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A Literature Survey on Opportunities and Challenges of Ride-Sharing Services

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Abstract

Ride-sharing services have revolutionized the way people commute in urban areas. They provide a cost-effective and convenient alternative to traditional transportation options like taxis and public transit. By utilizing technology to connect riders with drivers, these services have made it easier for individuals to get from point A to point B in a timely manner. A literature survey on opportunities and challenges of ride-sharing services reveals a plethora of insights into this rapidly evolving industry. The research points out the numerous benefits that ride-sharing services offer to both consumers and the environment. Furthermore, it sheds light on the challenges that these services face, such as regulatory hurdles and concerns about safety and security. One of the key opportunities highlighted in the literature survey is the potential for ride-sharing services to reduce traffic congestion and alleviate parking shortages in cities. By encouraging carpooling and reducing the number of vehicles on the road, these services have the potential to make urban areas more livable and sustainable.

Keywords: Literature Survey, Opportunities, Challenges, Ride-Sharing Services

I. Introduction

With increased urbanization and demand for transportation with linked issues of congestion, noise pollution, and harmful emissions, urban mobility is a more significant challenge than it seems for the future. Developing countries have several factors in common, including increased population

growth, resulting in increased urbanization, which attributes to the severity of the transport problems. Developing countries do not have sufficient public transport services to meet the travel demand. Public sector finances for transportation are so meagre that funding for public transport is inadequate. Urban mobility previously was dominated by private cars and public transportation. Since the public sector could not cater to the demand of the people, the private sector had to jump in. Tech companies have vehemently entered the transportation extent. Several new corporations and inventive business prototypes are developing, powering smartphones, GPS, electronic payments, social networks, and other novelties to create more transportation alternatives (Dewey, 2019). The very recent arrival of app-based android transport services has caused quite a stir in mobility in urban areas and transportation in general. The traits of flexibility and adaptability in any intervention are fundamental given the rapid modification in the app-based shared mobility market (ITF/OECD, 2019).

This includes ridesharing, the shared use of ride-sourcing vehicles, and demand-responsive transit, mainly bus services flexible to consumer demand about schedules, routes, and other services. Previously known as flex-route transit services (Fu, 2002) or demand responsive transport (Brake, Nelson, & Wright, 2004), these services now fall under the umbrella term of 'Microtransit.' The term micro-transit has only been coined in very recent years. The 'micro' prefix contrasts micro-transit with mass transit, aiming to serve the most significant number of riders possible. In contrast, micro-transit operates smaller capacity vehicles and targets a more limited client base. The micro-scale of cars and the transit nature of the shared rides bring all micro-transit services together (Rosa, 2018). Microtransit is defined as a privately or publicly operated, technology-enabled transit service that typically uses multi-passenger/pooled shuttles or vans to provide on-demand or fixed-schedule services with either dynamic or fixed routing.

The micro-transit services that have emerged over the last years rely on data and technology to achieve two objectives. To provide a great customer experience as vehicles and passengers are geo-localized, bookings are made in real-time, payments are cashless, seats can be guaranteed. Secondly, supply and demand are matched in real-time to improve efficiency, and pricing can accommodate collection and imbalances (Rosa, 2018). These two key elements enabled Uber, which started its operations in 2009, and Lyft, which

began operating in 2012, to revitalize the single-ride transportation business, attracting new customers and taking them from legacy taxi services that had not undertaken their digital transformation, which has now opened doors for more efficient micro-transit services which take account of how to decrease the number of vehicles by increasing ridesharing.

Micortransit is seen as a solution to several transport problems and is also seen as an alternative for suited, quick, and flexible demand that was left disappointed. It can also be seen as a striking substitute to driving or having your car; these services can potentially reduce auto use, ownership, and environmental problems on a larger scale. Previously this was said to be done by taxi cabs to fill out the current role of micro-transit services. But due to monopolistic behavior and specific regulations that limit supply and increase unreliability on the inefficiency of services. (Gilbert & Samuels, 1982).

Observational evidence indicates that micro-transit services can help solve problems in the transportation and infrastructure sectors. It can also help provide environmental benefits, but the actual extent of the influence cannot be calculated yet. While not specific to the effect of micro-transit services alone, one report estimated that using information and communication technology to optimize logistics of individual road transport could save up to 70 to 190 million metric tons of carbon dioxide emissions by 2020 in the U.S. alone (Neves, 2008). Individually, micro-transit participants can benefit from the shared costs of travel, reduced travel stress, reduced travel time which can be a problem due to congestion of vehicles on the roads at some routes and other incentives (Chan &Shaheen, 2012).

Although these kinds of transit services have been present for a while in Southern hemisphere countries and Asia, the technological development in the transportation sector has led to a wave of pilot projects and adoption in Europe and North America. Technological advancement allowed the real-time exchange of information and programmed optimization of the transit service. This idea of using smaller and more flexible shuttles is not new; New York City's dollar vans and the minibusses, which are very common in the developing world, have been around for decades (Bouton, Knupfer, Mihov, & Swartz, 2015). But the surge of connected, on-demand shuttle services is finding a loyal customer base and an operating model that allows the services to develop to new directions and cities.

The first comprehensive micro-transit operation — called Chronopro — launched by Transdev and its tech subsidiary Cityway started in September 2016 in Vitrolles, a city of 34,000 people in the south of France. Chrono warrants a reliable connection from a transit hub to office buildings within a nearby office park. Areas within the business cluster were previously served by two local fixed bus routes, replaced by Chronopro on-demand shuttles. The micro transit vehicles are well coordinated with the real-time arrival of buses at the transit hub, guaranteeing passengers a seamless connection every time. Shuttles to and from the transit hub can be booked through an app, a website page, or a call center. Routes are automatically computed according to demand to bring each passenger right to their destination within the office park service area.

Many companies followed suit. Chariot, owned by Ford Motor Company, is a passenger shuttle service. The commuter can get access to their mobile phone application through their smartphone. They can then ride a shuttle to wherever they want, which falls under the company's designated routes and during the commuting hours followed by the company. (Armlovich, 2017). A commuter can access Chariot through a mobile web browser or Android or iPhone mobile applications. After signing up on the app and buying the Chariot credits, the user can use the map to find any pickup stop. The passengers boarding ticket is shown on the app in a flashing code. As of May 2016, commuters had the option of multiple ride packs of credits and the choice of pay as you go.

Similarly, BRIDJ is another app-based bus service that provides 'demand-based' public transportation. This service entails an optimization engine, a customer portal, a driver, and a mobile phone app. The customers can book their rides on the app and later pay for their ride and track their whole journey. Boston was the first city in the U.S., where it started its operation, which was shortly followed by a process in Washington DC and Kansas City (Goodall, Fishman, Bornstein, &Bronthorn, 2017). BRIDJ's services in America were terminated in April 2017 due to an unsuccessful funding round. It was later picked up by the Australian company Transit Systems which started travel services in December 2017 in Sydney. The company was then subsequently acquired by SeaLink Travel Group in January 2010. After this acquisition, BRIDJ became an independent, privately-owned company.

In recent years, micro-transit services have been slowly yet steadily growing in terms of customers, drivers, and locations that are served by these companies. Despite many benefits, there are several hindrances to increased micro transit use, including reluctance to sacrifice the flexibility and convenience of the private automobile and desire for personal space and time. Many people can also be dubious of these services due to personal security concerns arising from riding with strangers (Bonsall, Spencer, & Tang, 1982).

However, there is also an ongoing discussion that micro-transit services unfairly go against existing rules and regulations, compete with public transport, give rise to congestion in peak hours, delude the commuters with non-transparent pricing practices, and jeopardize public safety. This position holds that micro-transit services are no different from taxi services since the latter pose similar threats. (Schaller, 2007). It depends on the argument that the government should enforce rules and regulations consistently. Companies that serve micro-transit services can protect market forces in exchange for following these rules and regulations. (Kahn, 1988). As city leaders revise policies on micro-transit services, there is an urgent need for an independent analysis of their mobility and environmental aspects.

2. Methodology

A thorough search of academic databases such as Google Scholar, JSTOR, and Science Direct was carried out using terms such as "ride-sharing," "peer-to-peer transportation," "carpooling," and "shared mobility." A thorough analysis of the selected publications was carried out to identify important themes, trends, and findings about the prospects and problems of ride-sharing services. This analysis entailed coding and categorizing the data to detect common trends and discrepancies among the studies. The results of the literature survey were combined and arranged into a cohesive narrative that provides an overview of the current research. This includes summarizing major findings, addressing their implications for policy and practice, and identifying gaps in the available literature for future research.

3. App-based micro-transit

Micro transit is a technology-enabled, privately or publicly controlled transit service that often uses multi-passenger/pooled shuttles or vans to provide on-demand or fixed-schedule services with either dynamic or fixed routing. App-based mobility services have a brief history dating back to the early 2000s. However, these services have grown exponentially and are now an essential

component of the urban transportation environment. Its goal was to identify key takeaways and develop regulatory guidelines to ensure that the consumer benefits of app-based mobility are maximized and that they successfully contribute to achieving broader public policy objectives (Stromberg, 2015).

Consumers have reaped significant benefits from app-based micro-transit services. All while cutting charges, they've boosted variety and enhanced essential components of service quality, such as availability, punctuality, comfort, and the subjective client experience. These advantages stem in part from the technological advancements they represent. They have, for example, enabled speedy and reliable matching of services and clients, as well as dependable, riders and drivers, must be able to pay without using cash, and they must be able to be identified effectively, as well as voyage logging. In various industries, App-based communication and payment services and GPS positioning have enabled new business models. Strong consumer demand for these services, on the other hand, has led to quick shifts in government policy, with prohibition giving way to more lenient regulatory methods in many circumstances. These, in turn, have been criticized for failing to sufficiently address the drawbacks of new mobility services, leading to calls for more stringent regulation. It's also common to hear that incumbents are unfairly disadvantaged when fighting against disruptors (Regulating App-based Mobility Services, 2019).

Traditional public transportation struggles to fulfil rising mobility demands, particularly in developing countries. The deterioration of public transportation makes room for alternate modes of transportation. Demand-responsive transportation is one such alternative mode of transportation (DRT). It is a versatile method of transportation whose operation is determined by user demand. Users often register their order by calling a phone number, which assists in planning pickup and drop-off routes. It's more common in places where public transportation isn't available or where public transportation can't keep up with demand, such as underdeveloped countries. Several studies have shown that DRT services can provide long-term local public transportation. App-based DRT services are fast gaining traction in Lahore, owing to the diminishing quality of public transportation. SWVL (option A) and Airlift (option B) bus services are two famous examples in Lahore. Choice A and B are both available on several routes in Lahore. The apps provide users with the option of suggesting different ways.

After careful planning and study, the priorities of the service are the launch of new routes. Users' satisfaction levels with these app-based DRT services must be assessed and the most valuable components. Previously, perceptions of spatial coverage, simplicity of booking a ride through an app, driver behaviour, and car ambience were not given much weight in studies. Furthermore, because these App-based DRT services are likely to impair already failing public transportation utilization, it is critical to gauge general satisfaction with them. The current study, which is one of the first of its kind in Lahore in the context of app-based micro-transit services, fills this hole (Ali, 2020).

3.1. Purpose

The study's main goal was to obtain the necessary information for the Implications of app-based micro-transit services. These aims should be considered in transportation planning within the context of each metropolitan setting. Appropriate means of transportation must be deployed based on their effectiveness and the features of each mode of transport, as well as the terrain in which they will be deployed. Different types of transportation are appropriate for distinct conditions and serve other objectives in vehicles. Legislators and operators must determine how satisfied passengers are with these services. Airlift and Swvl are employed in Lahore as micro-transit and flexible transportation options provided by local transit authorities. Even if the word is more used for real-time on-demand mobility solutions than for set routes and schedules, the nature of the service supplied has also been interpreted differently. At first, these two firms operated without permission, delivering app-mediated, bus-like services. Policy implications can be drawn from the findings of this study. Emphasizing service aspects like travel time savings, spatial coverage, and speed can also improve overall satisfaction. It is necessary to specify a more open method for introducing additional routes. Furthermore, establishing a precise mechanism for fare collection is likely to improve overall satisfaction (Abdullah, 2020).

3.2. Need of app-based micro-transit

a. Accessibility and coverage

Micro transit is a coverage-driven mode of transportation. It is appropriate for underserved low-density areas where consumers are dispersed. There is no suitable permanent line that can respond to the demands of a broader area since it consists of smaller vehicles with flexible itineraries.

b. Point-to-point flexibility

One of the most significant disadvantages of public transportation, which for many consumers surpasses many other potential benefits, is that the user cannot enjoy a direct ride from any area to a specific destination in most situations. Micro transit bridges this gap by providing flexible lines that adapt to each user's individual geographic needs (Moore, 2019). Maintain a regulatory climate that is favorable to emerging app-based mobility services.

App-based mobility services have seen fast expansion due to the significant welfare benefits. As a result, regulatory constraints mustn't operate as an unnecessary hindrance to realizing these gains. Rather than seeking to artificially slow or stifle the adoption of new business models and technologies, legislation should reflect a fundamentally permissive and facilitative approach to innovation that embraces market disruption. In circumstances where consumers are plainly at risk of substantial harm, this should not imply inaction. Lowering regulatory hurdles is critical for innovative business structures and modes with unclear profitability. Small-scale trials with less regulation can often yield valuable results. In such cases, governments should consider absorbing the first regulatory expenses rather than demanding reimbursement from new enterprises to foster innovation (Hietanen, 2018).

c. Treat incumbent mobility providers and new market entrants equally

Regulatory mechanisms should enable welfare advantages from app-based mobility services. At the same time, they must ensure that consumer safety and other critical consumer protections are maintained and that other public-policy objectives are not jeopardized. Pro-competitive regulation is required. This isn't to say that all market segments need to be governed the same manner, as different business models may necessitate distinct regulatory structures.

d. Concentrate regulatory efforts on addressing market shortcomings that have been recognized

Regulation should be based on a detailed understanding of how a particular market works and the discovery of significant market failures or equity problems. While governments may seek to regulate ex-ante to prevent evident harm, the nature of such services and the young market they operate in must be properly understood to avoid ineffective regulation and unforeseen costs (Licea, 2019).

The goals that micro-transit must achieve

- Increase coverage and accessibility in areas where public transportation is scarce.
- To improve collective transportation quality in some areas, create a better point-to-point flexibility service.
- To increase intramodality and link more users to public transit, provide first and last-mile connections.
- Increase ridership on coverage-driven routes to improve their economic viability.
- More correctly, detecting mobility patterns and demand points acts as a data source for transportation planning (García, 2018).

4. In the context of developed countries (case studies)

4.1. Helsinki (Finland)

The OECD's International Transport Forum (ITF) has conducted studies that supply us with helpful information. They've created simulations of shared mobility services (micro-transit and shared taxis) in numerous cities and scenarios. This research reveals that with only mass transit, door-to-door micros transit vans, and shared taxis, the whole mobility demand of the cities investigated can be met at a fraction of the cost of existing public transportation. Substantial urban benefits can be achieved in this alternative mobility paradigm, where shared services have replaced all private cars: congestion is eliminated due to vehicle sharing, CO2 emissions are reduced due to lower vehicle miles travelled, and public space is freed due to a reduced need for on-street parking. As a result, the OECD recommends that large-scale deployment of shared mobility services be undertaken to impact travel behaviours and be economically viable positively.

- **Implement new shared mobility options at a large scale to increase the appeal and reduce expenses.**

On-demand shared mobility services can only succeed if the necessary market circumstances and operational frameworks are in place. According to input from the focus group, users in the Helsinki metro region are open to such ideas. However, they must be applied on a big scale throughout the metropolitan area to be effective, not just in isolated areas. It's also essential to have enough size to keep costs under control. Any shared mobility economic model should be extensively analyzed regarding innovation

potential, cheap user prices, and regulation that ensures total society benefits. Success can be achieved only by having a high enough average vehicle load factor to cover all costs and a low enough price point relative to single trip services to attract clients. The capacity to group many passengers while still providing a good service (without too many detours) is directly related to the local transportation offer and demand density: the higher the density, the more successful the grouping of riders along the same route. Only a significant shift in behaviour, such as enough individuals abandoning their private cars in favour of shared transportation services, would increase the required density while improving traffic conditions (Leriche, 2019).

Figure1: Electric vans launched in April 2019 in Helsinki (Finland)

Such ideas should be used in our city, but with new technology that increases efficiency and service quality.

Lessons learned

- The service must address actual mobility demands, such as excursions that users genuinely need and value in their daily commutes.
- The passenger journey must be simple, frictionless, and trouble-free.
- When micro-transit serves a first/last mile role, it is critical to ensure riders make their connections every time.
- When compared to the costs of operating fixed-route buses, the load factor of the vehicles must be high enough to make the service financially viable.

- To make sound judgments on service design and marketing, it's essential to have precise data on unique journeys and users.
- To raise awareness and encourage trial, promotion and outreach are essential.
- Multiple domains face challenges that must be effectively addressed. It is critical to learn and adapt in real-time (Aman, 2020).

4.2. Mexico (North America) App-based transit service in Mexico City

App-based mobility became commonplace in Mexico City after the launch of Jetty. Initially, this firm operated without a permit, providing app-mediated, bus-like services. Their vehicles were of more excellent quality, and their drivers were more pleasant than taxi drivers; therefore, they quickly acquired popularity. Furthermore, their apps fixed the price, avoiding unpleasant haggling with drivers who regularly tried to charge more than the official meter. The inventor of Jetty received his doctorate from MIT, where he authored his dissertation on the formalization and professionalization of the jitney industry in Mexico City and Santiago, Chile. Jitneys have two significant benefits over ridesharing. For starters, the expense of a ride is spread out among a more substantial number of riders, allowing for lower costs. Second, rather than the vehicle detouring to pick up and drop off each passenger at their home, passengers must travel to and from stops to access the car. This allows for more direct routing and a higher number of daily passenger trips to be achievable. Jetty is a little company with a big goal: to help Mexico City traffic flow more smoothly. To do so, we aim to ensure that shared trips (shared taxis, vans, and buses) maintain the degree of comfort, safety, and dependability essential to delay, and preferably avoid, a modal shift to the private car. Jetty was confronted with three issues that were all intertwined. All three challenges took almost a year to complete.

a. Developing a minimum viable app
b. Obtaining a business license
c. Recruiting transportation providers to provide rides (Flores, 2019).

Jetty found a method to improve jitney operators' outdated business model by leveraging emerging technologies, resulting in a better experience for all parties involved: users, entrepreneurs, and government authorities... After years of trying to "formalize public transportation" and seeing the

problems that come with it, I'm beginning to see that leveraging the semi-regulated jitney model, which is closer to the people, more flexible, more demand-responsive, and less stiff than the State, its bureaucracy, and its never-ending political infighting, maybe a better approach."

Figure 2: fleet of jetty vans

Second, improving the quality and coverage of public transit is unachievable without significant capital investments or operating subsidies. This is especially essential for places like Mexico City, suffering fiscal difficulties. So far, the cars in our network have covered over 945 000 kilometres across the metropolitan area and have functioned magnificently. We had zero serious collisions and zeroed criminal events on our cars in our first year of operation. We've done so by a) investing in driver training and paying drivers a fixed salary rather than a commission, b) outfitting our vehicles with cameras and monitoring every trip, and c) establishing bidirectional communication with passengers and responding quickly to reports of unsafe driver behaviour or unfavourable pickup or drop-off locations (improving shared mobility is a precondition for autonomous and electric vehicles, 2018).

Companies like Jetty need to be established in our country; thus, a climate that encourages risk-taking and innovation would be beneficial. Instead of

brokering peace deals with incumbents, advocating for new regulations, or bringing lawsuits to defend our right to exist, we should spend our limited resources and attention on improving the passenger experience. Even in the face of hardship and significant technological, competitive, and regulatory challenges, companies like Jetty will find a way to redefine transportation in our cities.

4.3. Paris

This study aims to give a feasibility study analysis on LeCab, a French startup firm formed in 2018 that innovates in car transportation. This study aims to investigate LeCab's market, including its competitors, clientele, and differentiation. LeCab's main competition in the U.K. market is Black Cab. The 18-29 age group is the most prevalent taxi rider in consumer demographics. In terms of differentiation, LeCab's primary differentiators that set it apart from the competition are elegance environmental. As indicated by the use of environmentally friendly engines, taxi drivers, and the level of comfort provided to passenLeCab, community consciousness is a subsidiary of Keolis. This multinational transportation firm has teamed with Via Rail (previously, this section has presented this New York-based enterprise). Via provides the service's technology infrastructure, including the routing and optimization algorithm.

Figure 3: LeCab taxi service in Paris

LeCab presents itself as a convenient taxi service that can be booked via a smartphone app to go about Paris quickly. Leib uses Via's technology to match people with seats in vehicles travelling in the same direction. They say that by sharing cars with several consumers, they can minimize the number of individual car trips in Paris, lowering CO2 emissions, air pollution, and traffic congestion. They also intend to connect passengers with other forms of public transportation by providing on-time cab rides for scheduled train services. They also offer an airport connection service with flat fees that allow departure and arrival schedules (and any delays) to provide convenient pickup times. As a result of having a better grasp of the market, LeCab has seen a rise in sales and is strongly reliant on technology. Thanks to mobile technology and a phone application, a groundbreaking new service has been possible. The company was established solely to make it easier for commuters to get from one location to another. Customers can now order a cab in a more convenient, faster, and cost-effective manner (John, 2018).

We should use several primary local resources as part of our business firm. We'll teach them and give them the vehicles they'll be driving. Because they will be in direct contact with our future clients, they are seen as a valuable essential resource. Provide the app for smartphones and a link to our website. Our primary communication channel and relationship with our clients will be this channel. As a result, having a simple and reliable technology that any generation can use is critical. To deliver the service in Lahore, we will need to invest a significant amount of money, for example, to purchase cars.

Furthermore, the drivers might be an investment because we will train them. Not to mention the human resource costs. Even if we only have a small crew, to begin with, monthly salaries are a significant sum of money. Our cost structure will also include the cost of the company's application and website. We'll have to customize them for our market. Our Budge will detail and explain the specific budget and expense structure (Micro transit for urban mobility, 2019).

5. In the context of developing countries

5.1. New Cairo as a case study for an integrated micro-transit system: first and last-mile solutions (Egypt)

As the city grew, getting about became more difficult for those who did not have access to a private automobile. As a result, transit vehicles that followed a particular transit line and passed through specific transit stops were constructed. As the need for mass transit services rose, as did the spread of cities, the mobility system had to be divided into two main benefits. A trunk network is a sizeable long-distance transportation system primarily of high-demand buses, trains, and metro lines. The other service is a supplement that connects commuters to the primary service via local buses, minibuses, and other forms of transportation.

The first, last, and only miles issue isn't new; it's been around since public transportation's start. However, this problem began to occur as the length of the first/last/only miles' trips increased. This problem arises as cities grow or when the transportation infrastructure is underdeveloped, with only a few routes that do not adequately cover the metropolis. The main difficulty for city planners and service providers is connecting people's pickup sites to the city's transit network or their desired destinations. These considerations also impact the type of first- and last-mile mobility solutions available. Walking, which is regarded as the primary first, last, and only mile solution, is an example of active mobility solutions (Chidambara, 2019, Transit Forward RI2040, 2020), and cycling is an example of mobility solutions. Another option is to use motorized or electrical vehicles for non-active mobility. Other options, such as micro-transit, rely on high-tech solutions like mobile application-based services. Furthermore, the advent of park & ride services encourages private-car users to use public transportation by driving the first or final mile.

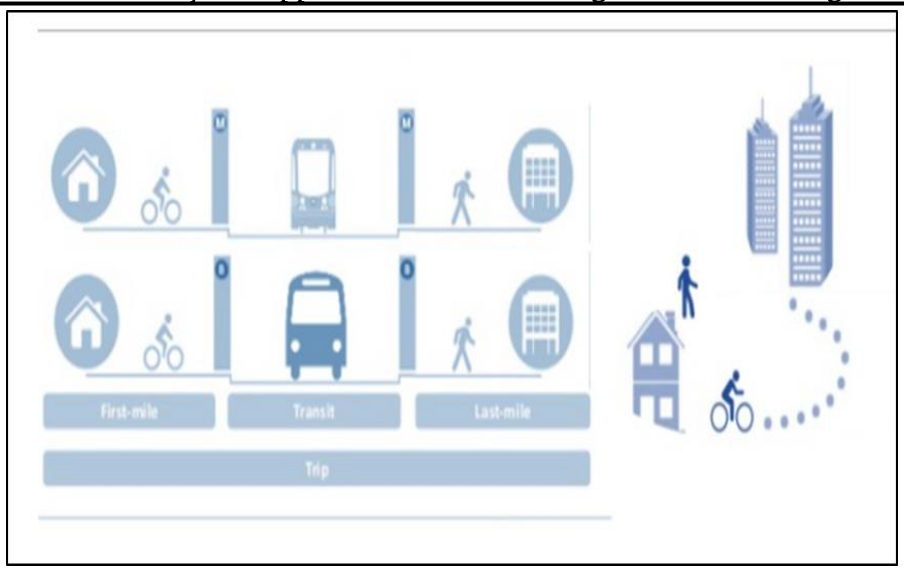

Figure 4: Left: First and Last Mile concept, right: Only Mile concept

The use of private cars is essential in New Cairo. According to the poll results, the private car is the primary form of transportation for over 74 per cent of the people. This reliance, however, is not primarily due to a lack of variety in New Cairo's mass transit offerings. While New Cairo has a variety of public transportation alternatives, the vast majority of these are trunk-network services that connect New Cairo to GCR villages rather than providing intra-city mobility. In some cases, ride-hailing can be used as a first- and last-mile option to persuade private-car owners to give up their cars and use public transportation. In addition, Park & Ride is one of the systems that may encourage private car owners to use their automobiles as a first and last-mile solution for taking public transit for the main trunk trip. Park and ride systems were favoured by 53% of poll respondents in New Cairo. These ways and modes are designed to connect users' origins to their destinations in the most straightforward, convenient, and long-lasting manner possible. Furthermore, first- and last-mile solutions tend to reduce the use of private cars while increasing the use of public transportation. According to the poll's findings, 56.5 per cent of New Cairo private vehicle users and 61 per cent of ride-hailing users would be more willing to switch to mass transit if first- and

last-mile challenges were satisfactorily addressed by first- and last-mile modes (El-Dorghamy, 2021).

It will be recommended that enough modes of transportation should be available to cover the entire city to have an integrated mobility system. Future research should look into this issue in various urban contexts in the country, including high-density areas and medium-density neighborhoods. Furthermore, specialized studies should be conducted to determine the applicability of the broad modes, such as establishing bicycle infrastructure, including bike-sharing programs, or providing adequate walking infrastructure (Hussin, 2021).

5.2. The digital matatu project: Using cell phones to create open-source data for Nairobi's semi-formal bus system (Case study of Nairobi, Kenya)

In many of the world's growing cities, semi-formal buses comprise the backbone of public transit networks. However, there is virtually little available and standardized data about these systems. The purpose of the Digital Matatus project in Nairobi, Kenya, was to explore if mobile technology's geo-location capabilities could collect data on a semi-formal transit system and if that data could then be translated into the GTFS data standard for broader use. The matatu network originated in Nairobi in response to a service gap created by the city's public transportation system's weak funding and administration. In contrast to other infrastructure, the vehicles are locally owned. They involve many small businesses and independent workers, from the operators (who often own large matatu fleets) through the drivers, touts, and technicians. Matatus typically stick to "official" routes, relics from the previous bus system. As the city expands and new roads are constructed, the operators build more unapproved routes. Nine thousand five hundred fifty-four matatus and buses currently serve the Nairobi region. The outcomes of this study imply that mobile technology, particularly mobile phones, which are becoming increasingly prevalent in developing countries, can be used to collect and distribute data for semi-formal transit in a modified GTFS format. As a result of our work in Nairobi, we were able to identify the benefits and technical requirements for

producing data on semi-formal transit. However, certain typical essential data elements for the standard, such as calendar, service frequency, and operation schedule, do not apply to matatu system data.

Furthermore, fares vary, as are routes and stops, based on traffic patterns, police checks, and commuter needs. Engaging with a diverse range of transgender experts and advocates, we devised a set of modified GTFS standards that would be adaptable to mass-transit systems with a high degree of informality, such as those found in Nairobi. Nairobi has a thriving I.T. economy and a higher mobile phone penetration rate than the rest of Kenya. An innovation and technology centre called the iHub, intended to inspire and encourage technology entrepreneurs by creating a shared learning community. The work as a whole demonstrates:

- (1) how the GTFS can be modified to semi-formal transport systems and used by other cities with such systems,
- (2) that both technology and transportation groups are looking for thorough data on semi-formal transit,
- (3) that making the data available in the GTFS standard format will aid in the development of transportation-related applications, and
- (4) that integrating the entire transit community in the data collection process can aid in the development of transportation applications. Our research team's engagement techniques for the data gathering procedure in Nairobi became as crucial as the data that resulted (WAIGANJO, 2018).

Lesson learned

We'll focus on including socioeconomic factors and travel patterns and extending the concept to a more extensive network. For example, the average income of persons living near transit stations might be used as a proxy for prioritizing public transportation spending. The prospective possibilities component attempts to weigh journey time according to the location's attractiveness. Applying the framework to a more extensive network (with more routes and stations) with fixed and variable headway routes will reveal more about the toolbox's data management capabilities and illustrate

temporal trends in network coordination. Many multimodal options for transit station entry and egress, such as park-and-ride and cycling, may improve future iterations of the algorithm (Fayyaz, 2018).

5.3. Tehran, Iran

In recent years, new technologies have significantly impacted human mobility in various ways, including changing and eliminating old travel restrictions and constraints. Mobile technologies influence travellers' requirements and preconditions for travel and travel's spatial arrangement, costs, and advantages. The use of ICT in transportation makes autos available in real-time and a range of convenient locations for individuals via an internet interface, reducing the need for people to own a private vehicle. Because of the ubiquitous use of smartphones, companies have created app-based transportation services that quickly connect customers with drivers. One of the most notable applications of ICT in transportation is "ride-hailing," a tech-driven version of traditional street-hailing. Transportation network companies (TNCs) offer shared mobility services that allow customers to book rides directly with car owners via smartphone apps. TNCs and ride-sourcing differ from traditional mobility options. They use particular algorithms rather than random selection to match passengers with the closest driver, resulting in increased functional and financial efficiency for both passengers and drivers.

With advancements in ICT and internet connectivity, a new mode of transportation has developed in Iran: Ride-hailing services based on an app are available on demand. Snapp is one of Iran's most recognizable local transportation network companies. Snapp made its debut in 2014 and has had a significant impact on Tehran's public transportation system. In the first few years of operation, five million travellers in Tehran and other major Iranian cities created Snapp accounts. It has provided more than 50 million journeys in Iran's major cities since 2014, with more than 100,000 drivers. For the first time in Iran's transportation system, passengers can request a trip using their smartphone, select a driver and car, verify the driver's profile, view the estimated charge, and choose to pay online or in cash.

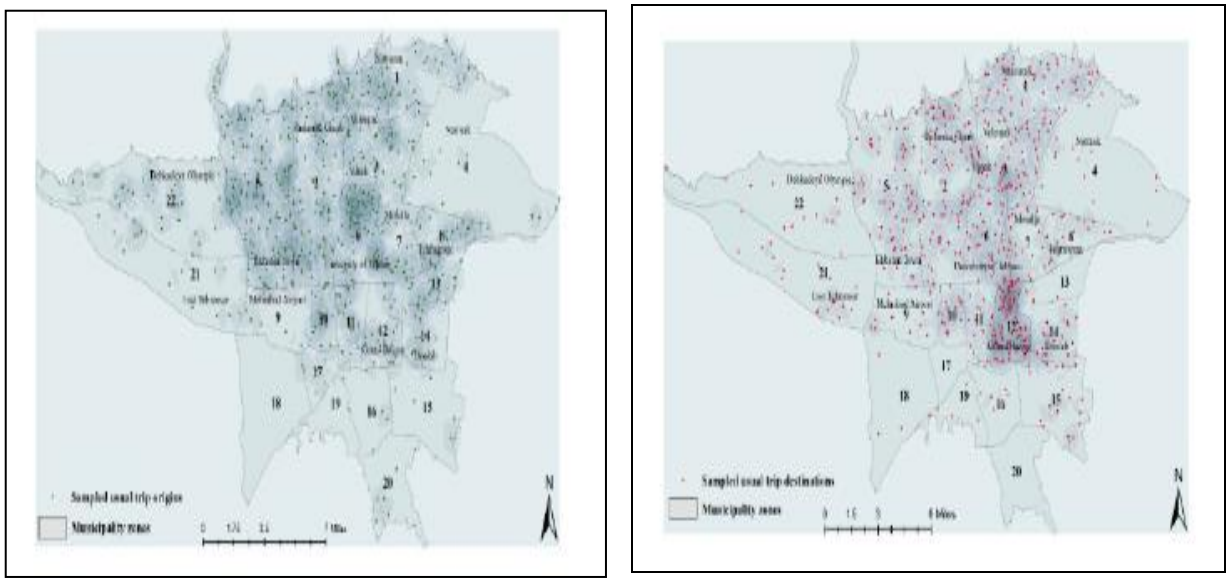

Figure 5: represent the densities of the most frequent origin (pick-up) and destination (drop-off)

Finally, after their ride, customers can provide feedback. According to the Tehran Taxi Organization, Snapp rides account for between 300,000 and 400,000 journeys each day in the broader taxi market. Although Snapp's ridership does not yet rival that of regular taxis, it is rising in popularity, mainly to the fact that consumers may afford a low-cost Snapp ride without having to share their taxis with others. The trip costs substantially less than a comparable Darbast cab because of Snapp's pricing policy, which is designed to compete at or below the price points of the cheaper, shared-ride taxis. The entire journey time in Tehran is often less than other means of transportation because the driver may manoeuvre around crowded roads using the Snapp app. Because of its popularity among single riders, Snapp operates as a private ride-hailing service, but the company's goal remains to improve the infrastructure for pooled/shared ride-hailing services.

This is one of the first studies investigating the factors influencing ride-hailing behaviour in a developing country like Iran. It's also one of the first to take into consideration both subjective and objective variables (such as

attitude), as well as direct and indirect correlations. Our land use attributes are the most significant shortcoming of this study. Because data at the disaggregated (address) level is not available, we aggregate our land-use variables at the zone level at trip origins. Because of their lack of access to and familiarity with smartphone applications, senior adults may find it challenging to adopt app-based transportation options. More research regarding the travel challenges of seniors who utilize ride-hailing services is required, and alternative advice for overcoming these obstacles (Hamidi, 2020).

We should need to look into the travel costs of ride-hailing adoptions and make alternative suggestions. The transportation sector is undergoing its most significant technological shift in a century, with new types of on-demand transportation taking advantage of technologies like GPS chips to deliver an app-based, on-demand vehicle that connects riders and drivers quickly and reliably. Individual attitudes and preferences directly impact mode choice as a mediating factor on demand for ride-hailing, affecting both direct and indirect ride-hailing trip frequencies (Zhang, 2020).

6. App-based micro-transit in Pakistan

Ride-booking, ridesharing, and ride-hailing are just a few of the words that have been coined to describe app-based ride services. There was, however, no unambiguous nomenclature. One of the first to invent the phrase transportation network businesses was the Pakistan Public Utilities Commission (PUC) (TNC). The PUC is a regulatory body in charge of ensuring public safety. Customers could rent cars for a short period on a flexible hourly basis initially. In the second generation of carsharing service models, customers can choose where they wish to pick up the car and leave it off. Peer-to-peer sharing is the third generation of sharing. People share their automobiles with others. As a result of adopting new technology, business models known as transportation network corporations emerged. "Offer pre-arranged transportation services for remuneration by connecting drivers utilizing their vehicles with passengers using an online-enabled application or platform (such as smartphone apps)," according to transportation network

corporations. These services have gained in popularity due to technological improvements such as cellphones and digital road maps for the general public. Uber and Careem are two well-known transportation networks in Pakistan (Nisar, 2021).

With the launch of Careem Bus in many cities, Careem's app-based mass transit service has discreetly moved to Pakistan. We were unable to confirm this because Careem did not react to our request for comment, but it looks that this is a test run for the service. Like Airlift and Swvl, the service is accessible via a unique 'Careem Bus' app (available for Android and iOS) that lets users search or explore different routes and select pickup and drop-off points from a list of stops and book seats. According to the information available on its app, all of them operate at 10 a.m. (only) on weekdays. The app also states that rides are presently available for PKR 1 (less than a cent). When we first tried the app, we were assigned a captain who drove a Daihatsu Hijet, an eight-seater minivan smaller than Airlift and Swvl's cars. Careem currently has these vehicles available in its primary ride-hailing app (car type: Dabba) in various cities across Pakistan (but you must reserve the entire car), implying that they may be employing its existing captains to conduct the pilot. We were unable to verify this. Careem Bus is launching its service in Pakistan for the fourth time. Swvl, one of the best-funded businesses in the Middle East and North Africa, which expanded to Pakistan earlier this year, as well as a local firm that was the first to establish an app-based bus hailing service in Pakistan and just raised a massive $12 million Series A backed by First Round Capital. To attract clients, both Airlift and Swvl significantly subsidize the rides. Both corporations are spending a lot of money on acquiring and maintaining supplies. Given the importance of the findings, it's essential to acknowledge the study's shortcomings. The international literature on mass transit associates uses with both economic and social benefits (Paracha, 2020).

Smartphone apps are revolutionizing urban mobility. From early traveller information systems to dynamic, customized, multimodal trip planning and assistance apps, technology has progressed from simple driving and static

public transit information. The development of these apps has progressed throughout time. Multimodal applications are beginning to integrate real-time data from various sources, building on knowledge gained from first-generation single-mode applications (Zia, 2021).

6.1. In the Context of Lahore

Lahore, Punjab's second-largest metropolitan city and most modern region, has been chosen as the study area. With a population density of 48 people per hectare, it is ranked 25th among its most densely populated cities. Vehicle ownership has increased five times faster than the city's population growth rate in the last five years, from 56 to 116 vehicles per 1000 people. Based on these figures, the city had a pressing need to establish a mass transit system that would attract and facilitate people more than their vehicles. The ability of a mass transit system to be accessed via a regular plan is critical in increasing ridership on the central system. In the absence of a formal feeder mode, entrance and egress excursions to and from the central transport system become critical (Tabasuum, 2018).

Swvl enters Pakistan and introduces an app-based bus hailing service in Lahore

Swvl, a Cairo-based app-based bus ticketing startup, has opened an office in Lahore, according to a company announcement on Facebook yesterday. Pakistan is Swvl's third market, after Egypt and Kenya. MENA bytes first reported Swvl's plans to expand to Pakistan earlier this month, but they denied any such plans when we contacted them for confirmation. Swvl, a private premium alternative to public transportation, was founded in 2017 and allowed riders to reserve seats on its "high-quality" bus network (owned and operated by third parties). According to the firm, customers board the buses from precise pickup points and are dropped off at pre-defined (virtual) stops. Startups like Swvl have a fantastic opportunity to solve some of these difficulties in Lahore. Swvl isn't the first company in Pakistan to offer this service. Airlift, a local startup that launched early this year and is closing its first round of fundraising, has already generated a lot of buzz in Lahore (and is allegedly also available in Pakistan's largest city, Karachi).

Table. 1: Potential supporting strategies for successful Mass-transit system

1. Integrating planning of land use and transportation system	
2. Rapid transit operations	High service level
	Providing exclusive bus-ways
3. Entire network perspective	Good route planning
	Providing feeder network
	Proving no competitive local service
4. Other conditions	ITS application for operations
	Marketing strategies

Although Lahore is a new market for Swvl, their team has sufficient knowledge of the dynamics of the local transportation sector, having previously worked there. In his former capacity as Careem's Market Launcher, MostafaKandil launched multiple cities in Pakistan. Swvl's Global Expansion Director Before joining Swvl in 2018, ShahzebMemon, a Pakistani national, worked as a Supply Manager for Careem (Pakistan). According to the findings of the analysis, existing public transportation/mass-transit services should be redesigned/realigned to expand coverage. There is still a need for further justification before such a service is implemented. Other aspects, such as commuters' willingness to utilize, should be investigated and debated in the future (Naeem, 2019).

6.2. Sustainable App-based micro-transit system

As shown in the diagram, an effective technique for achieving efficient, equitable, and sustainable micro transportation must account for four key issues. We must first and foremost understand users, their needs, and their values. Second, we must provide a user experience that promotes transparency and trust in the micro-transit system while encouraging users to adopt prosocial or cooperative attitudes, allowing them to accommodate one another, thereby improving the three system outcomes of efficiency equity

and sustainability. The user experience is reflected in the Cooperative Adaptive Ride Sharing (CARS) app. Finally, we must develop a micro-transit optimization model that allocates resources (in this example, rides) following those needs and values. Fourth, in addition to the aforementioned operational obstacles, constant improvement and meeting user needs necessitate outcome monitoring and evaluation to determine how well the components and the complete micro-transit system perform. These are what we refer to as "circumscribing operational concerns."

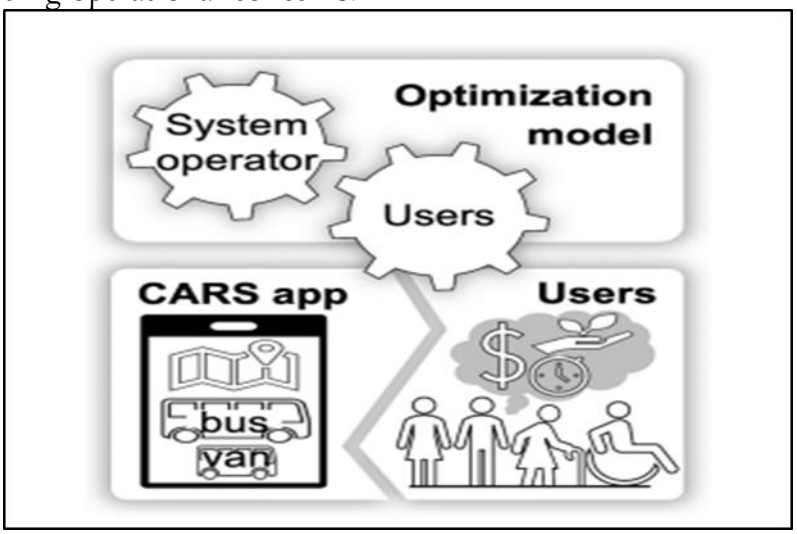

Figure 6: Schematic of the proposed user-adaptive approach

To quantify efficiency and sustainability, aggregate indicators such as a total number of passengers and probability density distributions of journey distance, length, waiting time, and several people in the vehicle are utilized. Equity is examined using spatiotemporal variables such as distribution of trip requests, waiting time, and delayed arrivals to see how the service is used and perceived across different geographies and neighborhoods. Verticalequity15, which is not apparent from the spatial-temporal metrics, quantifies the distribution of effects among users of various socioeconomic classes (e.g., per cent travels by low-income users). Consumer expenditures are reduced due to the lower-level strategy, including travel time, service rates, wait time to be serviced, and walking distance to and from the ride. Over time, the operator

and users decide how an adaptive dynamic programming model describes system dynamics (Munindar, 2020).

If the user criteria are too stringent, the optimizer will come up with solutions that aren't necessarily efficient or long-term. However, if customers are willing to be flexible, the optimizer can generate several viable solutions. For example, suppose a user selects a more extensive origin and destination location. In that case, the optimizer can look for ways to connect the car to an existing transit route, such as a bus, improving efficiency and sustainability (Bardaka, 2021).

Recommendations/Policy measures regarding app based micro-transit

- Create an information-centric government with an emphasis on open data and content. The data would be publicly available in device-agnostic ways for interoperability and transparency. Decoupling data from the Presentation opened up new possibilities for utilizing data across several devices.
- Create a centralized platform that multiple agencies can use. The General Services Administration (GSA) was tasked with creating a common site for sharing source code, solutions, and training across diverse technologies (the "create once, use many times" concept) (e.g., open content management systems, etc.). The process was aided by the federal Chief Information Officers Council (CIOC) and the Office of Management and Budget (OMB).
- When presenting statistics, keep the customer in mind. At least two existing priority customer-facing services were to be optimized for mobile, as well as high-value data and content from at least two existing critical customer-facing systems. The customer orientation included improving consumer-facing mobile services and introducing performance and customer satisfaction measuring tools.
- When implementing new technology, ensure that security and privacy are built in from the start. The government strategy considered the specific issues that the mobile environment presents.
  - The chance of misplacing a mobile device is increased.
  - The security of wireless communication is a concern.

- Bring your device (BYOD) may conflict with workplace security systems.
- The publicly available open data must also adhere to federal privacy rules (Sukumar, 2020).

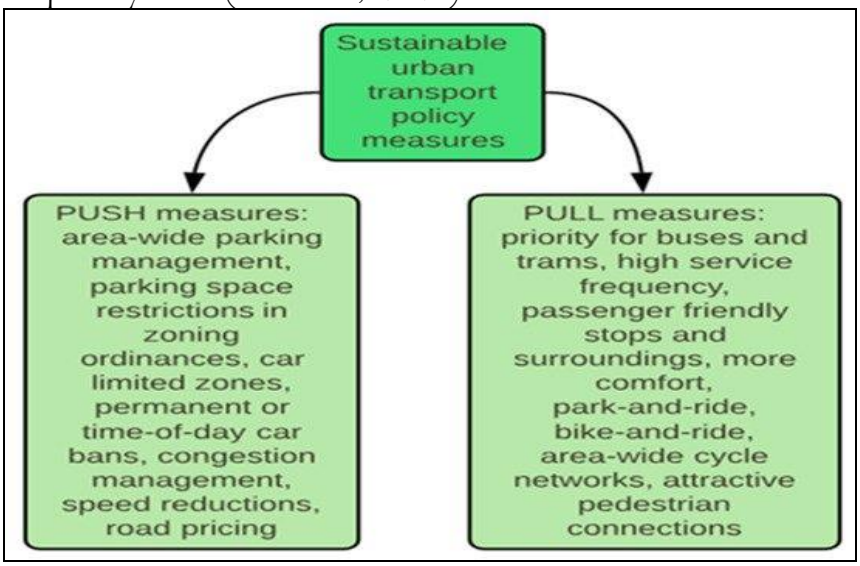

Figure 7: Sustainable policy measures for transit services

Source: transport geography and mobility

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