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Paratransit, Built Environment, and Urban Mobility – a Responsive Relationship

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1 ABSTRACT

Transit and mobility in developing countries are crucial issues, achieving appropriate mobility in residential neighbourhoods can be a huge challenge; due to the complex urban structure of the built environment and the prevalence of paratransit service that evolved to fill the formal public transportation system gap. This paper tries to answer the dilemma of the chaos and informality in local urban mobility inside residential neighbourhoods in Egypt through a systematic review that analyzes paratransit service in Egypt, discusses its role in supporting local urban mobility, and analyzes its relationship to the built environment in the local urban context regarding land use, accessibility, and socio-economic conditions.

To conduct this study, a comparison is made between paratransit services in Egypt and in some Asian countries that depend on paratransit as an official system that has its laws and guidelines and operates in an integrated manner with public transit. Also, a residential neighbourhood that depends mainly on paratransit in local mobility was selected in Alexandria, Egypt, and several components were assessed through the neighbourhood including service characteristics, pattern of movement, stops, congestion zones, regulations, safety … etc.

The results of the study highlight the deficiencies in Egyptian laws and regulations concerning the planning and design of residential streets and neighbourhoods to accommodate paratransit service. and recommend some regulations to be covered to achieve better local mobility inside residential neighbourhoods.

Keywords: Urban mobility, Built environment, Paratransit, Accessibility, Mobility planning

2 INTRODUCTION

Unlike most developed countries worldwide, which work to develop smart and sustainable mobility plans for people, including all means of transportation (train, metro, light rail, BRT, bus, and bicycle), most developing countries barely have any vision for a better and integrated transportation system. According to the United Nations' Sustainable Development Goals 2030 (SDGs), Goal 11: sustainable cities and communities "make cities and human settlements inclusive, safe, resilient, and sustainable"(United Nations 2015), where mobility is a main target to provide sustainable public transportation system that ensures safety, affordability, and accessibility for all people. However, in developing countries, transportation lacks the primary qualities for adequate urban mobility that are centered on: affordability, availability, accessibility, acceptability, safety, and sustainability (El-Khateeb 2017). Moreover, the prevalence of paratransit service that covers more than 60% of the transportation network is considered a main challenge for these countries (Williams, White et al. 2015, Behrens, McCormick et al. 2016).

Paratransit is an informal and semi-formal network that evolved to fill the gap in the formal public transportation system which does not respond quickly to the population growth and mobility demands in developing cities, and mitigate poor accessibility in low-income communities (Lubis, Buchori et al. 2020, Acheampong, Lucas et al. 2022), it has no specific routes, stops, schedule, or fare, and always develop in response to customers' demand (Cervero 2000, Cervero and Golub 2007, Finn 2012).While some see paratransit as a threat that weakens the transportation system of the city and causes congestion, others find it an opportunity for sustainable mobility. Paratransit network is complex, it is not a sign of informality or rural areas, It appears in most urban regions of cities, reaches the zones where the public transit failed to cover, and provides excellent accessibility. Consequently, it should be recognized as a constituent component of the public transportation system, and there is a need for an integration between the formal and paratransit systems, where the two systems serve each other in a reconciliation (Gota 2018, Talamini and Ferreira 2019).

Service between urban, rural, and peripheral zones is provided by paratransit, which begins at the neighbourhood level and adapts to reach main transit stations, markets, and core parts of the city, and serves as intermodal connections to the formal public transportation system (Gamble and Puga 2017, Talamini and Ferreira 2019). It operates mainly in the zones surrounding the main transit stations and stops, carries

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commuters from their place to destination, and ensures accessibility to the zones outside the catchment areas of the mass transit, so its role is important however its spontaneity is an obstacle.

This paper focuses on the informal transit in Egypt as a constituent of paratransit. It reviews and examines the laws and regulations of informal transit in different developing countries, especially in Asia, compares it to the current situation in Egypt, and highlights the main shortcomings and recommendations that should be taken into consideration to achieve an adequate integration between formal and paratransit systems. The paper's structure will continue as follows: section 3reviews the literature on paratransit and previous studies in developing countries and compares it to Egypt, section 4discusses the parameters of the built environment that affect urban mobility, section 5 presents the selected case study, findings and discussion, section 6 the main conclusion is given, and section 7 is concerned about recommendations and intervention scenarios.

3 PARATRANSIT IN DEVELOPING COUNTRIES

Paratransit is mainly concentrated in developing countries, and low and middle-income communities, its modal share represents nearly 50% in Asia, 80% in Africa, and 70% in South America(Salazar Ferro 2015, Behrens, McCormick et al. 2016). However, some countries have succeeded in dealing with, organizing, regulating, legalizing, and converting it into a complete local mobility network that operates in harmony with the official transportation system. While others are struggling to accommodate.

Paratransit mobility depends on affordability, availability, reliability, door-to-door accessibility, comfort, flexibility in schedule, routes, and stops, and speed of the service(Lubis, Buchori et al. 2020). However, many problems are associated with it, including traffic congestion, road accidents, noise and air pollution, and fuel consumption. Many scenarios were set up to overcome these problems including age-based retrofit programs, emission-based regulations, use of electric vehicles, fuel economy standards, and restrictions at sometimes.(Hook and Fabian 2009). WHO (2017)put strategies for paratransit accident reduction to ensure safer vehicles, roads, mobility, and road users' safety, and improve the built environment parameters and road infrastructure to accommodate different mobility options. This includes some interventions including exclusive paratransit lanes, traffic calming, improving road conditions, widening sidewalks, providing cycling facilities, providing vehicles with antilock brake systems and headlights, enforcing drivers to compulsory training, mandatory licensing of vehicles, enforcing speed limits, and enforcing alcohol and medical legislations.

3.1 Paratransit in Asia

The most successful paratransit models can be found in Asian countries like India, Thailand, Bangladesh, the Philippines, and Indonesia. The annual expansion average rate in paratransit system in these countries is 7% and their fleets are expected to double every five years especially the two and three-wheeler vehicles which currently constitute close to 30% of total motorized vehicles worldwide and is expected to reach 1.5 billion vehicles by 2050 (Kumar, Singh et al. 2016, Gota 2018).

3.1.1 Current situation

Paratransit appears in several modes in Asian countries including Auto Rickshaw, Bajaj, Minibus, Tata Magic, Vikram, Mahindra, Angkot, and Becak. It operates either motorized or manually and its capacity varies from 1-2 passengers to 20 passengers. These means vary from one context to another for example in the rural zones it has no license, fare, or route regulations, however, in urban cities, the paratransit is subjected to restricted regulations by the government and transport authorities considering licensing, fare, route, safety standards, and organizational structure(Kumar, Singh et al. 2016, Phun, Kato et al. 2019).

3.1.2 Laws and Regulations

The research reviewed the laws and regulations of paratransit applied in developing countries in India, Thailand, Bangladesh, Malaysia, Singapore, Vietnam, Indonesia, and Cambodia, these laws provide an effective model for regulating paratransit where the government, department of Transport, and regulatory bodies are always present to contribute to safe mobility, create convenient environment for paratransit operation, and work to integrate between paratransit and the formal transportation system. These regulations can be divided into two sections as follows:

(a) Legalizing Framework

- Licensing and permitting: To establish new paratransit services, operators must request a permit from the government's Department of Transport. The government's approval is based on the current service situation and passengers' demand; as the number of permits is limited to control the number of service vehicles.
- Route planning: To ensure traffic flow, avoid conflicts with the main transportation system, and cover the demand pattern, the service routes are designed and indicated through the regulatory bodies, and a fine is applied for not adhering.
- Fare regulation: The regulatory bodies are responsible for setting mechanisms to calculate the appropriate fare and periodical fare revision. In some places, metered fares are applied to calculate fares based on distance.
- Safety standards: Paratransit vehicles are required to meet certain safety standards, such as first aid kit, fire extinguisher, drivers' training, and periodic inspection to ensure compliance with these standards.
- GPS tracking: for real-time monitoring of vehicles; to make sure of their adherence to the designated routes and their adherence to regulations. In some cities, paratransit is organized through dedicated Apps-based systems that are used for booking and payment.
- Electric vehicles: encouraging sustainable mobility through the usage of electric vehicles and providing charging facilities to lessen environmental impacts on transportation

(b) Organizational Structure

- Public and private ownership: Ensure the ownership and operation of paratransit vehicles whether by individuals or components of a bigger organized private fleet
- Operators associations: The role of the associations is to represent paratransit drivers and their interactions with transport authorities.
- Coordination with transport authorities: verify the interaction between paratransit operators and transport authorities in charge of monitoring their activities. This includes data sharing, reporting procedures, and compliance monitoring.
- Road Infrastructure: To accommodate paratransit, the government makes investments in strengthening road infrastructure including widening streets and providing dedicated lanes for paratransit vehicles in which street design includes defined lanes inside residential neighbourhoods; to avoid conflicts with other modes of transportation and pedestrians and ease mobility and traffic flow, particularly in congested areas. These lanes are integrated into the built environment with consideration to lane width and turning radii. These street design considerations are planned to fit the movement and space needed for paratransit vehicles.
- Parking and stations: Create centralized pick-up and drop-off points for paratransit close to transit terminals, markets, and residential areas. This will give passengers a convenient and organized space to wait without being stacked in traffic congestion on main streets or around mass transit stations. and make it easier for people to switch between public transport and paratransit.
- Traffic management: using traffic signals and signages for paratransit vehicles to organize their movement in the built environment without contradiction with pedestrians, cyclists, and traffic.
- Road safety campaigns: The government aims to decrease accidents and increase transportation effectiveness by enhancing road safety. It runs initiatives for paratransit passengers and drivers to promote road safety, these campaigns raise public awareness of the value of safe driving and compliance with traffic regulations.

3.2 Paratransit in Egypt

Paratransit in Egypt is mainly focused on small vans, microbuses, minibuses, and three-wheelers tuk-tuk. On one hand, it is accompanied by many problems like traffic congestion, and lack of the primitive qualities for adequate urban mobility, and sometimes leads to social segregation based on the local urban context, built environment, and socio-economic status of the people. However, on the other hand, the paratransit's

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complementary role as an essential mode of mobility that people depend on is non-negotiable; it acts as a feeder for the main public transport, solves the challenges of accessibility and the first and last-mile connection problems in the peripheral urban zones of the city, and provide thousands of employment opportunities for unskilled workers (Cervero 2000, Valenzuela Jr, Schweitzer et al. 2005, Neumann 2014, C. Liu 2018, Acheampong, Lucas et al. 2022).

3.2.1 Current situation

Paratransit modal share in Egypt is nearly 55% of the whole transportation system (Salazar Ferro 2015, Behrens, McCormick et al. 2016), and it represents almost 83% of all motorized trips (Abd Alla, S. 2017). People depend on paratransit in their daily life routine; as it is the most available, flexible, and extended schedule means of transportation that respond to the shortage in the formal transit system.

Paratransit service in Egypt is divided into semi-formal and informal transit. The semi-formal transit is organized and licensed by the city's public transport authorities, it has specific routes and fares but no fixed stops, frequencies, schedules, or times. While, informal transit -which is the focus of this research- is mainly represented in the following classes (small vans, old microbuses, and 3-wheelers tuk-tuk) as shown in (Figure 1), It is not licensed or organized, has no exact information, has no specific routes, stops, frequency, fare, or time, operates on an extended schedule based on customers' demand, and concentrated on the local scale of the neighbourhoods.

A big share of the informal transitis represented in the tuk-tuk; a small size 3-wheeler vehicle that operates almost 24-7, especially in the inner local zones. It started to appear in 2005, according to CAPMAS (2021), Egypt contains 5,600,000 tuk-tuk, of which only 306,917 are licensed which is nearly about 5% of the total number of vehicles and the rest are informal ones. Egypt imports 50,000 tuk-tuk each year, which provide 150,000 job vacancy (Hosny 2013), It is an effective mean of transport; due to its small size and fast service that makes it easy to operate in the small zones, narrow streets, and complicated urban fabrics that public transport cannot reach.

However, the informal transitsector in Egypt is accompanied by several problems which can be grouped under three main categories: traffic congestion, accidents, and personal safety. This is due to the absence of regulations, surveillance, and law force.

3.2.2 Laws and Regulations

Several governmental documents, mobility reports, official plans, and transportation laws and regulations were reviewed, it was found that Egypt has no clear laws to regulate informal transit, there is no specific data or counts regarding their numbers or operators, and no definite legislation to regulate their routes, fare, schedule, operation zones, or safety standards. There is no force to legalize and license them except for some practices from the local authorities of each district, otherwise, they operate either without a license like in the case of tuk-tuks, or they are licensed as private cars like in the case of small vans, however, they operate commercially and pay no taxes.

Many governmental plans noted the importance of stopping importing the tuk-tuk, pan its mobility in the streets, and replacing it with small vans that operate on natural gas; due to its implications as it exceeds the capacity of cities and towns (Arafa 2021). However, all these plans failed to be achieved; due to the rapid and vast spread since 2010 especially in the local urban contexts, which led to the necessity to license and authorize the informal transit and find ways to regulate and integrate it into the whole transportation network of the city as an effective way for sustainable mobility.

Some successful attempts were made to organize tuk-tuk which resulted in organized fleets operated by private companies like Uber and Careem, these fleets have specific fees, facilities, and schedules, ensure personal security and safety standards considering drivers and vehicles, and sometimes they use Apps for booking and GPS tracking. However, these fleets operate on a small scale for local mobility inside private gated communities and residential compounds like El-Gouna City in Hurghada governorate on the Red Sea, and Marassi City on the North Coast of the Mediterranean Sea(Figure 2).

Table 1 represents a comparison of the paratransit service in Asian countries and Egypt; to summarize and highlight the main shortcomings and the promising interventions that were applied in these developing countries and achieved convenient practices and regulations for urban mobility.

Criteria	Developing countries in Asia	Egypt
Licensing	Yes	Partially
Route planning	Yes	No
Fare regulations	Yes	No
Safety standards	Yes	No
GPS tracking	Partially	No
Electric vehicles	Partially	No
Operators' associations	Yes	No
Coordination with transport authorities	Yes	No
Road infrastructure	Yes	No
Parking and stations	Yes	No
Traffic management	Yes	No
Road safety campaigns	Yes	No

Table 1: Comparison between regulations of paratransit in Asian countries and Egypt

4 BUILT ENVIRONMENT FACTORS THAT AFFECT URBAN MOBILITY

In studying the relationship between urban mobility and the built environment inside the neighbourhoods, most studies highlighted that the characteristics of the built environment are the potential that encourages informal transit to evolve, urban structure elements including land use, public transport planning, street pattern, urban fabric, demographic characteristics, social aspects, and economic status all influence travel behavior and mode choice, in addition to different measures of the built environment including the 5Ds variables defined by Cervero (density, diversity, design, distance, and destination accessibility) (Ewing and Cervero 2010, Guerra, Cervero et al. 2012, Gamble and Puga 2017, Tong, Wang et al. 2018, Kumar, Sekhar et al. 2020, Falchetta, Noussan et al. 2021, Acheampong, Lucas et al. 2022, Gupta, Bivina et al. 2022).

4.1 Land use diversity

Many scholars have cited that land-use patterns affect travel behavior and mode choice; this then impacts how paratransit is planned and spread. Studies defined land-use diversity as a combination of eight land-use categories that exist within the neighbourhood context: residential, commercial, industrial, recreational, transportation, government buildings, utility, and vacant land. When all amenities: schools, grocery, hospitals, facilities, and open spaces are in proximity and within walking distance, people depend less on informal transit for mobility.

4.2 Transportation accessibility

Representing the distance and time needed to access public transit and stations from the center of the neighbourhood, this gap determines where informal transit works as an intermodal system to achieve first and last-mile connectivity between homes and destinations.

4.3 Road infrastructure

Streets in terms of (design, width, pavement, and geometry) affect the ability to accommodate public transportation systems to serve the district, which in turn affects the use of informal modes that can reach these zones. sidewalks in terms of(presence, width, and quality), facilities for the physically disabled, presence of pedestrian crossing, traffic signs and signals, traffic speed, and volume. All these factors affect travel behavior and mode choice.

4.4 Walkable and friendly environment

Providing spaces that encourage active modes of travel in which sidewalks are well-designed to attract pedestrians and positively influence them to walk; as they find comfort, safety, cleanliness, continuity, surface quality with no obstacles, a buffer from traffic, greenery, shading, shops to screen, open spaces, and adequate lighting. Also, providing safe cycling lanes that are separated from traffic encourages people to use bicycles safely and reduces depending on the informal travel modes.

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4.5 Population density

In densely populated neighbourhoods the demand for transportation service is high, and informal transit often meets this demand and provides flexible transportation options that adjust routes, patterns, and schedules based on the local needs and amenities.

5 CASE STUDYALEXANDRIA, EGYPT

To better understand informal transit in Egypt and how it operates inside neighbourhoods, an analysis of a residential neighbourhood in Alexandria, Egypt was undertaken. The selected study area (Moharam-bek district) is considered a condensed middle-class residential neighbourhood within the urban context of Alexandria. The neighbourhood is served by public transit on the periphery however the inner zones inside the neighbourhood are barely accessible by public transport, a matter that leads to the revealing of informal transit the achieve local mobility inside the neighbourhood.

5.1 Methods

The survey is based on two steps; first, an observational analysis is carried on by taking rides on the existing modes of the informal system operating in the neighbourhood; to analyze the current situation, and second, conducting discussions with users and drivers about the service. The following key components were studied in the survey:

- Types of existing informal transit
- Vehicles' characteristics (safety, design, manufacture, etc.)
- zones of operation, and pattern of movement
- service stops, hotspots, and congestion zones
- Routes and scheduling
- Fare structure
- Operational characteristics
- Role and contributions of the service
- Existing regulations
- Licensing
- Social concerns and personal safety

Figure 3: paratransit vehicles in Moharam-bek, Alexandria – represented in tuk-tuks that operate illegally (researcher, 2023)

5.2 Findings

The study area is featured by the spread of tuk-tuks as shown in figures 3 and 4 in which they operate illegally, move in opposite directions without any regulations, and cause congestion and conflicts with trams

and vehicles. The key components of paratransit that were analyzed in the study area are summarized in table 2.

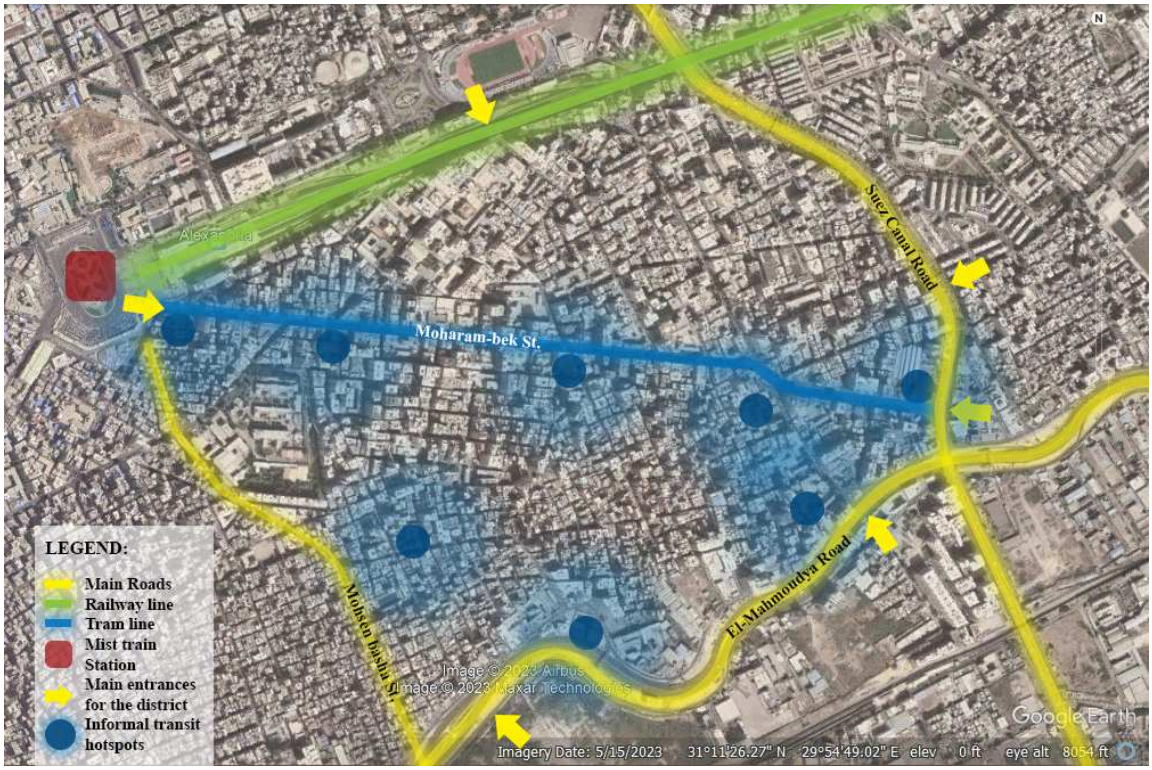

Figure 4: illustrative satellite image indicating context & mobility options in study area (source: Google earth, 2023)

Component	Description
Existing informal transit	Motorized tuk-tuk: a three-wheeled vehicle with a capacity of 2 passengers
Vehicle characteristics and safety standards	Vehicles are of poor quality, sometimes there is an overcapacity of 3-4 passengers, all vehicles run on diesel, and lack any safety standards considering driving techniques, maneuvering, their rush driving cause accidents with vehicles and pedestrians.
zones of operation, and pattern of movement	Tuk-tuks mainly operate in the inner zones and streets. And the main collector street in the neighbourhood (tram street) is their reference, where they start from or end at. The pickup points can be anywhere if the vehicle is empty.
service hotspots and congestion problems	Vehicle pick-up/drop-off stops are near the main railway station and bus stop at (Misr Station)and near the main markets; to carry people to their homes. And the main congestion appears when they move in opposite directions with the tram.
Routes and scheduling	Routes are highly flexible and dynamic based on customer demand, they operate in opposite directions to reach their destination. Scheduling is extended 24-7, and at the main hotspots the vehicles work on a queue system
Fare structure	There are no definite measures to calculate fares based on distance, drivers charge passengers at their discretion or based on negotiation; which leads to over-charging causing problems between drivers and passengers.
Operational characteristics	Tuk-tuks provide door-to-door and ride-hailing services. As soon as the passenger gets down, the drives tend to move back to the main hotspot zones.
Role and contribution	Tuk-tuks play a critical role in addressing local mobility needs inside a neighbourhood, providing connectivity between highly generating and attracting points, and achieving first and last-mile connectivity to public transit.
Existing regulations	There are no regulations applied to tuk-tuks, they operate chaotically.
Licensing	The majority of tuk-tuks are not licensed, a few tuk-tuks were noticed to carry license plates but that doesn't exceed 5% of the total number.
Social concerns and personal security	There are many concerns noticed regarding inappropriate drivers' behavior with users when negotiating fares and with other vehicles' drivers when complaining about their movement out of their lanes and in the opposite direction. Also, there are some accidents regarding kidnapping and harassment using tuk-tuks.

Table 2: Characteristics of the informal transit in the case study area (Moharam-bek district, Alexandria, Egypt)

5.3 Discussion

In the absence of adequate official data, the methods used for the case study formed a significant input, it provided information concerning informal transit operations and characteristics in urban neighbourhoods. The case study area showed that however tuk-tuks are accompanied by a huge amount of problems and have a lot of concerns: safety, personal security, congestion, traffic, fare, routes, and regulations, these modes of informal transit provide the needed local mobility inside the neighbourhood which is not served by public transport; this service is the only way to connect people to their destination whether to the main transportation terminals, markets, and other amenities.

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The study revealed that the characteristics of the built environment played a vital role in the spread of paratransit; high population density, condensed urban fabric, poor road infrastructure, irregular geometry of streets, and poor road planning hierarchy, all these factors obstruct public transit accessibility which in turn open the space for paratransit, also the deteriorated conditions of sidewalks and the unfriendly walkable environment prevent people from active transportation.

6 CONCLUSION

This paper has contributed to a better understanding of the role of paratransit service in meeting the needs of local urban mobility in Alexandria, Egypt. It helped to answer several questions considering: What type of local mobility inside neighbourhoods? What contribution does it add? What type of users does it serve? and What problems are accompanied with? On one hand, the paper showed that paratransit service is a problem that causes chaos and congestion inside neighbourhoods. However on the other hand, it highlighted its role in local urban mobility, it showed that this service is indispensable in the areas poorly served by public transit, this service is highly flexible to fit users' needs, although it may not be comfortable and safe, sometimes they represent the only choice for people to move to/from their destinations.

When comparing the situation in Egypt to the successful examples in Asian countries, it was found that Egypt almost has done nothing to solve the chaos and informality of paratransit service, the only consideration is some calls to license these vehicles and this is not the regulatory decision that ensures a better organization to the network. With more than 6millionvehicles that operate informally in the streets of Egypt, more decisions and laws have to be made to regulate and accommodate this service.

Learning from the Asian lessons, Egypt has to focus on the legalizing framework considering: obligatory licensing, route planning for the service, fare regulations based on the distance, GPS tracking for each vehicle, and safety standards including vehicle compliance, driver training, and regular inspections. Also, the organizational structure has to organize this service through specific laws and regulations for this type of transit and paratransit has to be represented by operators associations that are responsible for organizing public and private ownerships of vehicles, coordinating with transport authorities, ensuring continuous inspection and laws implementation, and solving the drivers' problems.

Moreover, one of the main problems of paratransit service is the accompanying congestion and accidents. Specific rules have to be formulated concerning traffic management that regulate the movement inside the built environment, indicate separate lanes especially on the main streets to prevent conflicts with cars, and determine specific parking and stations which have to be well designed and placed based on the analysis of the hotspots and transit terminals for each neighbourhood; to prevent overcrowding and street blocking

7 RECOMMENDATIONS

This paper sets the basic guidelines for the role paratransit plays in the urban environment and its effect on local mobility in Alexandria, Egypt. However, it highlighted the deficiencies and shortcomings in the Egyptian transportation laws that failed to accommodate paratransit service. These laws need to be considered by the government and decision-makers; to ensure adequate and safe mobility for all people.

First: mobility in Egypt has to be planned on two levels (two services) that work in integration with each other. The primary service is dedicated to long-distance mobility including railways, metro, tram, and BRT (known as trunk network), and the complementary service for local mobility, acts as an intermodal network that connects commuters to the primary service including local microbuses, vans, and tuk-tuks (know as the trunk-feeder network).

Second: Governments, transport authorities, and policymakers should acknowledge the presence of paratransit modes in cities and the role they play in urban mobility, analyze their challenges, and develop laws and policies that enhance the quality of services, organize their operation, and achieve safety based on the successful practices applied in Asian countries as discussed before.

Third: urban planners have to pay attention to the planning standards of the built environment and residential neighbourhood that achieve strategically placed hotspots like markets, hospitals, schools, amenities, and transportation hubs, smart planning enables residents to access services without the need to distant move and has enormous promise for reducing the demand for local urban mobility.

Fourth: attention should be paid to the improvements in roads and sidewalks infrastructure, urban design, and landscape, which in turn shall provide a friendly environment that encourages people to active means like walking and cycling, and reduce the need for local mobility.

Future research should consider how to apply these regulatory and organizational frameworks in the field, measure their effectiveness, and ensure law adherence.

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