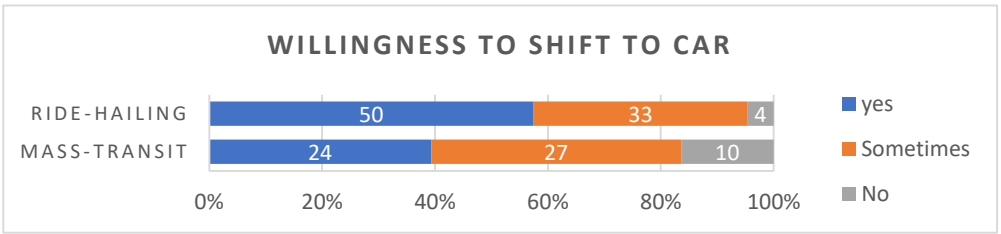


Figure 49: Willingness to shift to cars (Source: Author)

providers should exert efforts in developing their services and satisfying their users' needs to avoid any unsustainable shift in the mobility modal share.

Conclusion

By the analysis of these results, private-cars usage is the most dominant transportation mode within New-Cairo. Ride-hailing services were the second used mode, whilst mass-transit services were the least chosen mode to travel across the city. The availability and frequency of mass-transit services, as well as the first mile problem of reaching the mass-transit stops were the main reasons behind not riding mass-transit services. Furthermore, some private-car and ride-hailing users might be encouraged to shift to mass-transit services due to its relatively low costs. However, in order for this to happen, the first and last miles' issues must be solved, as well as ensuring a high quality of mass-transit services. Thus, service providers and mobility planners should be prioritizing the development of the first and last mile solutions, as well as developing the mass-transit services in order to encourage the private car users for a sustainable mobility modal shift and to avoid any undesirable shift from the mass-transit users towards private car mobility.

6. Chapter 6: Qualitative Analysis

In this chapter, the qualitative data from mapping the current transportation network in New-Cairo will be analyzed by producing and analyzing each mass-transit service individually as well as having a collective map with all the available mass-transit modes and identifying the total coverage area of the mass-transit network. Moreover, the First, Last and Only (FLO) miles will be qualitatively analyzed based on the interviews conducted within mass-transit commuters. Furthermore, semi-structured interviews were conducted with several service providers in order to have a better understanding for the overall system. The results for these interviews will be analyzed and expressed by drawing conclusions based on the semi-structured interview.

6.1. Mapping of the current transportation network in New-Cairo

Several mass-transit services are operating in New-Cairo, some of them are governmental public transportation systems such as the CTA buses. While some other services being provided by private companies like Mwaslat Misr buses. Moreover, there is a merged mass-transit system between the private sector and governmental authorities such as the NC buses. NC buses are owned by the New Urban Communities Authority (NUCA) and operated by Mwaslat Misr company. Furthermore, New-Cairo has also paratransit transportation system that includes microbuses and Suzuki buses. In addition to that, there is a demand-driven transportation services such as the services of the private companies SWVL and Uber Bus, as well as the informal three-wheelers services. In this section, the mass-transit services in the urbanized parts of

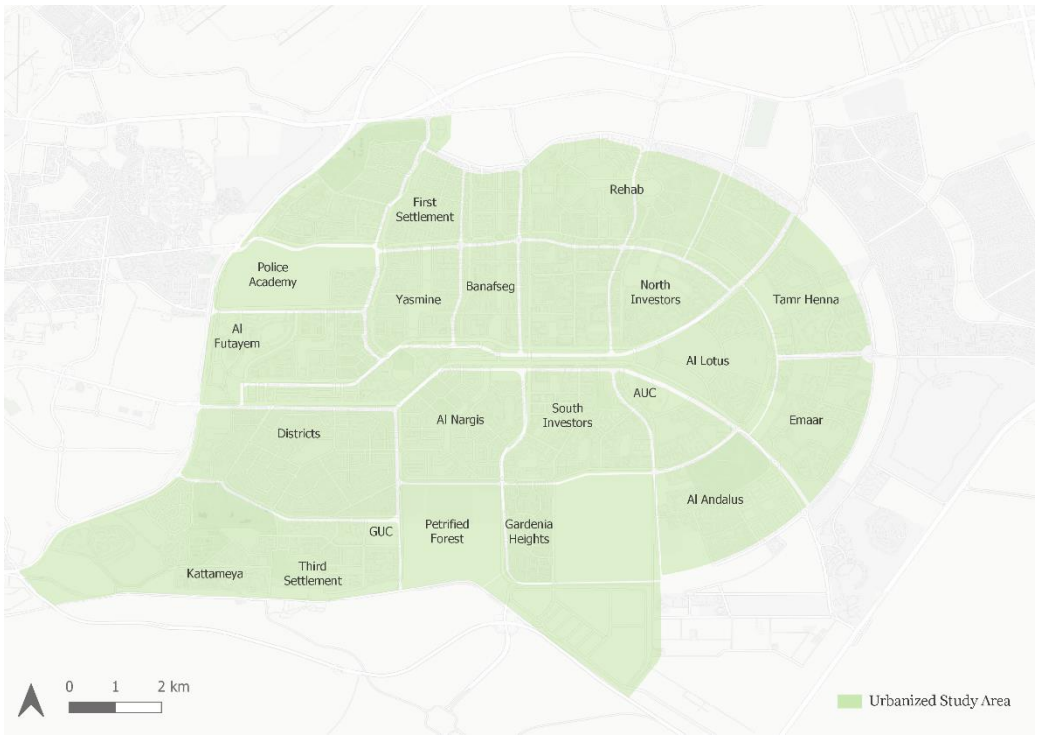


Figure 50: Urbanized Study Area (Source: Author; Data: TfC, 2018)

New-Cairo are analyzed in order to understand their coverage area as shown in Figure 50. The routes' data and information is from the year 2018 provided by Transport for Cairo (TFC). Furthermore, all the mentioned price data it is based on the prices in August 2020. As the prices tend to frequently increase recently as the government is trying to minimize the subsidy on several services and products including mass-transit and gas fuels.

CTA buses

The Cairo Transportation Authority (CTA) buses are governmental mass-transit services that operates within the Greater Cairo Region (GCR). The CTA buses are mainly a trunk network service that aims to connect the different neighborhoods of the GCR through fixed routes between main stations. New-Cairo has a total of 21 CTA buses routes in New-Cairo originating from one of the four main CTA stations; the first settlement, the third settlement, the fifth

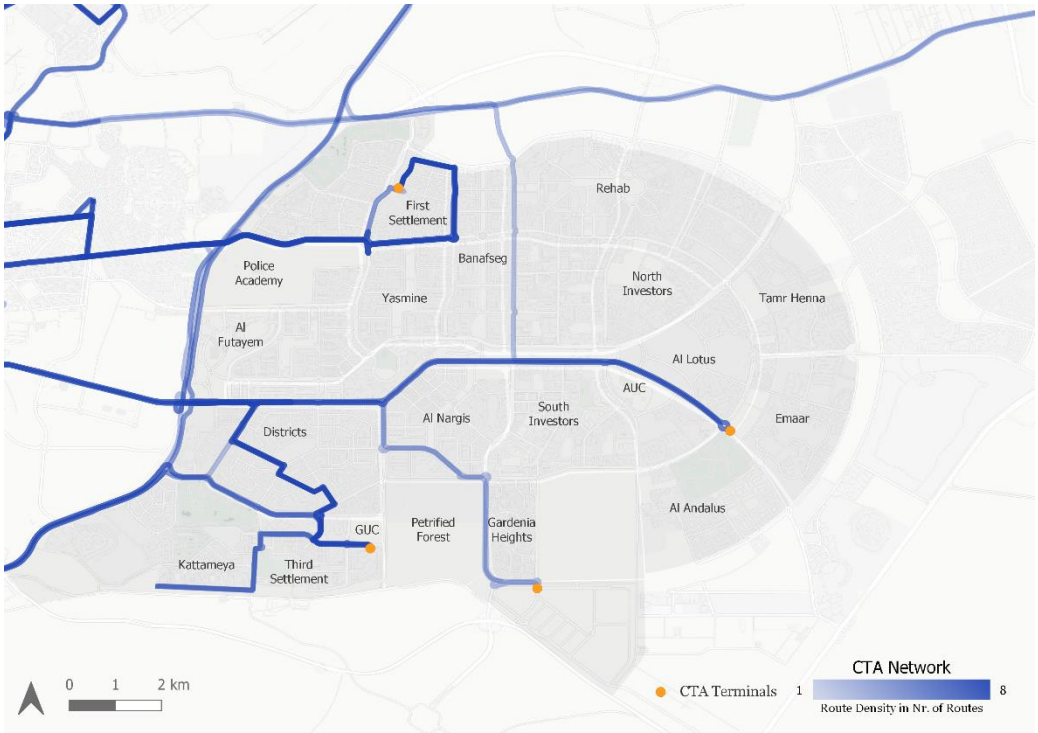


Figure 51: CTA Network (Source: Author; Data: TfC, 2018)

settlement and the industrial area stations. These routes tend to overlap in some parts, the main overlapping areas are in the beginning of the South 90Th road with a total of 8 buses routes. While 6 bus routes overlap at the first settlement, and 5 buses at the districts area as shown in Figure 51. The CTA services are partially subsidized from the government and the tickets ranges are between 4 to 7 EGP, with offering some more comfortable buses with a range of 10 EGP (August 2020).

Furthermore, the ticket's price is fixed for the whole route. Whether the commuter rode a short part of it or the whole route the price of the ticket remains the same. In addition to that, the CTA buses offers an on-demand pick-up and drop-off services that allows the commuter to get on the bus or leave it in any place within its fixed route

Mwaslat Misr

Mwaslat Misr (MM) is a private mass-transit services that operates within the GCR. MM buses are smart trunk network services buses that aims to enhance the mass-transit system in GCR through fixed routes trips. MM is using information and communication technology (ICT) and integrating it within its offered mobility services. This smart technology allowed them to include their routes within google maps and enabling the commuters to have a real-time information about their buses. MM has an overall of 4 bus-routes in New-Cairo, originating from its main terminal at Al-Lotus.

These routes tend to connect New-Cairo to different neighborhoods within the GCR. Moreover, it also focuses on connecting New-Cairo to the transportation network in the GCR and specially the Metro. Thus, all MM buses routes pass by a minimum of one metro station within its route. Furthermore, MM buses are mainly focused within New-Cairo's in two main axes. The main axis is within New-Cairo's main street, the South 90th road, while the other secondary axis is passing by Kattameya – Al-Golf street connecting it the south 90th road. Furthermore, MM buses also have on-demand pick-up and drop-off services. As for the trip tickets they are fixed for 15 EGP for the whole route, with some future plans to have tailored prices based on the commuter's pick-up and drop-off locations. However, they recently have a smart-card that can pre-charged that enables payment with a reduced price of 12 EGP (August 2020). In addition to that, MM tends to encourage private car-users to use mass-transit services by introducing a park and ride system at their main station in al Lotus.

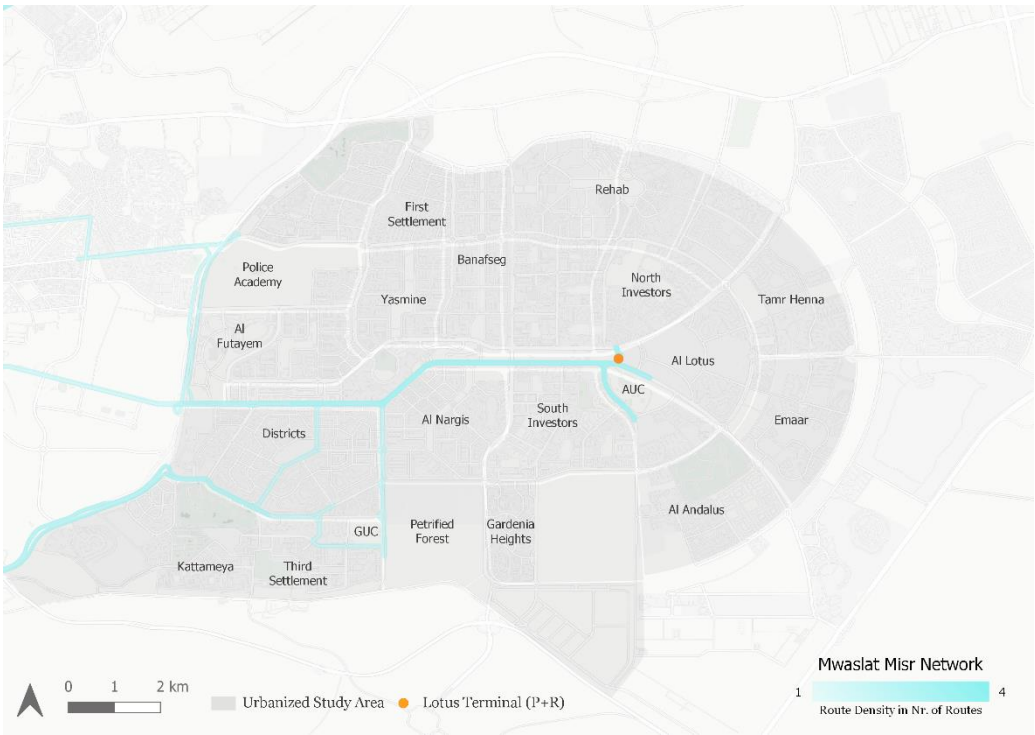


Figure 52: MM Network (Source: Author; Data: TfC, 2018)

Microbuses

Microbuses are paratransit modes of transportation that tends to offer both trunk network services as well as feeder network services depending on the area of operation. The microbuses most commonly operate in a 14 seated size bus. In New-Cairo, microbuses mainly tend to be a trunk network service by focusing its services in three main hotspots; the South 90th street, the first settlement and the mixed-use services area at the Districts. These hotspot areas are covered with several informal stations along its path. These informal stations originate 36 microbuses routes that connects New-Cairo to several neighborhoods across the GCR as shown in Figure 53. These routes are not totally fixed routes but have the tendency to deviate to avoid congestion based on the driver's preference.

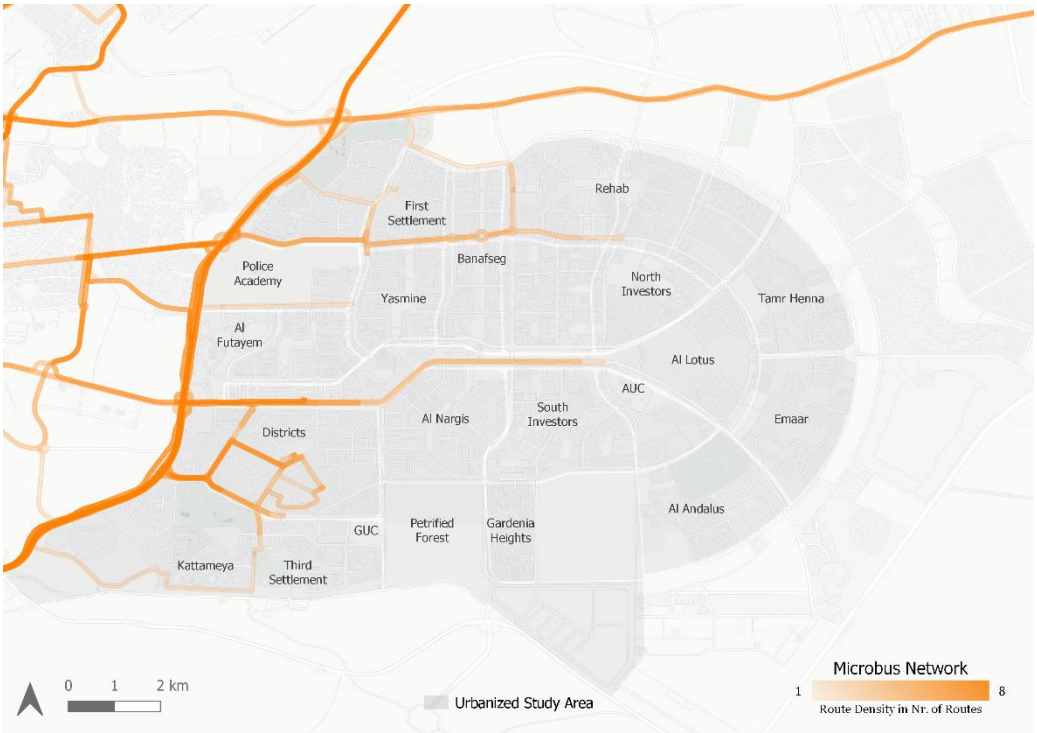


Figure 53: Microbus Network (Source: Author; Data: TfC, 2018)

Moreover, the prices for the microbuses services ranges from 3 to 15 EGP with the option of a tailored fare based on the pick-up or drop-off locations. Furthermore, the microbuses have flexible commuter's pick-up and drop-off services, while it will not start the route from the station before getting the bus fully occupied.

Suzuki-vans

Suzuki-vans are another form of paratransit mobility servies that operated within New-Cairo. Suzuki-vans are most commonly used as a feeder netowrk service to connect the commuters' to the areas where trunk-network services operates. Moreover, 21 suzuki-vans routes are operated within New-Cairo. These routes are mainly originating from several informal stops along its route. They are mainly concentreated at the district's area, followed by the south 90th street, whilst a few routes originates from the first settlmment as shown in Figure 54.

The suzuki-vans prices varies from 3.5 to 7 EGP (August 2020), with a most commonly fixed fare for the whole route due to its shortness. They also have a flexible pick-up and drop-off for the commuters, while it will not start the trip except with a full capacity. However, as the suzuki vans are limited to 7 seats, it tends to reach its full-capacity faster than microbuses.

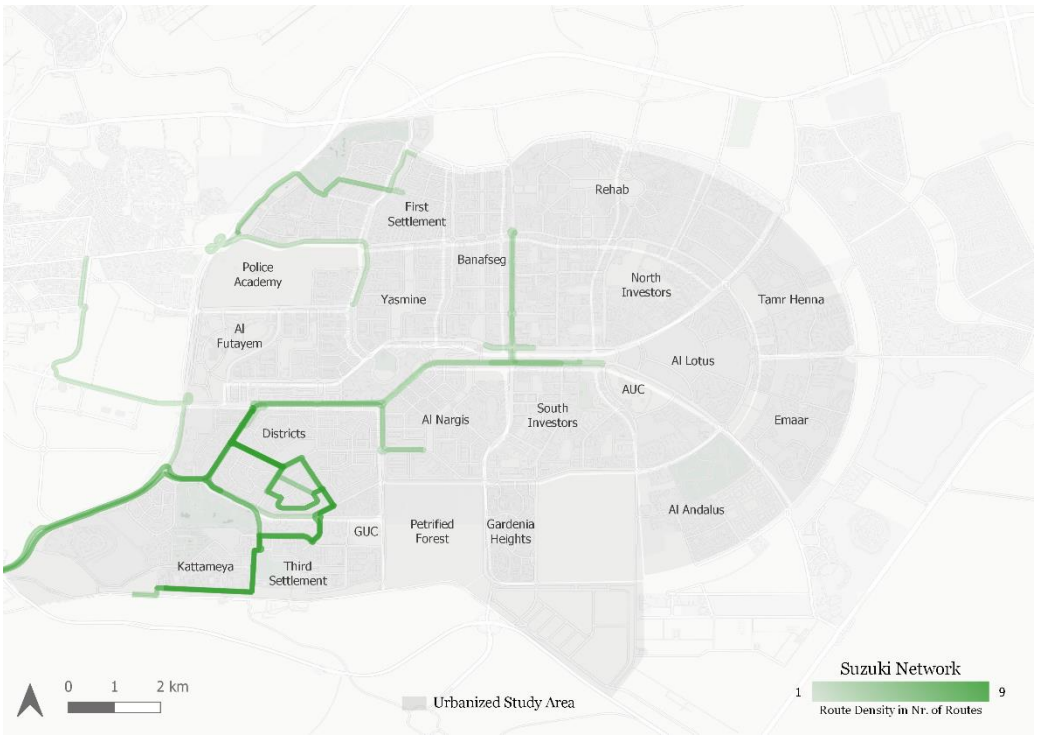


Figure 54: Suzuki Network (Source: Author; Data: TfC, 2018)

NC buses

New-Cairo (NC) buses are governmental buses that are owned by the New Urban Communities Authority (NUCA) and being operated by Mwaslat Misr company (MM). NUCA tend to provide these buses in new urban communities in order to connect them to the main transportation network. These inner-city buses are available within several new cities such as New-Cairo, 6th of October, Al-Sherook and etc. New-Cairo has 4 main NC routes. These routes tend to connect different neighborhood within New-Cairo to the main transportation network. Thus, most of the routes tend to connect the commuters to the South 90th road which has the most offered mobility services within New-Cairo as shown in Figure 55.

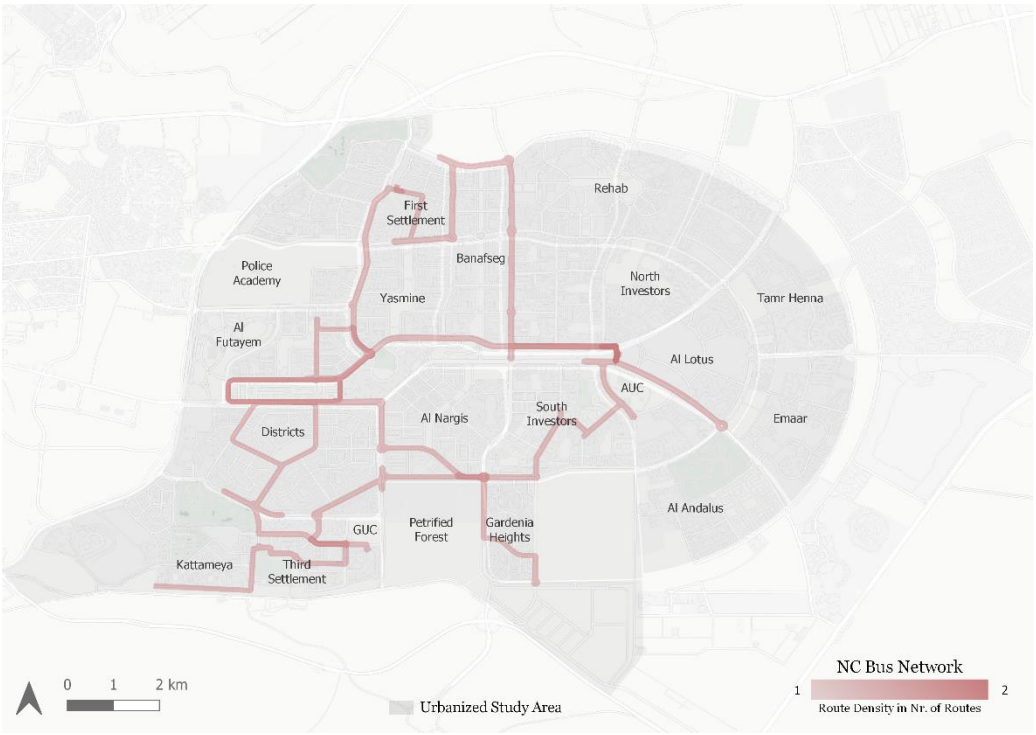


Figure 55: NC Bus Network (Source: Author)

NC buses have a fixed price of 5 EGP that can be paid cash or by MM smart card (August 2020). They also offer the commuters' the flexible pick-up and drop-off services. Furthermore, NC buses have several bus-stops that are characterized by a physical signage. Recently, these stops can be accessed within 400 meters' radius from almost 22.7 % of New-Cairo's urbanized area which is almost a 5 minutes' walk. Furthermore, almost 47.7% of New-Cairo's urbanized area can access these stops within 800 meters' radius which is almost a 10 minutes' walk. The coverage area for these stops are shown in Figure 56.

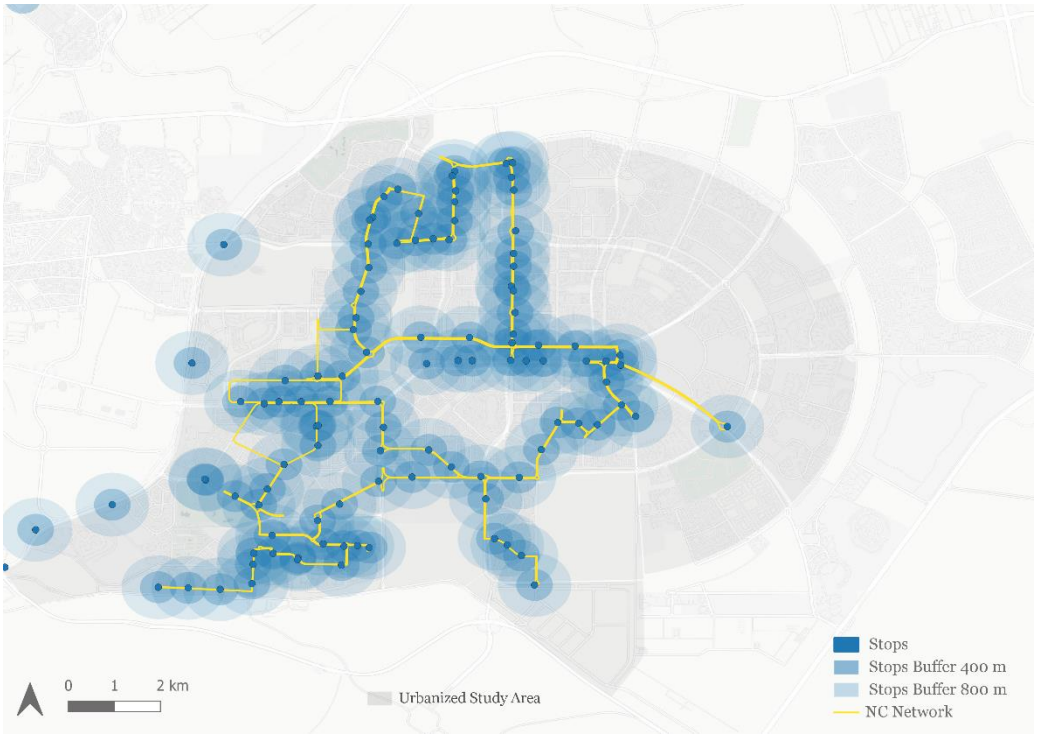


Figure 56: NC Stops Coverage (Source: Author)

Demand-responsive services

New-Cairo has demand-responsive mass-transit services. The operation of these services are not defined by a certain route or schedule, but rather defined by the demand of the commuters. Due to its flexibility and uncertainty, these modes cannot be expressed by mapping as they tend to change frequently based on the commuters' demand. Moreover, there are two main types of demand-responsive services in New-Cairo; Private companies' services like SWVL, Uber Bus and likewise as well as informal paratransit services such as the three-wheelers services.

SWVL, Uber Bus, etc.

Several private companies such as SWVL, Uber Bus and likewise tend to offer demand-responsive mass transit services. Their services are trunk network services aiming to cover the demand of the commuters to travel across the GCR. Moreover, these services are characterized by its non-fixed routes, as well as the usage of Information and Communication Technology (ICT) in the booking of the ride. These services are mainly defined by stops' locations rather than a route, which enables the drivers to deviate through a shorter route if no commuter needs to access the following stop. For this reason, the booking of these services are dependent on the pick-up and drop-off location that affects the price ranges as well which ranges in between 15 to 45 EGP (August 2020). Moreover, the pick-up locations are fixed to the location chosen on the application, while there might be some flexibility in the drop-off services along the used route.

Three-wheelers services

Three-wheelers services is a form of informal paratransit services that is not commonly found in New-Cairo. These services are operated by Tricycles that were originally moving goods to the construction sites and the industrial area of New-Cairo. Tricycles are very dependent on the commuters' demand, and mostly its users are construction workers and the industrial areas employees. Thus, it mainly functions on the weekdays during the working hours only. The tricycles offer a feeder network service, as its main usage is connecting the industrial area and the construction sites to the main transportation network that is mainly south 90th road.

The pricing for this service tends to change depending on the pick-up and drop-off areas, but it is within the range of 3 to 5 EGP (August 2020). Furthermore, these services are operated based on the demand of the users, thus commuters' can have very flexible pick-up and drop-off locations.

New-Cairo's full mass-transit network

New-Cairo has several mass-transit modes with different characteristics. By combining these modes together, we would observe the overlaying of these modes in several hotspots. These hotspots are mainly the South 90th road, the districts' mixed-use area, and the first settlement as shown in Figure 58. Thus, these hotspots would enable the commuters to choose from a variety of offered modes. However, these hotspots occur in a very limited area in New-Cairo, and the left of the city remains insufficiently covered with mass-transit services. Furthermore, in order to analyze the coverage area of the total mass-transit services coverage, a 400 and 800 meters' radius coverage method was applied. The results shown that only 46.9 km2 of the urbanized area of New-Cairo is covered with mass-transit services within 400 meters' radius which is 5 minutes' walk.

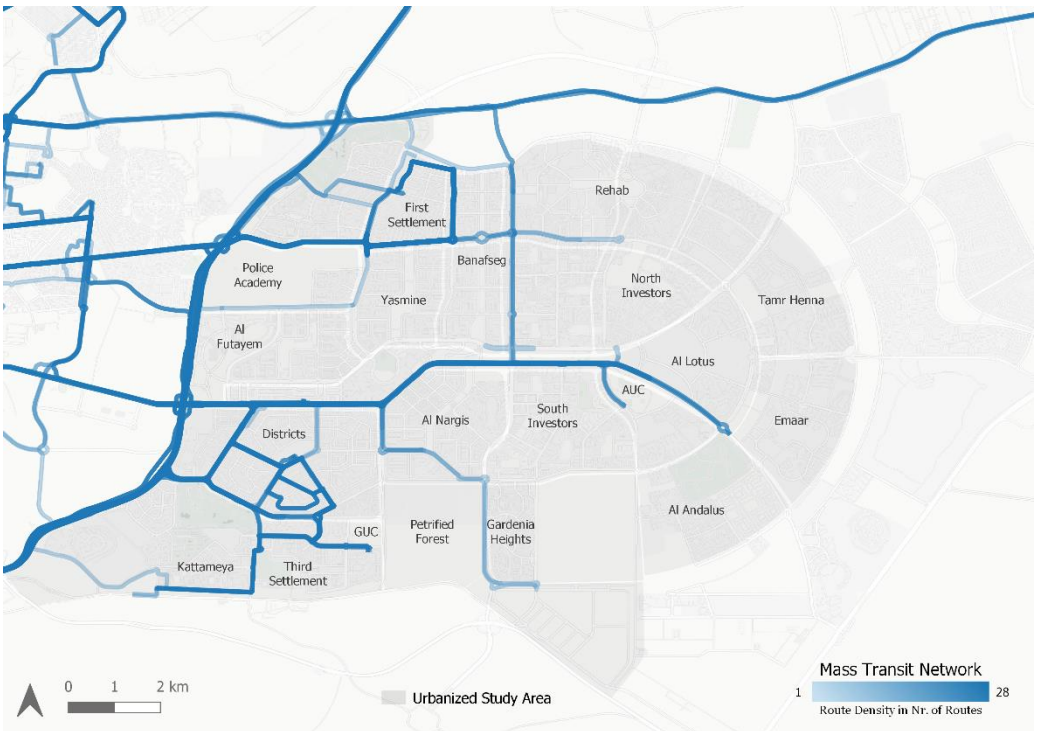


Figure 57: Full Mass Transit Network in New Cairo (Source: Author; Data: TfC, 2018)

Moreover, only 70.5 km2 of the urbanized area of New Cairo has mass-transit coverage within 800 meters' radius which is 10 minutes' walk. These areas represent 30% and 46% of the total urbanized area of New-Cairo respectively.

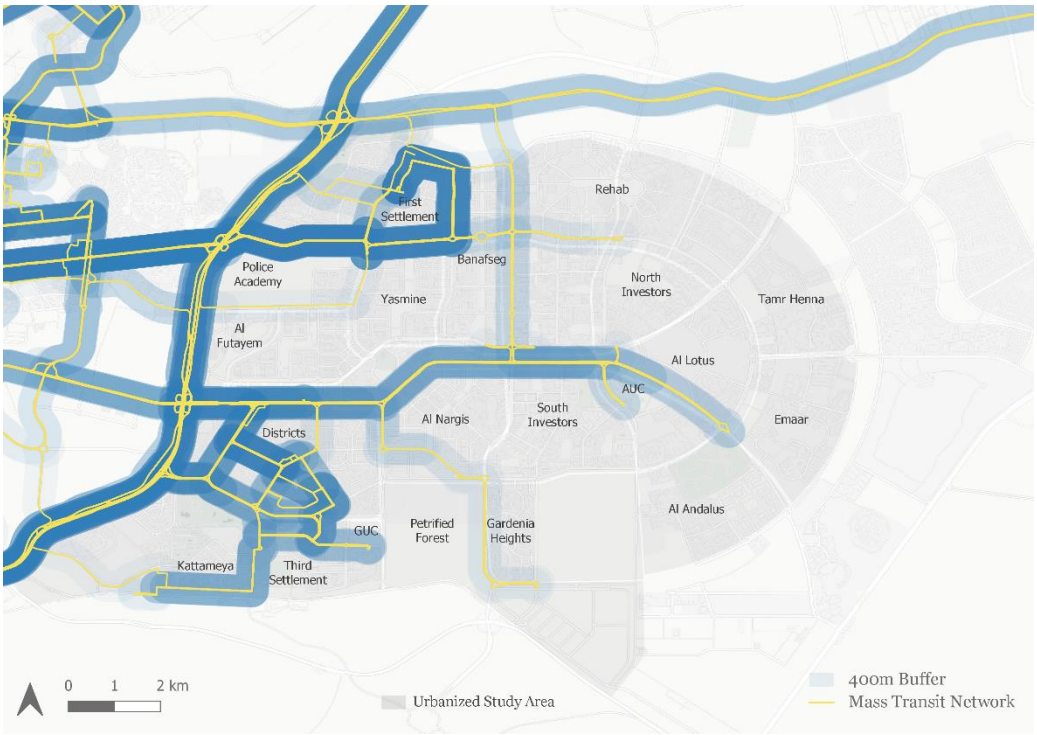


Figure 58: Mass Transit Network Coverage (400m) (Source: Author; Data: TfC, 2018)

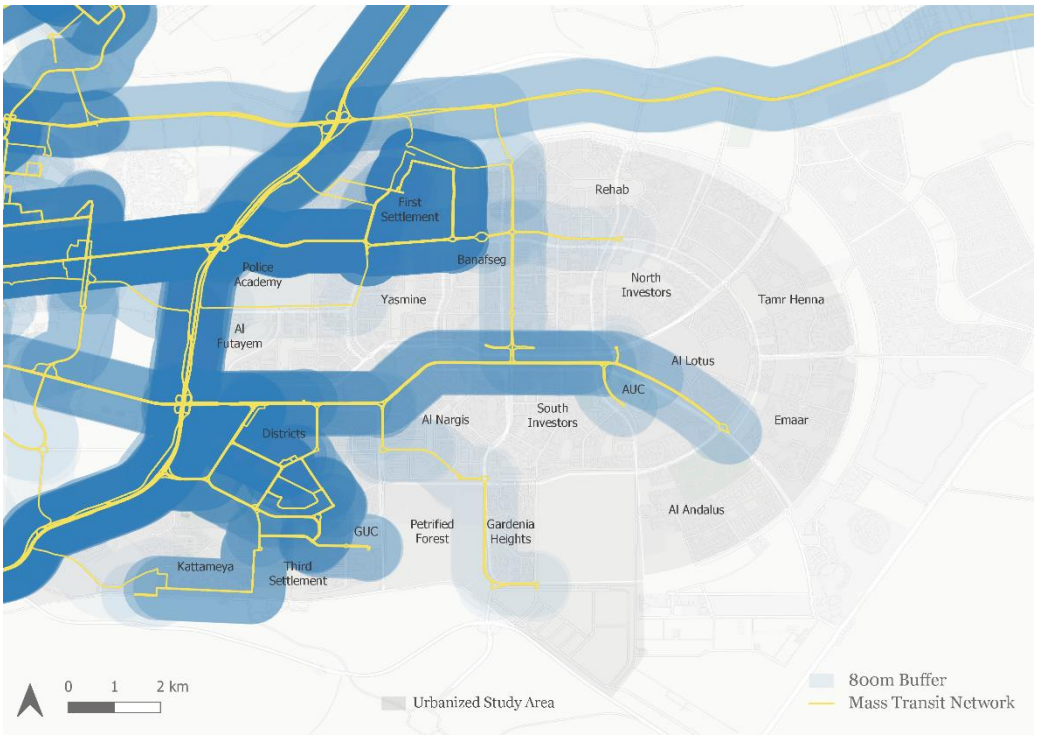


Figure 59: Mass Transit Network Coverage (800m Buffer) (Source: Author; Data: TfC, 2018)

Conclusion

New-Cairo has a variety of mass-transit modes that operates with different characteristics. Moreover, these modes are mainly trunk network systems. Thus, most of these modes tends to overlap in a few hotspots. This overlapping in modes gives the commuter the opportunity to choose the most convenient mode in term of comfort and pricing. However, there is shortage in feeder network systems to connect the commuters to these hotspots. NC-buses, Suzuki-vans and tricycles tried to provide a suitable first mile solution, however these modes are not fully covering the whole area. Thus, the first mile and connecting the commuters to trunk network services and the other way around are noticeable issue that needs future solutions and interventions.

6.2. First, last & only (FLO) miles experiences' mapping

For a better understanding of the first and the last mile experience within New-Cairo mobility network, 19 interviews were conducted with mass-transit commuters. The interviews were conducted to both residents and workers within different neighborhoods who use mass-transit services. The interviews were conducted to a total of twelve males and nine females. Moreover, fourteen interviewees were within the age range between 24 to 35 years. While three interviewees within the age range of 18 to 23 years, and two interview in the age range from 36 to 60 years. The used first, mile and only modes by these commuters were mainly the following; Walking, ride-hailing, private car, Suzuki buses or tricycles. As seen in the map below, the destinations of the First mile trips are concentrated in two main areas, South 90th road and the districts mixed-use area, which are the main hotspots for the mass transit network as presented in the previous network analysis. The commuters' origin's location and their first or last mile destination were mapped to understand their trips in the terms of the city as shown in Figure 60.

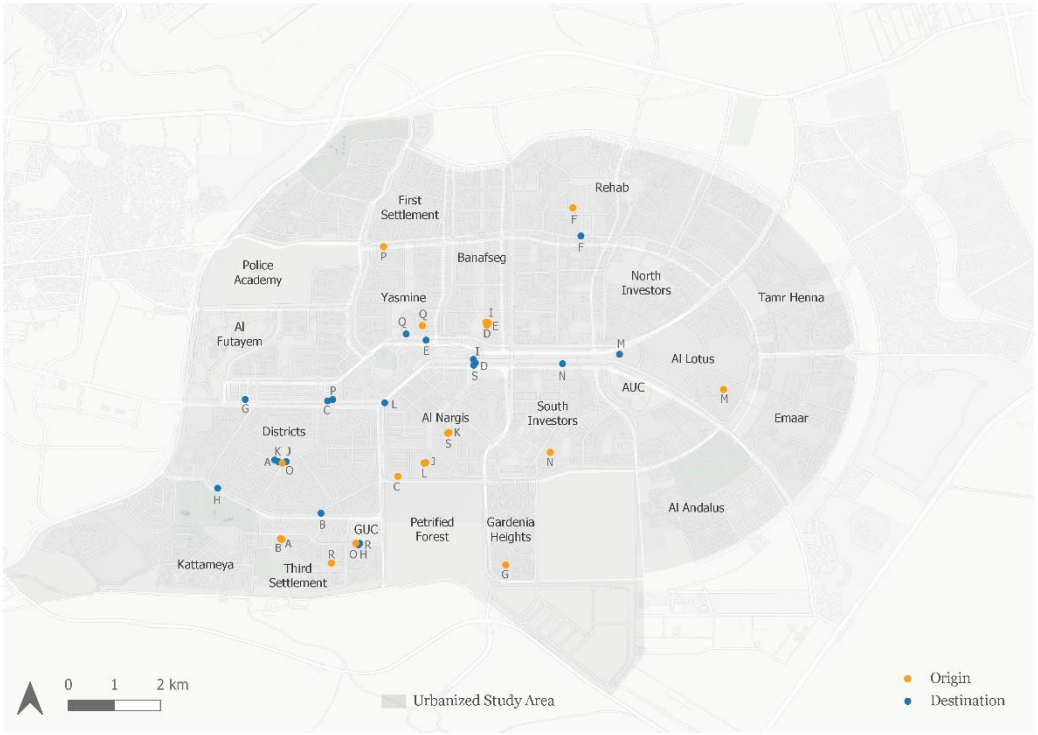


Figure 60:First and Last Mile Origin and Destination Points (Source: Author)

Walking

Walking is the first, last or only mode (FLO) for eight interviewees. These interviewees were six males and two females. Moreover, seven of them were within the age range of 24 to 35 years old, while only one interviewee was within the age range of 36 to 60 years old. In addition to that, two commuters of them were using Mwaslat Misr buses as trunk network service, also another two commuters of them were using SWVL. Furthermore, two commuters from them were using microbuses as their main trunk service, while two commuters had their destination within their only mile so walking is their only used mode. For a better imagination of the context of their walking trips, their trips were mapped as shown in Figure 61.

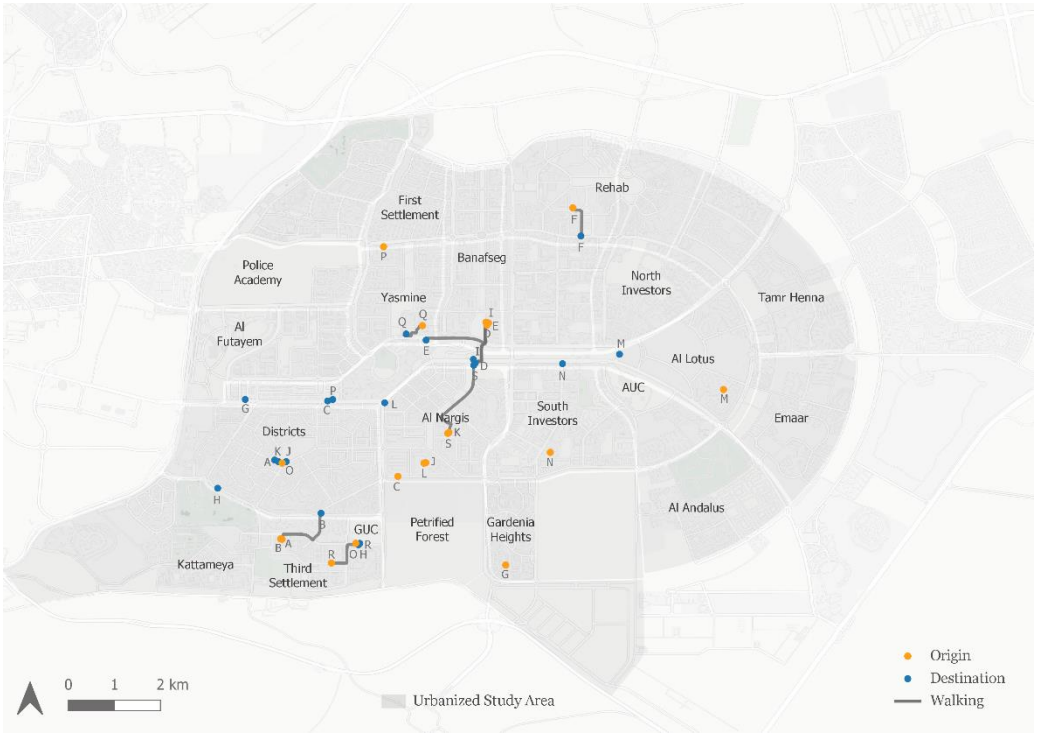


Figure 61: Walking as a First and Last Mile (Source: Author)

The most common issue for the interviewees in their FLO walking experience was the safety. Some walking routes included crossing main streets such as South 90th road. While also the street animals were one of the causes of the safety issue for some of the interviewees. The second main issue was the duration, as the range of their walking trips were from 12 minutes up to 18 minutes. Thus, it is a relatively high cognitive effort mode. Furthermore, the comfort of some of the trips was a disadvantage due to the roads and sidewalks quality as well the weather conditions in both winter and summer. Overall, they all agreed that walking was the cheapest available option, while some of them would not walk if they found a feeder network service such as Suzuki-vans or NC-buses.

Ride-hailing

Ride-hailing is used by five interviewees for their FLO trips. Three of them were females, while two were males. Moreover, 3 commuters of them were within the age range of 24-35 years, and two of them were within the age range of 18-23 years. Furthermore, two commuters of them were using Mwaslat Misr (MM) as their main trunk network service. While two were using microbuses, and one was using private company bus. The main issue that faced the commuters in ride-hailing services as a FLO mode was the high pricing for this relatively short trip. The pricing for the FLO trip was almost double the price of the microbuses and almost equivalent to MM which are the trunk network services. However, the advantages of ride-hailing services as FLO modes for the commuters were mainly the comfort and the short trip duration.

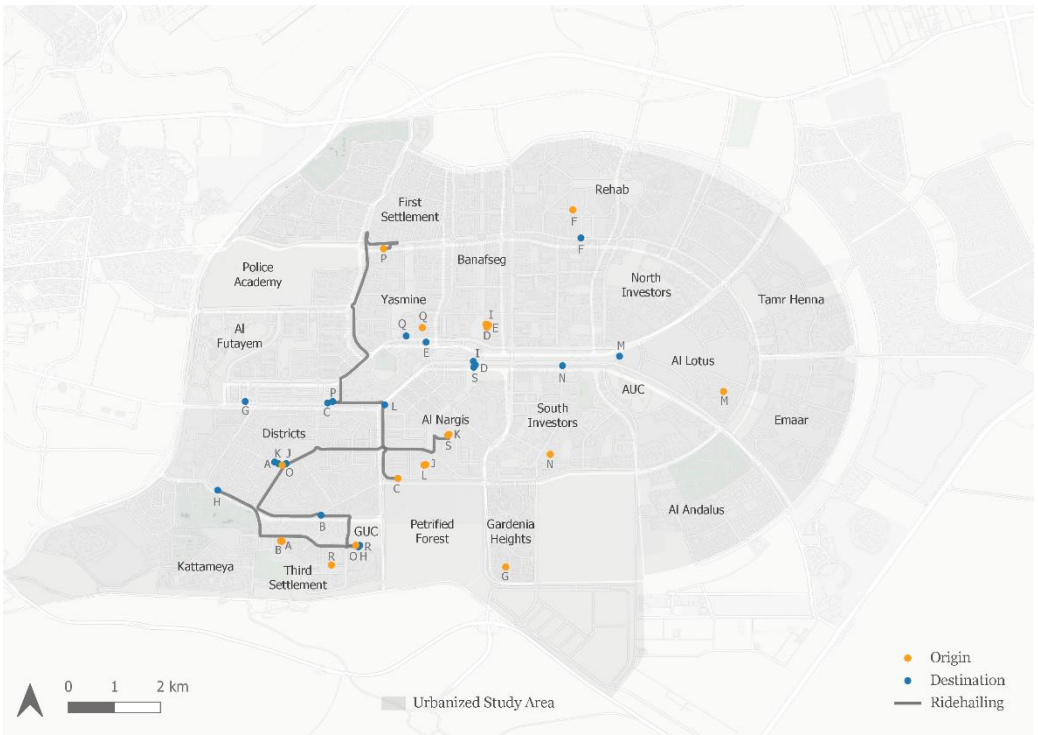


Figure 62: Ride-hailing as First and Last Mile (Source: Author)

Private-Cars / Park & ride

Three interviewees used their private car as a FLO mode. These interviewees were two females and one male. Moreover, two of them were within the age range of 24 to 35 years, while one was within the age range of 36-60 years old. Two of these commuters used MM as their trunk network services, while the third commuter used it to ride work bus. Also, one of them was encourages to use MM park & ride system at their main terminal at Al-Lotus. While the other two tend to leave their cars in the streets either near some residential buildings or commercial areas. Furthermore, the main advantage of this mode to these commuters were its flexibility, trip duration. While the main disadvantages for these commuters was parking safety, as well as having to cross the street on the way back to access the car. These commuters' trips are shown in Figure 63.

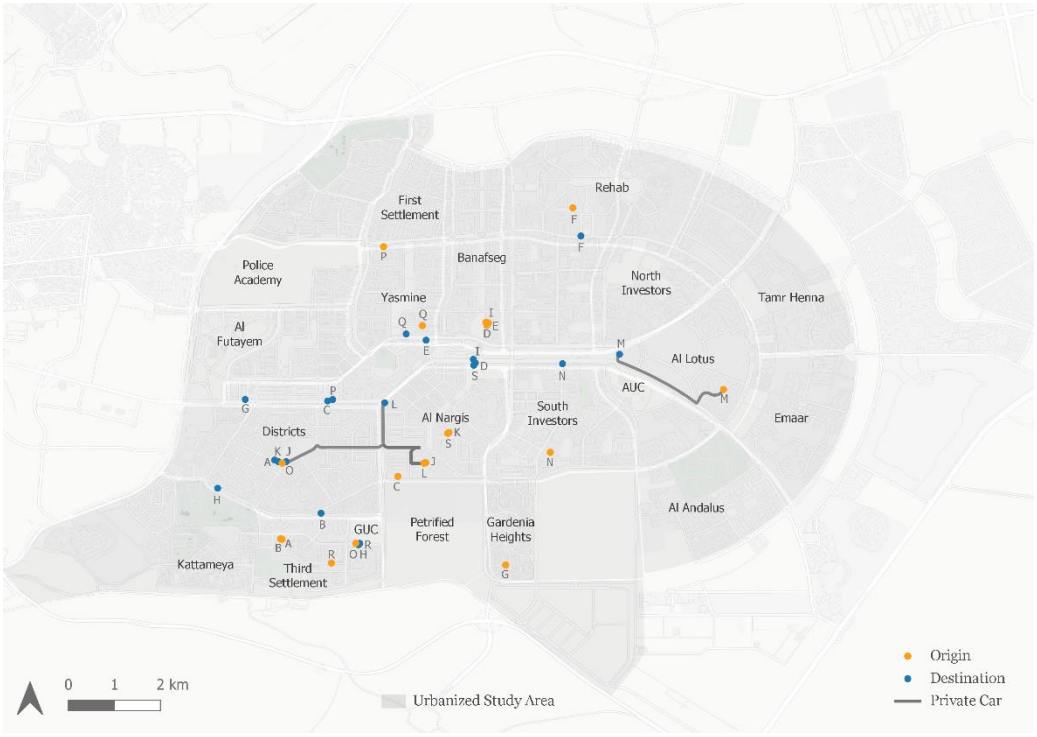


Figure 63: Private Car as First and Last Mile (Source: Author)

Suzuki-vans

Suzuki-vans were one of the used modes in the FLO trips for two interviewees. Both interviewees were male, while one's age range was between 24 to 35 year, and the other was from 35 to 60 years. Furthermore, Suzuki-vans did not connect the interviewees residence to the mass-transit stops directly, but a specific part of the trip had to be walked which ranged from 7 to 15 minutes' walk in these interviews. The Suzuki-vans FLO services advantages from the commuters' opinions were the affordable price, as well as their frequent availability. However, the main disadvantages from their point of view were the comfort of the Suzuki-van ride, as well as the overall long duration of the FLO trip by integrating a range of 15 minutes Suzuki-van ride and 7 to 15 minutes' walk. The Suzuki-vans interviewee's pick-up and drop off locations are represented in Figure 64.

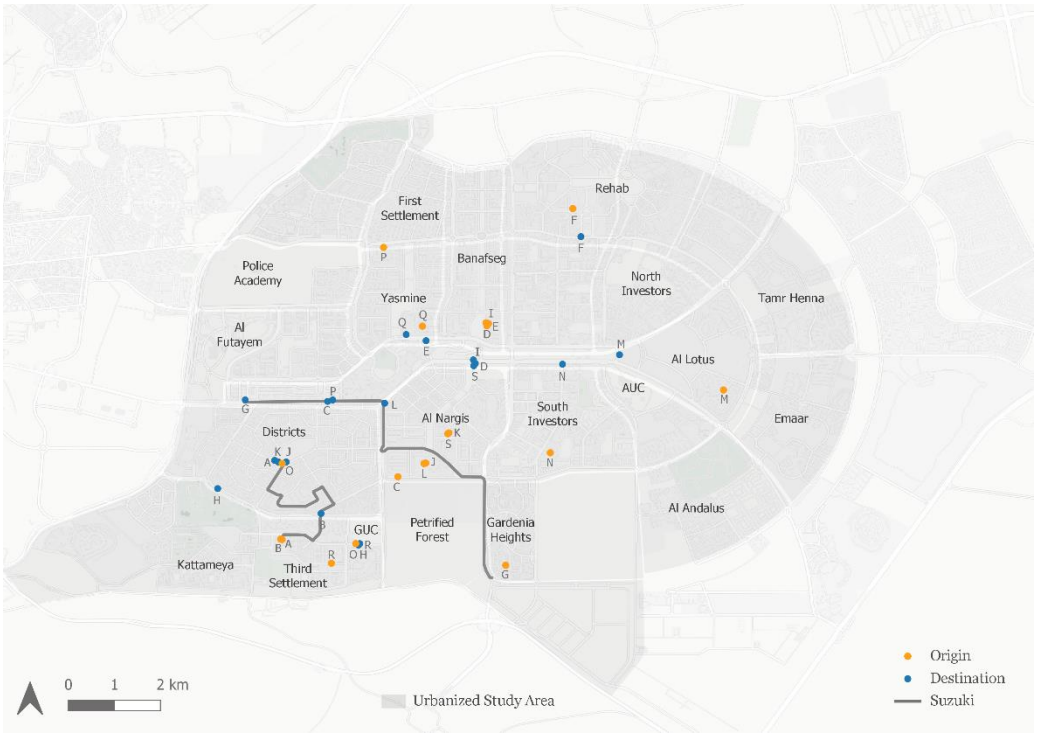


Figure 64: Suzuki as First and Last Mile (Source: Author)

Tricycle:

Tricycles are not commonly operating in New-Cairo. However, one interviewee was using it as a FLO mode to reach 90th street road. This interviewee lived in a gated community, thus his FLO trip included a 5 minutes' walk to the gate of the gated community, followed by a range of 5 to 10 minutes waiting a passer-by tricycle, then a 5 minutes ride in the tricycle to South 90th road. The main trunk service used by this commuter is MM. The advantage of this mode for the commuter was mainly its price affordability. However, the low-comfort level is one of the main disadvantages. As well as the availability of this service that is limited on the working hours of the industrial areas which is usually from 8 am until 6 pm. While the rest of the day remains uncovered with any other FLO mass-transit mode, thus the commuter tends to limit his trips to these operating hours or using ride-hailing services if he passed these operating hours. The main route of this commuter is shown in Figure 65.

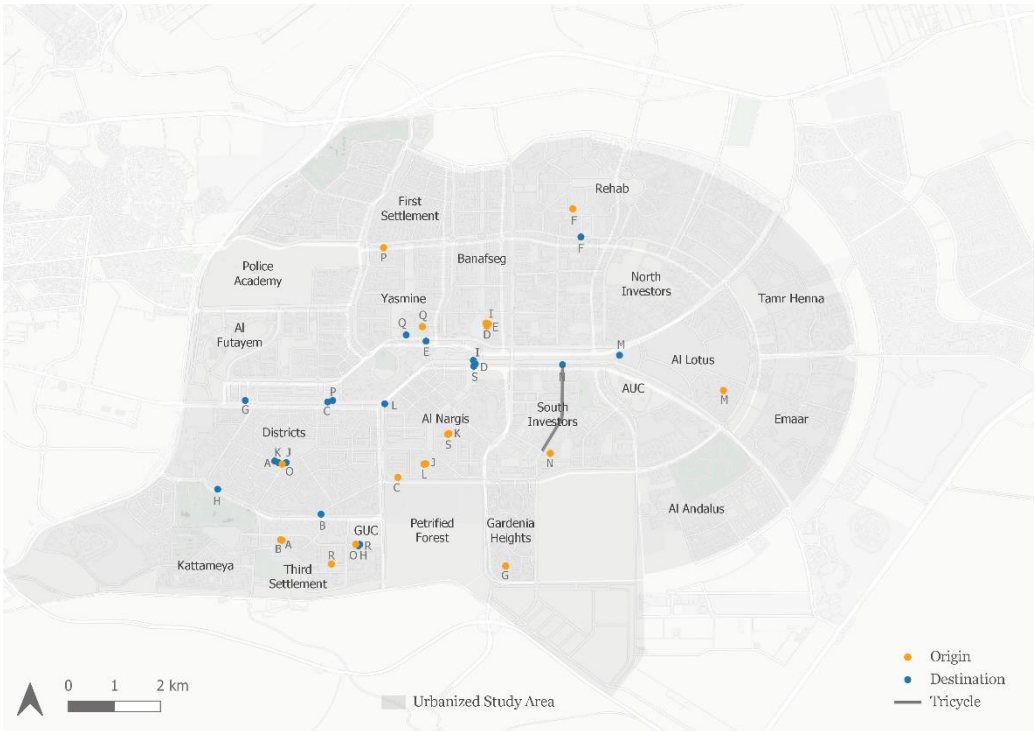


Figure 65: Tricycle as First and Last Mile (Source: Author)

6.3. Understanding service-providers

In order to furtherly understand the mobility network within New-Cairo. Three interviews were conducted with smart service providers that either operates as a trunk network system, or a feeder network system.

6.3.1. Mwasalat Misr (MM):

As mentioned in the background part, Mwaslat Misr is one of the leading private companies that provide mass transit services, especially in New Cairo. Thus, an interview with a transportation planner from MM in July 2020 was conducted, and the main insights were as follows;

Their vision was connecting New Cairo to the old city districts (Downtown) and to the public transportation network, specifically the metro stations. Thus all their routes are planned to pass by at least one metro station and all of their routes have to be revised and approved by the Cairo Transport Authority (CTA). Currently they do not only focus on New Cairo but started working in the GCR region as a whole but within the same strategy. Moreover, nowadays they do not just provide services across the districts of Cairo, but they are operating intra-city buses (NCs) that are planned by the New Urban Communities Authority (NUCA).

Regarding the frequency of the buses, the planners at MM try to manage between the demand of the users for a certain bus line and the existing buses owned by the company, after which they study the sufficiency to increase the frequency for a certain bus line in terms of financial revenue.

Their main target audience were the car users, as their data indicated that new cities and specifically New Cairo's main mobility mode for the majority of people is private cars. Subsequently, focusing mainly on targeting the car users required them to plan their trips with a high standard of service quality for users such as AC and Wi-Fi services.

Moreover, they are working with the most convenient on-demand pick-up and drop-off locations for the users, however they have several stops throughout the route that are mainly landmarks that were added after the route was planned. These stops are featured on-ground in New Cairo as signs that shows the buses passing by it, however these stops lack any shading or seating elements due to approval issues. In addition, these stops are integrating the ICT by having the buses time-schedule and frequency available on the Google Maps application, making it the first public transportation service in Cairo that enables bus tracking before riding it.

Furthermore, the first & last mile issue is not addressed in the main bus-lines stops' locations, but are mainly tackled within the NC bus stops that are planned by NUCA to act as a feeder network to public transportation. These stops were planned to connect all the neighborhoods of New Cairo to internal bus-lines (feeder network) that will connect them mainly to the South 90th street, which is the main street that has several main public transportation services. However, as a first& last mile solution to the main lines, they integrated a park & ride system in their main hub at Lotus, So that they can encourage the private car/motorcycle owners to use their vehicles for the first part of their trip by offering a safe parking service.

As for the payment and ticketing model for both MM and NC lines, MM developed a Smart pre-paid Card that gives you a significant discount compared to the normal cash payment method. This card was also a method of focusing on different target-groups that have a limited mobility expenses rate, as well as encouraging the commuters to have cash-free trips. However, the payment method is a ticket for riding the bus regardless of the pick-up and drop-off location, which means that a person riding the bus from the beginning until the end of the route would pay the same amount as a person riding just a portion of this trip. To address this issue, they are currently developing another payment model that would allow the ticket prices to differ based on the pick-up

location. Moreover, they are also planning to develop their smart cards to include other public transportation means like the Metro.

6.3.2. SWVL (Peak-only private buses):

SWVL is a peak only service provider operating as a private company. Recently these peak only services became a crucial part of many peoples' mobility, especially in the new cities. Thus, an interview was conducted with a transportation planner from SWVL in June 2020, and the main insights were as follows;

Their main vision was providing a high quality mass transit service that prioritizes the comfort of the commuter in order to decrease the usage of the private transportation means, be it ride hailing applications or private car usage. Their supply of the trips is entirely based on the demand of the commuters. They plan their trips based on the market research and the commuters' suggestions received on their social media platforms. Thus, they do not have a fixed time-plan or routes, but they rather adapt their trips based on the peak hours of the demand from the commuters.
Just like the modern business models, SWVL Company does not own any buses but only operates them. That gives them the advantage of increasing or decreasing the trips supply based on the commuters' demand. However, one of the main challenges is the relation between the bus owners and drivers; Thus SWVL tends to have several training sessions for the drivers in order to enhance this relation.
Their main target audiences are the private car users, the ride hailing, and taxi service users, as these users would be able to afford this service, that is relatively more expensive than public mass transit. Thus, they tend to focus on the comfort and the quality of their service in order to encourage the private car, ride hailing and taxi service users to save money and use a more sustainable travel mode.

As for the trip model, SWVL is using a strict pick-up location indicated in the mobile application, while having a more flexible drop off location. However, SWVL trips have fixed stop locations indicated in the mobile application rather than a certain route, thus flexible drop-offs are organized casually on-trip as the bus might change its route to avoid congestion or etc…
The pick-up and drop off locations are mainly chosen based on the demand of the commuters. They try to achieve a walkable first & last mile approach from the stops, and have succeeded in certain districts like Maadi, but larger districts with less density like New Cairo proved harder to achieve. Nevertheless, walkability is not a sustainable first and last mile option in New Cairo but still it is one of the top three districts using SWVl services, as the users tend to use ride hailing and taxi services to the stops.
As for the payment and ticketing model, SWVL has both options for either online payment or cash payment. However, it is not integrated or linked to any other transportation modes. In addition, the fare price varies based on the pick-up and drop off locations.

6.3.3. Rabbit (FLO miles' service provider):

Rabbit start-up is a unique mobility service provider in Cairo, they are mainly tackling the neglected part of the system, which is the first and last miles of the journey, as well as the only mile challenge within the same district.
An interview was conducted with an R&D engineer in May 2020, and the main insights were as follows:
Rabbit is a start-up that began working in Cairo in 2019. Their vision is connecting the commuters with the various public transportation means. In other words, they provide services for the first and last mile of the commuters' trip, and work as an only mile solution in short distance trips.
They planned their model based on several international models and especially European models, as they are the most successful recently. Their services are

electric scooter renting, with plans to include other modes such as electric bicycles, etc.

Their main target audience are mass transit users, and having them use rabbits as a first & last mile mode. Moreover, they are planning to integrate with other mass transit service providers in order to merge both services and offer the commuter a door-to-door trip. Furthermore, they are also working on providing their services in large gated communities like al Rehab and Madinaty in as an only mile mode.

As for the payment and ticketing mode, Rabbit has a single option of online payment through its mobile application.

As they are still developing the most sustainable way to introduce Rabbits to the Egyptian streets. They are currently offering day rentals for a minimum of 1 day and a maximum of 7 days that are renewable. However, the usage for a single trip is currently undergoing testing in New-Giza gated community and in some North Coast villages like Marassi due to safety issues. The single trip model has a fixed starting fare, in addition to a fare based on usage time.

They are currently running 100 rabbits, with a plan to offer 300 rabbits by the end of 2020, and increasing to 3,000 rabbits by 2020. The choice of the electric scooter mode aims to reduce the physical effort of people using it, making it a viable option for all age groups.

Currently, the service is most used in New-Giza, as it is the trial of a single trip usage model, followed by Maadi and Zamalek districts.

Conclusion

New-Cairo has several mass-transit modes and services. Most of these modes are mainly trunk network service that tends to connect the most vital areas in New-Cairo such as the South 90th road and the districts' mixed used area to other neighborhoods within the GCR. These modes tend to give the commuters a variety of mass-transit options by reaching these hotspots. By conducting several interviews with mass-transit commuters, their main FLO was towards and from the previously mentioned hotspots. This FLO connection of the origin of the commuters to these hotspots was the weakest link in New-Cairo's transportation network with very limited mobility options.

Furthermore, by interviewing the services providers, Mwaslat Misr mentioned that their offered service is mainly a trunk network that aims to connect New-Cairo to Downtown-Cairo as well as the main transportation networks such as the metro stations. However, as for the FLO issues, they try to attract private car-users by the park & ride system within their main terminal in Al-Lotus. They also try to cover the FLO miles by the NC buses. Going to SWVL , they also mentioned that they are a demand-driven service, that mainly operates for longer distances such as trunk-network services. As for the FLO connection they mainly rely on other modes to solve this issue like mainly ride-hailing services. However, future plans of integrating their service with a FLO service is an option. Moreover, Rabbit company tend to solve the FLO issues by shared microtransit modes such as electric scooters. They have future plans to integrate their services with trunk-network services at their main stations.

Part V: Discussion and Conclusion

7. Chapter 6: Discussion and Conclusion

7.1. Discussion

New-Cairo is highly depending on private car usages. The survey results shown that the private car is the main mobility mode with almost 74% of the residents. However, this dependency does not reflect a lack of variety of mass-transit services within New-Cairo. On the contrary, based on mapping of the existing mass-transit services within New-Cairo, there is a variety of mass-transit services such as CTA buses, MM buses, microbuses, Suzuki-vans, NC buses and demand driven services such as SWVL, Uber Bus, and Tricycles. However, most of these services are trunk-network services that tend to connect New-Cairo to the GCR neighborhoods without giving attention to intra-city mobility. While there are various mass-transit modes offered in New Cairo, they are clustered in main hotspots, resulting in overlapping of these services and modes, leaving the rest of New Cairo with limited to no mass transit coverage. For these blind spots in the system, reaching the hotspot is a challenge due to the lack of first and last mile options. So, similar to the international scenarios, the First, Last

and Only (FLO) miles' issue is the weakest link within the transportation network. Cities worldwide tend to solve the FLO mile issue in order to enhance the mass-transit services and decrease the car-dependency. Developing infrastructure that encourages active mobility modes such as walking, and cycling is one of the FLO issues' solutions. This solution was the most chosen in the analyzed survey by almost 66% of the total survey respondents wanted FLO services like these in New-Cairo. While other solutions are introducing shared-micromobility services such as shared-bicycles or scooter which can be electrical devices or normal. These services are similar to the services that Rabbit start-up tend to offer in Cairo, which 25.9% of the survey respondents wanted to have in New-Cairo as FLO mode. Furthermore, ride-hailing can be used as a FLO solution in some cases to encourage private-car users to leave their cars and ride mass-transit services. In addition to that, Park & Ride is one of the systems that can encourage private car-users to use their cars as a FLO mile solution to ride mass-transit services for the main trunk trip. Inspired from this approach, MM are using the Park & Ride system in their main station at Al Lotus to encourage New-Cairo residents to leave their cars and ride their mass-transit services. Moreover, 53% of the survey respondents wanted to develop park & ride systems in New-Cairo. All these approaches and modes tends to connect the users' origins to their destinations with the easiest, most convenient, and sustainable way. Moreover, the FLO solutions tend to significantly decrease the private car usage, and increase the mass-transit ridership. Also, based on the survey results, 56.5% of New-Cairo private car users and 61% of the ride-hailing users are more willing to shift to mass-transit services if the FLO mile issues were sufficiently solved by FLO modes. Furthermore, in order to have a strong mass-transit system that can compete with the private cars, urban planners tend to use the integration of the existing service in one system. An integrated system that offers the commuter a door to door multimodal trip experience can compete with the private car-usages. The mobility systems tend to have several levels of integration such as; payment

and ticketing integration. The payment integration level is available in Cairo only within MM and NC buses which are both operated by MM company. However, there is a future project in Cairo that tend to have a smart card that enables payment to several mass-transit modes such as buses, metro, monorail, and several other modes. Also, the integration of information and communication technology (ICT) is one of the main levels of integrations in mobility systems. This system enables commuters to access real-time information about the mass-transit services that enables them to pre-book, track and pay for their multimodal trips. In Cairo, some mass-transit companies tend to integrate the ICT technology in their operation such as MM. MM bus-routes are integrated within Google Maps application which allows users to track the buses and know their real-time schedule. It can also be integrated with other public transport services such as the Metro services that has also real-time information integrated in Google Maps application. Also, demand-driven mass-transit companies such as SWVL and Uber Bus integrates the ICT technology in their services with an application that allows them to access trip schedules and pre-booking and online payment features. However, these applications are not multimodal, they just show the companies own offered services. Furthermore, Cairo has mega mobility projects to be implemented within the next years, including the new metro lines, the monorail, the high-speed rail, BRT system. These projects are mainly trunk-network services which will facilitate the mass-transit across the GCR. However, there is not any announced plans on how they are planning to connect the commuters to these trunk networks or the development of any mega feeder network system or FLO solutions.

7.2. Conclusion

Private cars usage is the main challenge that faces sustainable mobility and mass-transit services. Developing an integrated public transportation services that offers door-to-door multimodal transport would be able to compete with

this issue. However, in order for this to happen, the whole city has to be covered by sufficient modes of transportation. But, by analyzing New-Cairo's transportation network we found several overlapping services at the main hotspots. This overlapping is good as it offers the commuters the chance to compare and choose the most suitable and convenient option. However, the overall coverage of these services is in sufficient and there are not sufficient modes to connect the neighborhoods to the transportation hotspots. This FLO mile issue is the main issue in the transportation network in New-Cairo that negatively affects the mass-transit ridership. Thus, this FLO mile issue should be solved in order to have the applicability to do an integrated multimodal public transportation system that can challenge the private-car usages and decrease it.

7.3. Future Recommendations

For having an integrated mobility system, the whole city should be covered with sufficient modes of transportation. However, The First, Last and Only (FLO) issues vary within cities and neighborhoods based on the local context. Thus, future studies should examine this issue within different urban context in Cairo such as high-density neighborhoods like Embaba and Haram or likewise, and medium-density neighborhoods like Nasr-City and Heliopolis and likewise. Furthermore, specific studies should test the applicability of the general FLO modes chosen by the survey respondents in this survey like developing cycling infrastructure including bike-sharing services or a sufficient walking infrastructure as FLO solutions. Moreover, interview with governmental authorities such as Cairo Transport Authority (CTA) or New Urban Communities Authority (NUCA) would be beneficial to know the governmental approaches and plans for mobility in New-Cairo. In addition, interviews with paratransit service providers might be insightful to understand how the informal system tends to develop solutions to fill in the demand of the commuters.

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9. Appendices

9.1. Appendix A: Survey Questions

	أسئلة عامة
1	السن
2	الجنس
3	متوسط الدخل الشهري
4	نوع المسكن
5	أين يقع أكثر 3 اماكن تتردد عليها (جهة تعليمية، أو مكان العمل ، أو مكان الترفيه وخلافه ...) ؟
6	ما هي وسيلة تنقلك الرئيسية بين نواحي القاهرة ؟
	سيارة خاصة
1	هل تتملك أي من الاتي:
2	كيف تتحرك في نطاق القاهرة الجديدة ؟
3	ما هي مميزات التنقل بسيارة خاصة بالنسبة لك ؟
4	ما هي عيوب التنقل بسيارة خاصة بالنسبة لك ؟
5	ما هو متوسط مصاريف تنقلك الشهرية ؟
6	ما هو متوسط الوقت الذي تقضيه يوميا في التنقل ؟
7	كيف تتبضع احتياجات منزلك الأسبوعية ؟
8	كم هو بعد أقرب المحلات التجارية لمنزك ؟
9	اذا سبق لك السفر الى الخارج ، ما كانت وسيلة تنقلك في المدينة ؟
10	ما سبب اختيارك لهذه الوسيلة ؟
11	لماذا لا تستخدم وسائل التنقل الجماعي (النقل الجماعي الحكومي، أوالخاص مثل مواصلات مصر أو سويفل أو خلافه ...) كوسيلة رئيسية للتنقل في القاهرة؟
12	كم هو بعد أقرب محطات التنقل الجماعي لمنزك ؟
13	ما هي وسائل التنقل الجماعي التي تمر على أقرب محطة لمنزلك ؟
14	كيف تقيم طريق المشاة من منزلك لمحطة النقل العام ؟ [متصل (بدون عقبات)]
15	كيف تقيم طريق المشاة من منزلك لمحطة النقل العام ؟ [آمن]
16	كيف تقيم طريق المشاة من منزلك لمحطة النقل العام ؟ [مريح (جودة الطريق)]
17	كيف تقيم طريق المشاة من منزلك لمحطة النقل العام ؟ [ممتع]
18	كيف تقيم طريق المشاة من منزلك لمحطة النقل العام ؟ [مظلل]
19	من وجهة نظرك ، ما هي المشاكل التي قد تواجه سائق العجلة من منزلك حتى محطة التنقل الجماعي؟
20	هل تميل الى المشي أو ركوب الدراجات بشكل أكثر في نطاق منزلك هذه الأيام (خلال فترة جائحة فيروس كورونا)؟
21	في حالة الاجابة بنعم ، ما هوالسبب ؟
22	هل يمكنك استخدام احدى الوسائل التالية اذا تم تطويرها بشكل مقبول ؟
23	فى حال تطوير الوسائل السابقة للوصول لمحطات التنقل الجماعي، هل ستتشجع لاستخدام خدمات التنقل الجماعي؟
24	هل ستتقبل خدمة جيدة لكن أقل من مميزات استخدام السيارة الخاصة في مقابل توفيرالمال ؟
25	هل تقبل قضاء فترة أطول في المواصلات اليومية للهروب من عيوب استخدام السيارة الخاصة ؟

	سيارات التنقل المنفرد
1	هل تتملك أي من الاتي:
2	لماذا اخترت التنقل بخدمات النقل الجماعي ؟
3	ما هو متوسط مصاريف تنقلك الشهرية ؟
4	ما هو متوسط الوقت الذي تقضيه يوميا في التنقل ؟
5	هل تحتاج ركوب عدة وسائل نقل للوصول لوجهاتك في أغلب الأحيان؟
6	كيف تتحرك في نطاق القاهرة الجديدة ؟
7	كيف تتبضع احتياجات منزلك الأسبوعية ؟
8	كم هو بعد أقرب المحلات التجارية لمنزك ؟
9	ما هي عيوب التنقل بخدمات النقل الجماعي (تشمل النقل الحكومي والخاص مثل مواصلات مصر أو سويفل أو خلافه ...)؟
10	لو كان بامكانك تطوير جزء في رحلتك من المنزل لوجتهك ، أي جزء من الرحلة ستختار ؟
11	كم هو بعد أقرب محطات النقل الجماعي لمنزك ؟
12	ما هي وسائل النقل الجماعي التي تمر على أقرب محطة لمنزلك ؟
13	كيف تصل الى أقرب محطة نقل جماعي من منزلك ؟
14	اذا توفرت لك سيارة خاصة , هل ستختار التنقل بها والاستغناء عن النقل الجماعي (تشمل النقل الحكومي والخاص مثل مواصلات مصر أو سويفل أو خلافه ...)
15	ما سبب اجابتك السابقة ؟
16	كيف تقيم طريق المشاة من منزلك لمحطة التنقل العام ؟ [متصل (بدون عقبات)]
17	كيف تقيم طريق المشاة من منزلك لمحطة التنقل العام ؟ [آمن]
18	كيف تقيم طريق المشاة من منزلك لمحطة التنقل العام ؟ [مريح (جودة الطريق)]
19	كيف تقيم طريق المشاة من منزلك لمحطة التنقل العام ؟ [ممتع]
20	كيف تقيم طريق المشاة من منزلك لمحطة التنقل العام ؟ [مظلل]
21	من وجهة نظرك ، ما هي المشاكل التي قد تواجه سائق العجلة من منزلك حتى محطة التنقل الجماعي؟
22	هل تميل الى المشي أو ركوب الدراجات بشكل أكثر في نطاق منزلك هذه الأيام (خلال فترة جائحة فيروس كورونا)؟
23	في حالة الاجابة بنعم ، ما هوالسبب ؟
24	من واقع خبرتك، ماذا سيكون الحل الأمثل للرحلة بين منزلك ومحطة التنقل الجماعي ؟

	التنقل الجماعي
1	هل تتملك أي من الاتي:
2	لماذا اخترت التنقل بخدمات التاكسي أوالتنقل المنفرد (أوبر ، كريم , خلافه ...) ؟
3	ما هو متوسط مصاريف تنقلك الشهرية ؟
4	ما هو متوسط الوقت الذي تقضيه يوميا في التنقل ؟
5	ما هي عيوب التنقل بخدمات التاكسي أوالتنقل المنفرد (أوبر ، كريم , خلافه ...) بالنسبة لك ؟
6	كيف تتحرك في نطاق القاهرة الجديدة ؟
7	كيف تتبضع احتياجات منزلك الأسبوعية ؟
8	كم هو بعد أقرب المحلات التجارية لمنزك ؟
9	اذا توفرت لك سيارة خاصة , هل ستختار التنقل بها والاستغناء عن خدمات التاكسي أوالتنقل المنفرد (أوبر ، كريم , خلافه ...) ؟
10	ما سبب اجابتك السابقة ؟
11	لماذا لا تستخدم وسائل التنقل الجماعي (النقل الجماعي الحكومي، أ والخاص مثل مواصلات مصر أو سويفل أو خلافه ...) كوسيلة تنقلك الرئيسية في القاهرة ؟
12	كم هو بعد أقرب محطات النقل الجماعي لمنزك ؟
13	ما هي وسائل التنقل الجماعي التي تمر على أقرب محطة لمنزلك ؟
14	كيف تقيم طريق المشاة من منزلك لمحطة التنقل العام ؟ [متصل (بدون عقبات)]
15	كيف تقيم طريق المشاة من منزلك لمحطة التنقل العام ؟ [آمن]
16	كيف تقيم طريق المشاة من منزلك لمحطة التنقل العام ؟ [مريح (جودة الطريق)]
17	كيف تقيم طريق المشاة من منزلك لمحطة التنقل العام ؟ [ممتع]
18	كيف تقيم طريق المشاة من منزلك لمحطة التنقل العام ؟ [مظلل]
19	من وجهة نظرك ، ما هي المشاكل التي قد تواجه سائق العجلة من منزلك حتى محطة النقل الجماعي؟
20	هل تميل الى المشي أو ركوب العجل بشكل أكثر في نطاق منزلك هذه الأيام (خلال فترة جائحة فيروس كورونا)؟
21	في حالة الاجابة بنعم ، ما هوالسبب ؟
22	هل يمكنك استخدام احدى الوسائل التالية اذا تم تطويرها بشكل مقبول ؟
23	فى حال تطويرالوسائل السابقة للوصول للنقل العام، هل ستتشجع لاستخدام خدمات النقل العام ؟
24	هل ستتقبل خدمة جيدة لكن أقل من مميزات استخدام خدمات التاكسي أوالتنقل المنفرد في مقابل توفير المال ؟
25	هل تقبل قضاء فترة أطول في المواصلات اليومية للهروب من عيوب استخدام خدمات التاكسي أوالتنقل المنفرد ؟

9.2. Appendix B: Multinomial Logit Model

Case Processing Summary

		N	Marginal Percentage
Mode2	Mass transit	61	10.8%
	Private car	415	73.7%
	Ride-hailing	87	15.5%
Valid		563	100.0%
Missing		0	
Total		563	
Subpopulation		188[a]	

a. The dependent variable has only one value observed in 128 (68.1%) subpopulations.

Model Fitting Information

Model	Model Fitting Criteria -2 Log Likelihood	Likelihood Ratio Tests Chi-Square	df	Sig.
Intercept Only	580.364			
Final	470.237	110.126	24	.000

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	384.277	350	.100
Deviance	338.990	350	.654

Pseudo R-Square

Cox and Snell	.178
Nagelkerke	.228
McFadden	.130

Likelihood Ratio Tests

Effect	Model Fitting Criteria -2 Log Likelihood of Reduced Model	Likelihood Ratio Tests Chi-Square	df	Sig.
Intercept	476.693	6.455	2	.040
Gender_male	482.709	12.471	2	.002
Income_lessthan2000	480.217	9.980	2	.007
Income_2001_4000egp	470.967	.730	2	.694
Income_morethan15000egp	474.288	4.051	2	.132
Residence_Villa	483.177	12.939	2	.002
Residence_Gatedcommunity	482.724	12.487	2	.002
Residence_Appartment	475.238	5.000	2	.082
Dest_S	479.205	8.967	2	.011
Dest_S_m	482.500	12.263	2	.002
Dest_LL	471.688	1.450	2	.484
Age_25_35	476.291	6.054	2	.048
Age_morethn36	473.068	2.831	2	.243

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

Parameter Estimates

Mode2[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Private car	Intercept	-.748	.760	.968	1	.325			
	Gender_male	.189	.299	.397	1	.529	1.207	.672	2.171
	Income_lessthan2000	-.333	.498	.447	1	.504	.717	.270	1.902
	Income_2001_4000egp	-.088	.506	.031	1	.861	.915	.339	2.468
	Income_morethan15000egp	1.294	.763	2.877	1	.090	3.646	.818	16.259
	Residence_Villa	2.099	.572	13.492	1	.000	8.160	2.662	25.013
	Residence_Gatedcommunity	2.152	.602	12.785	1	.000	8.599	2.644	27.968
	Residence_Appartment	1.187	.557	4.540	1	.033	3.276	1.100	9.756
	Dest_S	.923	.457	4.078	1	.043	2.517	1.027	6.164
	Dest_S_m	1.274	.452	7.926	1	.005	3.574	1.473	8.676
	Dest_LL	.457	.508	.808	1	.369	1.579	.583	4.278
	Age_25_35	-.306	.359	.727	1	.394	.736	.364	1.488
	Age_morethn36	.621	.441	1.981	1	.159	1.861	.784	4.420
Ride-hailing	Intercept	-2.642	1.120	5.565	1	.018			
	Gender_male	-.771	.380	4.104	1	.043	.463	.220	.975
	Income_lessthan2000	.865	.559	2.393	1	.122	2.375	.794	7.104
	Income_2001_4000egp	-.378	.554	.465	1	.495	.685	.232	2.029
	Income_morethan15000egp	1.016	.904	1.263	1	.261	2.761	.470	16.228
	Residence_Villa	1.671	.801	4.354	1	.037	5.319	1.107	25.563
	Residence_Gatedcommunity	1.594	.831	3.676	1	.055	4.924	.965	25.124
	Residence_Appartment	1.306	.795	2.701	1	.100	3.691	.778	17.518
	Dest_S	2.014	.738	7.453	1	.006	7.493	1.765	31.817
	Dest_S_m	2.263	.729	9.634	1	.002	9.614	2.303	40.137
	Dest_LL	.911	.821	1.232	1	.267	2.486	.498	12.416
	Age_25_35	-1.018	.452	5.074	1	.024	.361	.149	.876
	Age_morethn36	.249	.518	.231	1	.630	1.283	.465	3.543

a. The reference category is: Mass transit.

Classification

Observed	Predicted			
	Mass transit	Private car	Ride-hailing	Percent Correct
Mass transit	4	56	1	6.6%
Private car	5	406	4	97.8%
Ride-hailing	1	76	10	11.5%
Overall Percentage	1.8%	95.6%	2.7%	74.6%

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دراسة حالة القاهرة الجديدة

ملخص

مع التمدد العمراني للمدينة الذي يحدث في مصر وخاصة في القاهرة، والتوجه في بناء مدن جديدة غير مركزية، يجتاح المدن الجديدة الاعتماد الأساسي على السيارات الخاصة كوسائل نقل رئيسية. ونتيجة ذلك، أن جهود تطوير المواصلات الجماعية أصبحت محدودة في هذه المدن. فمن جهة أصبحت المواصلات الجماعية محدودة الامكانيات والخدمات التي تسمح لها بتغطية مساحات محدودة في هذه المدن، ومن الجهة الأخرى يصعب الوصول الى الخدمات المتوفرة من المناطق التي ليس بها خدمات نقل جماعي. ترجع هذه الظاهرة من سوء كفاءة حلول الميل الأول والأخير في توصيل السكان لخدمات النقل الجماعي مما يؤثر سلباً على نسبة ركوب السكان لهذه الخدمات.
ولذلك يهدف هذا البحث لاستكشاف العلاقة بين حلول الميل الأول والأخير كجزء من نظام نقل متكامل ونسبة ركوب السكان لخدمات النقل الجماعي في المجتمعات العمرانية الجديدة مثل القاهرة الجديدة. ولعمل هذا، يجب تحليل منظومة النقل الجماعي وحلول الميل الأول والأخير الموجودة وتحديدها على الخرائط. بالإضافة الى ذلك، سيتم تحليل انماط تنقل سكان القاهرة الجديدة، وتحليل امكانية رغبتهم في ركوب وسائل النقل الجماعي في حال تطوير حلول الميل الأول والأخير عن طريق استبيان الكتروني. علاوة على ذلك، سيتم عمل مقابلات مع مقدمي خدمات النقل الجماعي ليتم مناقشة إمكانية التعاون بين الجهات المختلفة لتحقيق نظام نقل جماعي متكامل.

كنتيجة لهذا البحث، منظومة النقل الجماعي في القاهرة الجديدة عندها عدة خطوط نقل رئيسية تساعد في ربط المدينة بباقي انحاء القاهرة الكبرى. ومع ذلك يوجد خلل في منظومة التنقل بين بأنحاء المدينة تظهر في حلول الميل الأول والأخير. وكنتيجة لتحليل النتائج في هذا البحث، يوجد علاقة واضحة بين سوء حلول الميل الأول والأخير ونسبة ركاب خدمات النقل الجماعي.
هذا البحث يعد أساس لاستكشاف مناهج لتخطيط أنظمة نقل جماعي متكاملة في المدن المصرية وبالتحديد المجتمعات العمرانية الجديدة. يجب بناء أبحاث أخرى في المستقبل على نتائج هذا البحث لتعزيز وتجريب الحلول المحتملة للميل الأول والأخير

كلمات دالة: الميل الأول والأخير، أنظمة نقل متكاملة، نسبة ركوب النقل جماعي، المدن الجديدة،القاهرة الجديدة، رغبة في تحويل نظام النقل، خدمة التنقل

إقرار

هذه الرسالة مقدمة في جامعة عين شمس وجامعة شوتجارت للحصول على درجة العمران المتكامل والتصميم المستدام .إن العمل الذي تحويه هذه الرسالة قد تم إنجازه بمعرفة الباحث سنة 2020

هذا ويقر الباحث أن العمل المقدم هو خلاصة بحثه الشخصي وأنه قد اتبع الإسلوب العلمي السليم في الإشارة إلى المواد المؤخوذه من المراجع العلمية كلٌ في مكانه في مختلف أجزاء الرسالة..

وهذا إقرار مني بذلك،،،

التوقيع:

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التاريخ: 2020

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دراسة حالة القاهرة الجديدة

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