



Barriers to Using Shared Mobility Electric-Scooters in Dubai: The DEMATEL Approach

العوائق التي تمنع استخدام الدرجات الكهربائية في دبي

by

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Abstract

This study investigates barriers to the widespread adoption of shared mobility electric scooters (e-scooters) in Dubai. Using the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method, the research identifies key obstacles such as weather conditions, safety concerns, limited availability, and service coverage. Expert opinions validate the findings, emphasising the need to address these barriers to enhance e-scooter acceptance and usage in the city.

Keywords: electronic-scooter, barriers, shared mobility, DEMATEL

خلاصة

تبحث هذه الدراسة في العوائق التي تعيق الانتشار الواسع للدرجات الكهربائية المشتركة (الإسكوترات الكهربائية) في دبي. باستخدام طريقة مختبر اتخاذ القرار و التقييم، تحدد الدراسة العوائق الرئيسية مثل الظروف الجوية، والمخاوف الأمنية، والتوافر المحدود للدرجات الكهربائية، و تغطية الخدمة. تؤكد آراء الخبراء صحة النتائج مشددين على ضرورة معالجة هذه العوائق لتعزيز قبول واستخدام الإسكوترات الكهربائية في المدينة.

الكلمات الدالة: الإسكوترات الكهربائية, عوائق, التنقل المشترك

Dedication

I dedicate this thesis to my father, my unwavering beacon of support and my greatest cheerleader. Throughout my academic journey, you have been my number one fan, offering encouragement, guidance, and unwavering belief in my abilities. Your steadfast support has been the cornerstone of my achievements, and I am profoundly grateful for the sacrifices you have made to ensure my success. This dissertation stands as a testament to your enduring influence on my life, and I express my deepest gratitude for your unwavering belief in my potential. Thank you, Dad, for being my constant source of inspiration.

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Chapter 1: Introduction

1.1 Research Background

Shared mobility was described by researchers as a creative kind of transportation that allows users to have limited access to use the service for a short period to meet their needs. Also, having different types of shared mobility helps the users to select what type of service meets their demands. Shared mobility covers a diverse range of technologically advanced services and technologies that provide immediate access to new services and travel information, while also enhancing existing public transportation methods such as fixed-route transit. These services consist of ride-sharing, car-sharing, innovative variations of bike-sharing, technology-driven shared-ride services, unique private modes of transportation, and travel itinerary services that facilitate the choice of travel alternatives. Furthermore, these services are readily accessible to customers through a variety of electronic communication devices, including smartphones (Cohen, Shaheen, & American Planning Association, 2016).

The adoption of shared transport modes, sometimes referred to as "shared mobility", has experienced significant growth in recent years. Shared mobility allows users to use transportation modes for short periods when they need it (Ting et al., 2021). Furthermore, the transportation industry, particularly start-ups, is actively pursuing alternative and supplementary mobility solutions in urban areas in response to the growing demand for environmentally friendly transportation and improved accessibility (Machado et al., 2018). The development of shared mobility has presented new transportation choices for cities, including ride-hailing services (e.g., Uber or Lyft) and the utilisation of electric scooters (e-scooters) through sharing platforms. Simultaneously, traditional modes of shared transportation, such as bike-sharing and car-sharing, have experienced significant growth.

Typically, bicycles, electric scooters, vehicles, and rides are not directly shared among individuals but rather hired through private enterprises or cooperatives. Shared mobility can be facilitated either through a business-to-consumer (B2C) model or a peer-to-peer (P2P) model, often facilitated by companies (Mouratidis, 2022).

Shared mobility plays an important role in transforming any city to become more sustainable, and several studies have demonstrated that shared micro-mobility effectively decreases greenhouse gas (GHG) emissions by substituting personal car journeys. Research also suggests that shared micro-mobility can alleviate traffic congestion and decrease fuel use, resulting in reduced emissions and increased environmental awareness (Cohen, Shaheen, & American Planning Association, 2016). Ride-sharing is a transportation system that enables travellers to share a journey with someone who has similar travel plans to divide the expenses of petrol, tolls, and parking fees. It enables the practical utilisation of unoccupied seats and has the potential to decrease fuel consumption (Ting et al., 2021).

While e-scooters have been around for a while, renting them has only just become a possibility. Ever since the first shared e-scooter programmes were introduced in late 2017 in the United States, e-scooters have been a very popular form of transportation for people living in cities all around the world. By the end of 2019, shared electric scooter services were operational in about 300 urban areas. Several research investigations have indicated that the utilisation of shared e-scooters is more common in communities characterised by a large concentration of individuals with advanced levels of education. Prior research indicates that the primary reasons for utilising e-scooters are time efficiency, leisure, and financial benefits. However, the relative importance of these incentives differs among studies and appears to be contingent upon the specific circumstances (Mouratidis, 2022). E-scooters have gained

popularity due to their ease of use, flexibility, and enjoyable riding experience, effectively meeting the significant market demand–supply gap (Jiao & Bai, 2020).

1.2 Dubai Smart Mobility Initiatives and Its Sustainable Transportation Outcomes

The Roads and Transport Authority (RTA) of Dubai has launched the Dubai smart mobility initiatives, which aggressively encourages public transportation use while attempting to lessen dependency on vehicles. The autonomous metro system, advanced tram project, effective bus system, and creative water bus/taxi system are among the initiatives that the RTA has given priority to (Iyanna et al., 2019).

Dubai Metro & Tram: The Dubai Metro, one of the longest autonomous metro networks in the world, has significantly reduced the carbon footprint of the city by providing an effective and environmentally responsible alternative to traditional public transportation that works with electricity and is linked to different locations across Dubai. One of the characteristics of the tram and metro is its environmental friendliness that help reduce traffic (Kullīyāt al-Taqnīyah al-‘Ulyā, 2018).

Intelligent Traffic Management System: The real-time traffic management system is one of Dubai's main smart transportation efforts, implementing traffic systems that are based on current traffic conditions to reduce congestion and expedite travel times. After implementing Intelligent Traffic Systems (ITS) in November 2020, Dubai's Roads and Transport Authority (RTA) reduced travel times by 20%, shortened emergency response times by 30%, and enhanced incident monitoring by 63%. They do this by using an advanced traffic management system that is backed by Green IS technology and collects data from various sources, including GPS devices, cameras, and traffic sensors. This technology gives commuters and traffic controllers access to real-time information, enabling them to plan their journeys

effectively and make necessary adjustments to maintain the traffic flow (Kullīyāt al-Taqnīyah al-‘Ulyā, 2018).

Electric Vehicle Initiatives: Dubai is embracing green urbanisation and moving towards sustainability goals. The city has put in place a number of incentives to promote the usage of electric cars. The Roads and Transport Authority (RTA) and the Dubai Electricity and Water Authority (DEWA) collaborated to create this initiative. With these incentives, they hope to remove common obstacles to electric vehicle adoption and foster a supportive atmosphere for users. DEWA launched its free charging programme for registered electric vehicle users in 2017. Since then, the programme was expanded to include non-commercial customers until the end of 2021. Additionally, starting on the 1st of July, 2020, the RTA has strengthened this initiative by giving free parking badges and exempting Dubai-licensed electric vehicles from public parking costs for a period of two years. When taken as a whole, these programmes highlight Dubai's dedication to converting its transportation infrastructure into a more environmentally and energy-conscious model, mirroring a regional trend towards decarbonisation and technological innovation in mobility (Iyanna et al., 2019).

Smart Rental Bikes: As part of its urban mobility plan, Dubai has introduced the Smart Rental Bikes project. The objective is to enhance the city's connectedness and encourage eco-friendly choices. Through smartphone applications and interactive digital platforms, consumers can conveniently access, identify, and rent bicycles with this unique approach. Smart Rental Bikes lessen the dependency on conventional modes of transportation and ease traffic congestion by offering environmentally friendly mobility options. Moreover, by promoting a reduction in carbon emissions and an active and healthy lifestyle culture, this project is in line with Dubai's environmental goals. The launch of Smart Rental Bikes in Dubai

is evidence of the city's leadership in using technology to promote mobility and shows its dedication to developing flexible transportation systems that meet the demands of contemporary society (Iyanna et al., 2019).

Public Buses: The Dubai government always aims to strictly align the environment with all of its projects, so there is a constant update for public buses. Modern technologies are included in new buses to lower emissions and increase fuel efficiency (Kullīyāt al-Taqnīyah al-‘Ulyā (United Arab Emirates) & Institute of Electrical and Electronics Engineers, 2019).

U-Drive: U-drive is the leading car-sharing service in the Middle East that offers automobile rental on a per-minute basis (Kullīyāt al-Taqnīyah al-‘Ulyā (United Arab Emirates) & Institute of Electrical and Electronics Engineers, 2019).

S'hail consolidates all transportation services provided by the RTA, including Dubai Metro, Dubai Tram, and RTA taxis and buses into a single platform. Additionally, S'hail provides the ability to book taxis (Kullīyāt al-Taqnīyah al-‘Ulyā (United Arab Emirates) & Institute of Electrical and Electronics Engineers, 2019).

Water Taxis and Ferries: Dubai's water taxis and ferries offer a different mode of transportation that helps to lessen traffic while also providing beautiful and environmentally friendly travel options along the city's waterways (Kullīyāt al-Taqnīyah al-‘Ulyā (United Arab Emirates) & Institute of Electrical and Electronics Engineers, 2019).

1.3 The Importance of E-Scooters in Terms of Sustainability

Various concepts and beliefs, including traditional neighbourhood design (TND), smart growth, transit-oriented development (TOD), and new urbanism, are linked to sustainability in urban development. The improvement of active transportation for short journeys and public transit for longer trips is the common goal of all these proposals. The foundation of sustainable

urban development is encouraging people to walk, cycle, or take public transportation to important locations including employment centres, retail establishments, entertainment venues, and schools (Kheybari, Rezaie, & Farazmand, 2020). Furthermore, urban mobility is a major driver of the intelligent and sustainable development of cities, which translates into significant investments in transportation infrastructure to guarantee that residents have access to intelligent and reasonably priced modes of transportation. Technology has been essential in recent years in encouraging more environmentally friendly means of transportation (such as public transportation and active modes). This is because smart mobility seeks to provide a smooth, flexible, integrated, safe, on-demand, and convenient mobility experience. Flexibility (enabling users to select between multiple modes through intelligent and dynamic navigation), efficiency (providing efficient mobility options), integration (configuring end-to-end routes independent of modes of transportation), sustainability (promoting cleaner and sustainable operations), security and safety (efficient data sharing and connectivity models to ensure road safety), social benefits (offering equitable opportunities to use public transportation), automation (facilitating automation in all processes), accessibility (affordable for all), and user experience (efficient processes to ensure better experience) are some of the attributes associated with smart mobility (Dias, Arsenio, & Ribeiro, 2021).

Electric scooters, commonly used in scooter-sharing services, have emerged as the most readily available mode of electromobility for the typical consumer. Undoubtedly, the utilisation of electric scooters has a beneficial influence on urban transportation and the environment, thereby diminishing the quantity of internal combustion automobiles within cities. Electric scooters in urban mobility systems possess several benefits, including compact dimensions and lightweight design, enabling easy transportation and convenient usage for

activities such as shopping or commuting (Kubik, 2022). The primary benefits of these sorts of vehicles, particularly e-scooters, are evident in their attributes such as the dimensions, weight, speed, manoeuvrability, and adaptability. The above-mentioned attributes have allowed e-scooters to establish themselves as a viable option for transportation over short distances, particularly for the first and final segments of a journey. Using e-scooters is likely to result in a corresponding decrease in the use of cars for short distances. The use of e-scooters instead of cars leads to a significant enhancement of environmental and urban sustainability in cities. Due to the notable benefits of e-scooters compared to cars, such as their environmental friendliness (less noise and lower emissions), ability to save space, and particularly their capacity to alleviate congestion, there is an evident necessity and demand to allow e-scooters in urban areas as a sustainable means of transportation. One more benefit of e-scooters, in comparison to e-bikes, is their capacity for altering their dimensions. This feature allows for easy adjustment while embarking on public transportation and enables the implementation of multimodal journeys, in conjunction with any subsystem of public transportation (Glavić et al., 2021).

Micro-vehicles are frequently characterised as innovative, sustainable means of transportation that have little economic and environmental consequences. Significantly, they can aid in diminishing travel duration on congested roads, speed up short-distance trips, and do not necessitate the possession of a driving licence (Bozzi & Aguilera, 2021a).

Sanders, Branion-Calles, and Nelson (2020) illustrate that e-scooters are favoured for various reasons, notably their speed, convenience, capacity to substitute automobile journeys, and the enjoyment and relaxation they provide. The primary advantages of e-scooter usage among regular users include their superior speed compared to walking, convenience, potential

for enjoyment and relaxation, suitability for hot weather conditions, ability to reach destinations without the need for a car, cost-effectiveness, positive environmental impact, and enhanced user safety perception. When used as a method of transportation that connects the final mile of a journey, shared e-scooters that are both economical and easily available can greatly improve the overall experience of using several modes of transportation and encourage the usage of public transit. In addition, the integration of combined transportation and shared e-scooter usage enables individuals to expand their reach to a significantly larger geographical region compared to either mode individually. Consequently, this may lead certain travellers to relinquish driving for longer journeys (Yan et al., 2023).

1.3.1 Environmental Benefits

Since its start, e-scooters have experienced a significant decrease in their carbon footprint, with a notable 70% reduction in CO₂ emissions per kilometre since January 2019. Like other electric vehicles, such as cars and bicycles, e-scooters alleviate traffic congestion, produce no air pollutants, and operate quietly, so not contributing to noise pollution in urban areas. As an illustration, utilising an e-scooter results in the emission of approximately 64 to 237 grams of carbon dioxide (CO₂), which can be subsequently diminished by an additional 20 to 30% after two years. E-scooters offer a more ecologically sustainable alternative when compared to conventional cars, which release between 147 and 414 grams of CO₂. In general, the fundamental attributes of e-scooters categorise them as a sustainable means of transportation (Glavić et al., 2021).

1.3.2 Economic Benefits

An important benefit of this mode of transportation is the cost range of electric scooters, rendering them accessible to various economic brackets. In addition, the supplementary

upkeep incurs minimal expenses, particularly when considering the e-scooter's charging process, which can be carried out at any location that fulfils the fundamental criteria for charging mobile devices. This benefit, for instance, holds great importance when comparing it to electric vehicles, which typically necessitate a dedicated charging infrastructure (Glavić et al., 2021).

1.3.3 The Covid Dimension

The global dissemination of Covid-19 has profoundly transformed our previous lifestyles, job patterns, travel habits, and social conduct. The distinctiveness of this situation is seen in the full transformation of both the modal share and the safety of some modes of transportation. E-scooters offer an additional significant benefit, which is the ability to complete a journey while adhering to physical distancing measures (Glavić et al., 2021).

1.4 The Dubai Role in Adopting Sustainable Shared Mobility

Due to congested roadways and the fact that carbon emissions contribute to global warming, the government is looking for a sustainable replacement for the current transportation infrastructure that also uses new technologies to improve safety and air quality. Dubai is expected to rank as the #1 smartest city in the world, making it the happiest city overall. A significant step towards accomplishing these strategies' goals is smart mobility, which is quickly revolutionising urban transportation and altering how cities function (Iyanna et al., 2019).

As part of Dubai's broader plan for a smart and sustainable urban environment, electric scooters, or "e-scooters", have become essential to the city's efforts to meet its sustainability targets. The Roads and Transport Authority (RTA) of Dubai, in collaboration with the General HQ of Dubai Police, has officially commenced the utilisation of electric scooters on authorised

cycling routes in 10 districts of Dubai, effective on the 13th of April, 2022. This action is being implemented by Resolution Number 13 for 2022, which was approved by His Highness Sheikh Hamdan bin Mohammed bin Rashid Al Maktoum, Crown Prince of Dubai and Chairman of the Executive Council. The resolution aims to establish regulations for the utilisation of scooters in Dubai. It contributes to the initiatives aimed at transforming Dubai into a city that is accommodating to bicycles and marks the significant achievement of the e-scooter pilot programme that commenced in October 2020. The individual referred to as "His Excellency" Mattar Al Tayer, the Director-General and Chairman of the Board of Executive Directors of the Roads and Transport Authority (RTA), stated that the first stage will include the following areas: Sheikh Mohammed bin Rashid Boulevard, Jumeirah Lakes Towers, Dubai Internet City, Al Rigga, 2nd of December Street, The Palm Jumeirah, and City Walk. According to Al Tayer, the coverage includes safe roads and tracks in certain areas such as Al Qusais, Al Mankhool, and Al Karama. Additionally, there are 167 kilometres of dedicated tracks for bicycles and scooters across Dubai. The selection of these districts was based on specific criteria, such as high population density, designated areas for development, the proximity to public transportation and metro stations, the existence of integrated infrastructure, and locations with a strong emphasis on traffic safety. Only four companies, namely Tier, Lime, Arnab, and Skurt, are permitted to operate e-scooters inside the specified districts. Among these, two are international companies (Tier and Lime) while the other two are local companies (Arnab and Skurt). These companies must distribute a minimum of 2,000 e-scooters (Iyanna et al., 2019).

Dubai's sustainability plan includes lowering its carbon impact. Since they run entirely on electricity, e-scooters contribute to a reduction in the transportation sector's overall carbon

emissions. This is essential for a city trying to fight climate change and cut greenhouse gas emissions. Due to its rapid urbanisation and population increase, Dubai faces issues with traffic congestion. For short-distance transport, e-scooters provide a practical substitute that lessens the need for automobiles and eases traffic congestion. This can reduce the total load on the city's transportation system and result in a more effective utilisation of the current road infrastructure.

E-scooters can be a useful first- and last-mile option that enhances Dubai's bus, subway, and tram systems for public transit. E-scooters encourage more locals and visitors to use public transportation by offering a seamless connection, which lessens the reliance on private vehicles and promotes a more environmentally friendly form of transportation. Dubai has established itself as a frontrunner in smart city projects, utilising technology to raise the level of living in cities. With their use of cutting-edge technologies like GPS, the Internet of Things (IoT), and smartphone apps for convenient access and effective fleet management, e-scooters align with this ambition. This integration contributes to the overarching goal of building an intelligent and networked urban mobility ecosystem. When e-scooters are charged with green energy, the environmental advantages of investing in renewable energy sources, like solar electricity, are further enhanced. This helps the city achieve its overarching objective of raising the proportion of renewable energy in its total energy mix (Bozzi & Aguilera, 2021b).

Dubai is a city that is expanding rapidly on a worldwide scale, combining technical innovation, leadership, and rapid urbanisation. In light of this, Dubai has embraced both smart mobility and green information systems (Green IS) into multiple aspects of its urban development. In an effort to improve mobility and lower carbon emissions, the Road and Transport Authority (RTA) in Dubai has launched programmes that use Green IS. Green

infrastructure and mobility play a particularly important role for cities like Dubai, which are changing quickly and are under growing pressure to reduce the environmental effect of their transportation systems. Apart from Green IS, smart mobility technologies comprise many approaches meant to improve the effectiveness, security, and ecological sustainability of transportation systems. According to a report released by the Dubai Roads and Transport Authority, Dubai aims to set a new standard in mobility by providing sustainable and easy access to transportation for all of its citizens. In Dubai, combining Green IS with smart mobility offers a way to realise the city's sustainability goals. Green information systems (Green IS) can be used to manage traffic, reduce congestion, and reduce greenhouse gas emissions, as demonstrated by the deployment of ITS in Dubai. Green IS can also help with the creation of energy-charging systems for Dubai's growing taxi fleet. This supports the city's attempts to improve transportation and is consistent with its dedication to environmental sustainability (Şengül and Mostofi, 2021).

1.5 Problem Statement

Using shared mobility services like e-scooters has become a major trend in urban transportation around the world. Even though the benefits of shared mobility are clear, UAE people are still very hesitant to use these services (e-scooters). The goal of this study is to find out what stops a lot of people in Dubai from accepting and using the e-scooter as a shared mobility choice. Even though the shared mobility industry is growing quickly around the world, not enough is known about the unique problems Dubai people face when they try to use these services. This dissertation aims to research the barriers that prevent people who live in Dubai from using e-scooters.

1.6 Aims and Objective

This study aims to explore the obstacles preventing e-scooter shared mobility from becoming widely adopted in Dubai. This study intends to discover and analyse the linked elements impacting the adoption and usage of e-scooter services in the city through the use of the Decision-Making Trial and Evaluation Laboratory (DEMATEL) approach.

By investigating the causal linkages between these characteristics in an effort to identify the main obstacles people have when thinking about shared mobility choices for e-scooters, the ultimate goal is to offer experts in transportation service providers with useful information so they can make strategic choices that will advance and improve the shared mobility of e-scooters in Dubai.

Chapter 2: Literature Review

2.1 Definition of E-Scooters

Electric scooters, or e-scooters for short, are motorised personal vehicles having handlebars, a standing platform, and usually two tiny wheels. Designed for short-distance travel in cities, these lightweight and small vehicles provide an environmentally beneficial substitute for more conventional forms of transportation like cars or bicycles. They are frequently utilised for traveling, running errands, and fun activities. They are also being incorporated more and more into shared mobility networks, where users can rent them out via smartphone apps for brief periods (Mourad, Puchinger, & Chu, 2019).

2.2 Types of Shared Mobility

As mentioned, there are different types of shared mobility, for example, ride-sharing – the implementation of ride-sharing systems has great promise in reducing traffic congestion and mitigating CO₂ emissions. The original car-sharing system was established in Zurich, Switzerland, in 1948 to provide access to individuals who lacked the financial means or chose not to have a vehicle (Cohen, Shaheen, & American Planning Association, 2016).

Bike-sharing: The concept of commercial bike-sharing is straightforward, where individuals become members of a company that allows them to utilise shared bicycles, typically for little or even no expense, for short-term travels. This adaptable temporary usage programme offers additional travel options for both private vehicles and public transportation. When using a shared bicycle service, customers can often reserve, collect, and return the bike using only self-service options or a suitable smart device (such a phone or tablet). Bike-sharing could be a useful way to include first- and last-mile trips into transportation while also being environmentally friendly (Meng et al., 2018).

Bike-sharing is often regarded as the most ecologically conscious form of shared mobility, both by citizens and in general. Individuals who prioritise environmental issues highly appreciate the ecological advantages of bike-sharing. Studies conducted in Brazil and China have revealed that individuals who have environmental concerns tend to exhibit more inclination towards utilising bike-sharing services (Mouratidis, 2022).

Shared E-Scooter: Shared e-scooters are a recent addition to shared micro-mobility systems, offering rapid, convenient, and adaptable access to public transportation. They are primarily utilised for short-distance travel. The interest in comprehending the determinants that impact travel patterns and the utilisation of e-scooters is swiftly increasing (Hosseinzadeh, Karimpour, & Kluger, 2021).

2.3 Barriers of Using E-Bikes

The primary concern that was mentioned most often was safety. The increased pace of e-bikes heightens safety concerns, as a collision occurring at a higher speed is more likely to lead to a more severe injury due to falling or colliding. Attaining balance can be particularly difficult, especially when it comes to bicycles with only two wheels. Another issue expressed by e-bike users pertained to the assessment of their peers. Several studies have documented that participants in surveys or interviews expressed the belief that using electric assistance while cycling was perceived as dishonest, or not as proper riding standards by others. E-bike users reported instances of receiving hostile remarks, verbal disapproval, or mockery. The questionnaire and interview results consistently indicated the possibility of theft as a prominent worry. One primary reason for this fear was the idea that e-bikes, which are often pricier than regular bicycles, were more prone to theft or vandalism. E-bikes are significantly heavier than traditional bicycles due to the additional weight of electric motors and battery

packs. The limited dissemination of information regarding e-bikes is a significant obstacle to their broader adoption. When novel technology is introduced, individuals often exhibit resistance due to its unfamiliarity or perceived lack of validation. Electric bicycles often have a higher price point in comparison to traditional bicycles. Various studies have recognised the elevated price of e-bikes as a notable obstacle (Lee & Sener, 2023).

The system's usability was hindered by the substantial time and effort necessary for its operation, combined by the unavailability of the Bussines support system during nighttime hours. The primary obstacle that impacts both BSS and Electronic speech system is safety. Women, in particular, have expressed concerns about riding next to motorised vehicles and the risk of falling. These concerns, which include fears of collisions and loss of control, have been further amplified by the covid pandemic. As a result, the use of bike- and scooter-sharing systems may be influenced by additional motivations and barriers related to the fear and risk of infection (Filipe Teixeira et al., 2023).

A study about electric bikes in Oslo found that not enough bike lanes, safety concerns, and bad weather were big reasons why people did not ride bikes. The study also found that trip time and comfort were the most important factors in choosing the mode. E-scooter users said that a low chance of accidents, saving time on travel, and being able to choose how to travel were important for daily life – e-scooters meet the last two requirements. More than half of the accidents in this study happened without anyone else on the road being there. This shows how important it is to have good infrastructure. A study from Chicago looked at cities other than Oslo and found that e-scooters were a good alternative to cars for short trips up to 3 kilometres if parking was limited and other non-auto choices were just as good as driving. One study found that young tourists with more education are most likely to use shared mobility. Other

studies found that a person's willingness to use a shared bike relied on how many times they had used one before. If a person had used a shared bike before, they liked both the private bike and the shared bike a lot more. Another international study looked at people's willingness to walk and bike instead of taking the car for short trips. The Norwegian data showed that the ability to change the mode choice relied on the weather and people's walking and biking habits. Based on this and other research, it looks like the most important things that determine the willingness to use new forms of transportation are familiarity, experience, education, and age (Finsveen, Hoen, & Pitera, 2019).

2.4 Barriers of Using Public Transport

Regarding public transport (PT), it has been demonstrated that despite the gradual elimination of numerous physical impediments within fixed-route systems, there are still prevalent challenges that hinder general accessibility to PT systems. In addition to the inadequacy of public transportation routes in meeting the specific needs of persons with disabilities (such as not taking them to their desired destinations and having limited service coverage), there are physical obstacles that further hinder their mobility. These obstacles include inaccessible routes in the built environment, such as poorly maintained footpaths, as well as inaccessible stops and stations that lack level-entry boarding facilities. Furthermore, there is a failure to properly clear wheelchair securement zones, among other issues. Certain individuals with disabilities encounter attitudinal challenges from drivers, such as drivers neglecting to announce stops, as well as a lack of understanding. Additionally, some face difficulties with inaccessible communication, intricate routes, and schedules, or the inadequate presentation of information. The cumulative effect of several challenges, such as feelings of uneasiness and doubt stemming from past experiences or a lack of knowledge regarding the

use of public transport (PT), might potentially result in individuals with disabilities (PWD) avoiding the utilisation of PT (Neven & Ectors, 2023).

2.5 Barriers of Car-Sharing

Fixed-based car-sharing depends on public "investment" because it needs designated, easily accessible parking for shared cars, frequently on the street. The overall number of parking spots available for non-scheme members is decreased when parking spaces designated only for shared vehicles are dispersed throughout the city to give adequate coverage to the population. This may cause opposition from the local community. This requirement may be in place in neighbourhoods where parking spaces are scarce or may be granted as a privilege to the local population in another way (Somenahalli et al., 2019).

2.6 Mobility as a Service

Mobility as a service (MaaS), a concept that offers a unified platform for different modes of transportation, has gained significant popularity as a primary solution for addressing current traffic problems. This service offers a comprehensive platform that combines different modes of transportation, such as cars, buses, subways, and bicycles. It analyses the travel needs of individual users and provides tailored solutions by connecting the necessary means of transportation for their journey from the starting point to the destination. This approach encompasses a wide range of transportation options, including traditional vehicles and public transportation, as well as advanced forms of mobility such as self-driving cars, shared vehicles, and personal mobility devices. Numerous studies have confirmed the effectiveness of mobility as a service (MaaS) in meeting the needs of various users. These studies have also predicted that the MaaS market will grow in size due to its commercialisation (Ko et al., 2022).

The disadvantage that some countries will face if they decide to implement mobility as a service (MaaS) is that when planning the adoption of MaaS, financial means need to be found and financial capabilities should be evaluated. Some businesses do not want to take part in MaaS projects because they do not have the money to run them, even though they can help them make more money and gain market share. It is important for people to believe and want to use a MaaS system for it to work since a business cannot stay open without customers. To make it easier for people to use MaaS, laws, rules, and standards should support it. However, MaaS projects are slowed down in many countries because there are not enough rules about data security, open data standards, third-party ticket sales, or traffic funding. The TISM method is used to look at the things that are stopping the adoption and growth of the MaaS system. This method helped them figure out what the biggest problem is with adopting MaaS in Istanbul, so they can now focus on how to solve it (Kayikci & Kabadurmus, 2022).

Chapter 3: Methodology

3.1 DEMATEL

The Battelle Memorial Institute Geneva Research Center proposed the DEMATEL technique in 1972–1976 to identify the interdependencies and influence values between the relevant variables. According to a methodical approach, every factor is assigned to one of the influence values between the factors. The Decision-Making Trial and Evaluation Laboratory (DEMATEL) method is chosen to perform a thorough examination of the obstacles that prevent the widespread implementation of shared mobility. The research design involves conducting a comprehensive literature evaluation to provide a solid theoretical basis, while identifying variables that are in line with the study objectives. Data collection involves the incorporation of viewpoints from experts. The DEMATEL method is selected to confirm the existence of a relationship/interdependencies among components or reflect the relative level of relationship within them. The analysis seeks to establish cause-and-effect correlations, offering insights into significant obstacles, their interconnections, and the overall effects on the adoption of shared mobility. Below are all the identified barriers that are related to the adoption of e-scooters, and I performed a comprehensive literature analysis using databases like Google Scholar and the BUiD library resources to find relevant studies examining factors influencing the use of e-scooters.

3.2 Barriers to Using E-Scooters

There are many reasons why electric scooter-sharing systems (ESSs) are popular. They are seen as possible solutions to many environmental problems caused by traffic, such as noise and air pollution. They also have many benefits, such as being easy to use, accessible, and affordable. They do not need as much parking or movement space as shared bikes, and they

can make it easier to get to transit stops and parking lots. Because of this, a problem at any of these levels can make it hard to use a certain mode of transportation. For example, users' worries about safety and the careless way e-scooters interact with other cars and people walking around cities because of poor micro-mobility infrastructure are examples of macro-level barriers that make it harder to use e-scooters. There is a conceptual model in this study that is built on the extended technology acceptance model (TAM3). More factors have been added to this model as new theories to help build the theoretical model and see how these factors affect people's plans to use e-scooters. The results of the Author study showed that the developed model was consistent and made sense, which showed that it was reliable. The findings indicate that eleven significant elements strongly influence individuals' intentions to utilise e-scooters. These factors include perceived value, trust, subjective standard, individual creativity, reliability, mentality, perceived simplicity of use, privacy concerns, awareness of the environment, and perceived enjoyment. To get more people to use e-scooters in cities, these results help make practical suggestions for transportation planners, lawmakers, and e-scooter operators. The most important policies to bring attention to e-scooters are including them in MaaS plans, making sure they are accessible, making sure that media ads show ESSs correctly and their benefits, and running the right marketing campaigns to show that e-scooters are a green way to get around. Because micro-mobility is such an important part of sustainable development, these rules will make people more likely to use e-scooters, which will help make cities better and more environmentally friendly (Samadzad et al., 2023; Zhang & Kamargianni, 2023).

3.3 Weather

Research conducted in Indianapolis, Indiana, revealed that the number of e-scooter trips decreased by 80% during the winter season. The researcher (Hosseinzadeh, Karimpour, & Kluger, 2021) also conducted a comparative analysis of the temporal patterns of shared e-scooter excursions in Minneapolis, Minnesota, and Austin, Texas State. The study examined the usage patterns of e-scooters in these cities and found that the number of trips on e-scooters is highest during afternoons and weekends in Austin and evenings in Minneapolis. The study also investigated the influence of weather-related factors on the usage of shared e-scooters using a statistical method called ordinary least squares. The findings revealed a significant correlation between rain and snow and a decrease in the number of trips. However, wind speed and average temperature did not have a significant impact on the number of trips. Nevertheless, elevated temperatures were correlated with increased distances and accelerated speeds (Hosseinzadeh, Karimpour, & Kluger, 2021). Sanders, Branion-Calles, and Nelson (2020) claimed that it can be too hot to ride an e-scooter so using alternative mobility is better than using an e-scooter. The UAE's summers can be unbearably hot, which deters some people from using bicycles or walking. Temperature and air quality are significant aspects that influence an individual's willingness to utilise shared mobility. Factors such as precipitation, wind, heat, and poor air quality limit the broader acceptance of shared e-scooters (Bozzi & Aguilera, 2021).

3.4 Physical Injuries

A substantial body of scholarly work examines the incidence of physical injuries associated with the utilisation of e-scooters, particularly in the United States, Australia, and New Zealand. Various articles emphasise a significant surge in e-scooter injuries following the

implementation of shared programmes. The primary cause of these injuries is typically attributed to a lack of balance or falling (Bozzi & Aguilera, 2021).

Safety-related barriers were chosen with similar frequency by both groups, while the specific barriers varied based on experience. Non-riders exhibited a significantly higher likelihood of expressing concerns about feeling shaky or falling and lacking control. On the other hand, previous and occasional riders were significantly more likely to mention the insufficient availability of safe riding locations. A survey revealed that more than 40% of individuals who do not use e-scooters, almost 50% of individuals who have ridden e-scooters in the past or occasionally, and 35% of individuals who ride e-scooters regularly expressed concerns about the possibility of colliding with someone or being struck by someone when riding an e-scooter (Sanders, Branion-Calles, & Nelson, 2020). The primary obstacles to the utilisation of e-scooters pertain to apprehensions regarding safety (such as the risk of colliding with or being struck by others, inadequate availability of secure riding areas, and concerns about instability or potential falls).

3.5 The Challenges of Storage and Passenger Transport

Practicality-related hindrances are an issue for e-scooters (such as the absence of storage capacity for luggage or accommodating passengers, and impracticality for longer journeys). Younger individuals who do not ride e-scooters were notably more inclined to choose obstacles associated with practicality, such as the incapacity to carry heavy loads or transport people, and the impracticality of e-scooters for extended distances (Sanders, Branion-Calles, & Nelson, 2020).

3.6 Safety Measures

The apprehensions regarding the safety of e-scooters, including both riders and pedestrians, can provide a substantial obstacle. The presence of accidents, absence of helmets, and insufficiency of safety measures may discourage individuals from utilising e-scooters. (Bartkowiak et al., 2021; Bozzi & Aguilera, 2021).

3.7 Physical Activity

The idea that e-scooters are a simple, low-effort form of transportation is promoted by rental companies. Nevertheless, riding e-scooters is unlikely to provide any significant fitness advantages. Consequently, the usage of e-scooters may have adverse effects on physical activity, particularly if they replace walking and cycling (Bozzi & Aguilera, 2021).

3.8 Lack of Connectivity

Residents in places with established public transit networks may encounter challenges in utilising these services for their whole journey due to the restricted connectivity and coverage. The absence of designated e-scooter lanes or enough infrastructure for secure e-scooter usage can pose a hindrance. Inadequate amenities may prompt a sense of insecurity or cause users to encounter inconvenience when utilising e-scooters. Lack of widespread availability and accessibility of e-scooters in all regions of Dubai may deter prospective users from integrating them into their daily transportation routine (Ma et al., 2019). As a result of the insufficient allocation of road space specifically for e-scooters, riders frequently resort to utilising sidewalks or bicycle lanes for riding and parking, causing disruptions to the flow of other modes of transportation (Jiao & Bai, 2020).

3.9 Long Travel Distance

Due to the excessive population in numerous places in the UAE, people often encounter challenges in depending on communal transportation, particularly while commuting for job purposes. Individuals who have a considerable distance to travel and anticipate that using an e-scooter will cause them to be delayed may be dissuaded from utilising it (Ma et al., 2019).

3.10 Limited Knowledge

Certain individuals may lack awareness regarding the presence of e-scooter services, as well as the proper use and advantages associated with them. The absence of knowledge may hinder the acceptance of this method of transportation (Amin, Amin, & Cho, 2023).

3.11 Cultural and Social Pressure

If shared mobility choices are viewed as lacking in prestige or causing inconvenience, cultural norms and societal pressures may discourage individuals from utilising them. The acceptance and adoption of new means of transportation can be influenced by cultural attitudes. Should there exist a social stigma or a lack of acceptance towards e-scooters, individuals can display reluctance in utilising them (Amin, Amin, & Cho, 2023).

3.12 Governance and Policy

Both Australia and India face similar challenges when trying to adopt shared mobility, and Rajak, Parthiban, and Dhanalakshmi (2021) mentioned that the absence of effective governance and policy in India poses a significant obstacle to implementation. One of the barriers that India faces is related to how difficult it is to change government policies and consumption patterns and move towards more greening of transportation. Rajak, Parthiban, and Dhanalakshmi (2021) used DEMATEL methodologies to understand the cause-and-effect relation among the barriers that have been identified to adopt a sustainable transportation

system from the perspective of the supply chain. Meanwhile, Jie et al. (2021) highlighted the same barriers that India faced when trying to understand why the government of Australia rejected ride sources in most states; they discovered there are a lot of regulations that affect the adoption of ride-sourcing, that it is expensive for drivers to start this form of business, and there were a lot of suggestions that the government should issue broader rules that will support innovation.

A lot of different shared transport services, like Uber, started to come out to compete. As a result of these changes in South Korea, shared transport services based on Artificial intelligence like "TADA" and "Kakao Taxi" have sprung up. Individuals thought that these new mobility services would help make traveling easier and more efficient for everyone. In Korea, the fourth industrial revolution and new information and communications technology (ICT) are happening quickly. However, shared mobility services like TADA have been legally problematic. Mobility service providers are also having a hard time starting their services because the taxi industry is strongly against them. Because of this, the conflicting goals of the taxi business and the ride-hailing companies have turned into a social issue. Korean law doesn't allow new transportation services like TADA. These services fail to be innovative because they cause problems with the car industry, which worries about job security, lack of laws, and social awareness. This study applied the text mining method to online news big data to confirm the existence of diffusion barriers to shared mobility services (Kim, Lee, & Son, 2021).

Regulation in numerous nations currently serves as a challenge to innovation and transformation in the transportation industry, particularly about legislation governing the taxi

market and the allocation of ticket-selling rights for public transit (Lund, Kerttu, & Koglin, 2017).

3.13 Independence

Jie et al. (2021) mentioned that the desire to be independent and have their own space gets in the way of why people won't use e-scooters-sharing as an option. The researcher employed factorial analysis (Exploratory factor analysis) to discover a reduced set of variables and investigate the underlying theoretical structure of components that influence shared mobility. Additionally, binary logistic regression was utilised to forecast whether participants would or would not engage in shared mobility ride sources.

Long-held beliefs and values, such as the need to stay independent, the importance of maintaining private space, and the sense of status that comes with owning a private car, also make it hard for transportation sharing to grow. Real-time car-pooling programmes have failed many times, even though there is a big market for them. One main reason given is that there are not enough people. Also Standing, Standing, and Biermann (2019) say that dynamic car-pooling needs some committed drivers to make up for demand that is not met. With dedicated drivers, you can be sure of a good level of service during busy and slow times.

While shared mobility has a lot of benefits such as a decrease in congestion and pollution levels and saving transportation costs, it also has a lot of challenges. Sovacool and Griffiths (2020) identified three major challenges: number one is designing both the interior and exterior of any shared mobility, the second challenge is it is not easy to arrange proper transportation, and the last and most important thing is building trust among the users in using shared mobility.

3.14 Low Income and Living in a Poor Area

Most public efforts to encourage shared movement fail because people tend to act in their own best interests, which hurts society and the environment. In general, people need a smartphone with Internet access and a legal credit card to use shared mobility services (e-scooters). This is another important issue that needs to be dealt with. Some people with low incomes might be left out because they cannot afford this. Also, people who live in areas on the edges of cities have a hard time using shared mobility services because most of them are only available in central areas. To ensure the effectiveness of a shared mobility plan, the service must be both inclusive, meaning it allows individuals from every income level to utilise it, and accessible, enabling individuals of all abilities to make use of it. Safe guarantees the security and well-being of the population. An innovative transportation service that embraces supports, and encourages the adoption of new and disruptive technologies, while also being sustainable by minimising negative environmental effects, as well as being effective in terms of time and cost of travel, poses a significant challenge. This necessitates the establishment of a dynamic and adaptable regulatory structure that can effectively respond to ever-evolving technological advancements (Machado et al., 2018).

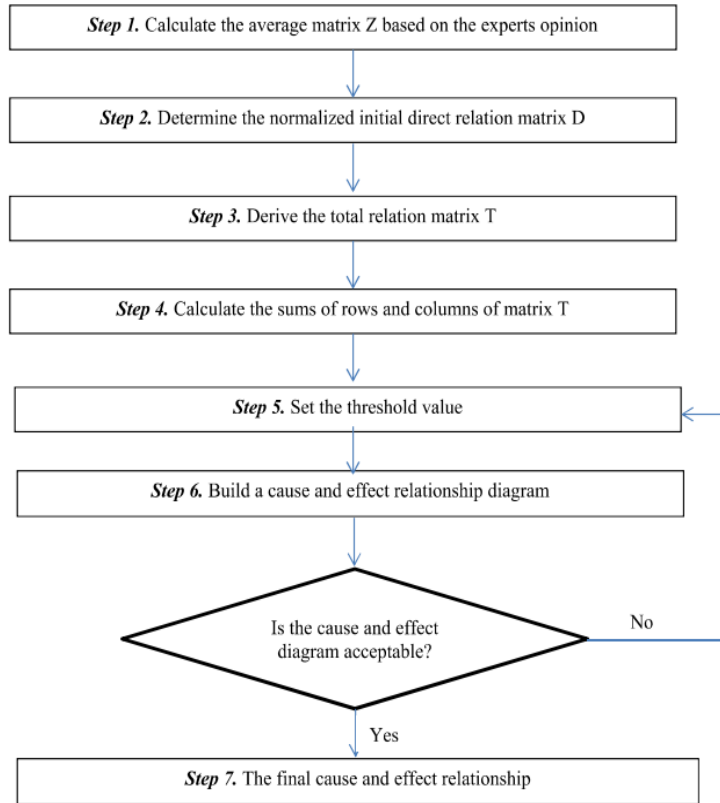
Table 1*Summary of the List of Barriers for Using E-Scooters in Dubai*

Objective	Key Findings	Reference
A review of the factors influencing the adoption of new mobility technologies and services	Weather barrier • E-scooter trips decreased by 80% during the winter season • The UAE's summers can be unbearably hot, which deters some people from using bicycles or walking	(Zhang & Kamargianni, 2023)
Shared e-scooters: A review of uses, health, and environmental impacts, and the policy implications of a new micro-mobility service	Injuries • Physical injuries associated with the utilisation of e-scooters • Feeling shaky or falling and lacking control • The insufficient availability of safe riding locations • The possibility of colliding with someone or being struck by someone when riding an e-scooter	(Bozzi & Aguilera, 2021a) (Sanders, Branion-Calles, & Nelson, 2020)
To scoot or not to scoot: Findings from a recent survey about the benefits and barriers of using e-scooters for riders and non-riders	No space available • The absence of storage capacity for luggage or accommodating passengers, and impracticality for longer journeys	(Bartkowiak et al., 2021)
Shared e-scooters: A review of the uses, health, and environmental impacts, and the policy implications of a new micro-mobility service	Physical activity • Riding e-scooters is unlikely to provide any significant fitness advantages	(Bozzi & Aguilera, 2021a)
Multi-stakeholder's assessment of bike-sharing	Lack of connectivity	(Ma et al., 2019)

service quality based on the DEMATEL–VIKOR method	- Challenges in utilising these services for their whole journey due to the restricted connectivity and coverage - The absence of designated e-scooter lanes or enough infrastructure for secure e-scooter usage can pose a hindrance - Lack of widespread availability and accessibility of e-scooters in all regions of Dubai may deter prospective users from integrating them into their daily transportation routine	
Multi-stakeholders' assessment of bike-sharing service quality based on the DEMATEL–VIKOR method	Long travel distances	(Ma et al., 2019)
An application to predict the range of electric two-wheelers using machine learning techniques	Limited knowledge The absence of knowledge may hinder the acceptance of this method of transportation	(Amin, Amin, & Cho, 2023)
An application to predict the range of electric two-wheelers using machine learning techniques	Cultural and social pressures The acceptance and adoption of new means of transportation can be influenced by cultural attitudes	(Amin, Amin, & Cho, 2023)

3.15 Research Design

The research and design process is shown in Figure 1. After collecting the questionnaires, this study used the Microsoft Excel software to process the data. To maintain confidentiality and privacy, it has been decided not to mention any individual or company names in the final report.

Figure 1*DEMATEL Methodology Summary*

The DEMATEL process consists of the following steps:

Step 1: A total of 10 experts were contacted to answer the DEMATEL questionnaire; based on their experience, they evaluated the cause-and-effect relationship between the identified barriers by using the DEMATEL Scale (0: No influence, 1: Very low influence, 2: Low influence, 3: High influence, 4: Very high influence).

Sample Questioner:

	A	B	C
A	0		
B		0	
C			0

- The influence of a particular criteria over itself is zero
- Experts to fill the cells by evaluating the influence of the row over the column
- After gathering the data from the experts, we will combine them in one table by calculating the average value
- The initial relation matrix (Z) is prepared factors in the matrix that are referred to as " m_{ij} " where:
 - m_{ij} refers to the degree of influence of "i" on "j"
 - (i refers to rows)
 - (j refers to columns)

Sample Z-Matrix

i \ j	A	B	C
A	0	Z_{AB}	Z_{AC}
B	Z_{BA}	0	Z_{BC}
C	Z_{CA}	Z_{CB}	0

Step 2: Normalised initial direct matrix D is constructed by $D = A \times S$:

$$\text{Where } S = \min\left(\frac{1}{\max \sum_{i=1}^n a_{ij}}, \frac{1}{\max \sum_{j=1}^n a_{ij}}\right)$$

Every element in matrix D lies between 0 and 1.

Sample D-Matrix

i \ j	A	B	C
A	0	D _{AB}	D _{AC}
B	D _{BA}	0	D _{BC}
C	D _{CA}	D _{CB}	0

Step 3: The total relation matrix T is generated by $T = (I - D)^{-1}$:

- Where the I is identity matrix
- Calculating the T matrix required the use of 2 matrix formulas in Microsoft Excel
- MINVERS to find the inverse of a matrix
- MMULT to multiply the matrices

Step 4 : After finding the T matrix, calculate the sums of row and columns for matrix T.

The prominence and relation are calculated for each criterion:

$$R_i = \sum_{j=1}^n t_{ij}$$

$$C_j = \sum_{i=1}^n t_{ij}$$

$R_i + C_j$ is called the "Prominence" and $R_i - C_j$ is called the "Relation".

Sample T Matrix with D and R

i \ j	A	B	C	D
A	0	t _{AB}	t _{AC}	D _A
B	t _{BA}	0	t _{BC}	D _B
C	t _{CA}	t _{CB}	0	D _C
R	R _A	R _B	R _C	

Step 5: *Casual* diagram to be prepared by calculating the following:

- **D+R:** Will refer to the influence of the horizontal axis, and will indicate the influence between different factors

- **D-R:** Will refer to the influence of the vertical axis, and will indicate the relationship of different factors
- Positive values mean "Cause"
- Negative values mean "Effect"

Sample Casual Diagram Table 2 and Plot Figure 2

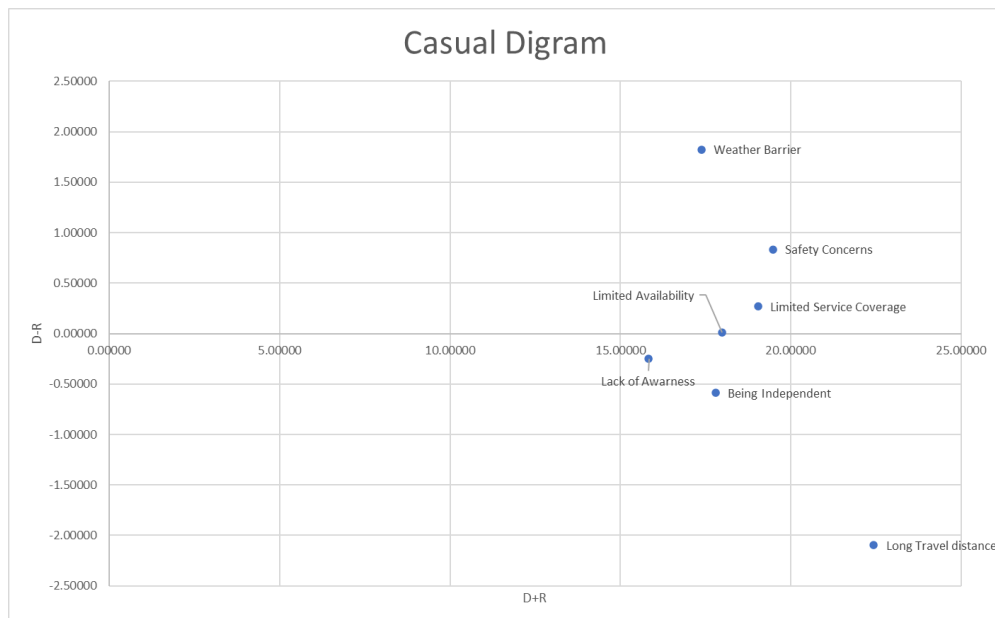
Table 2

Sample DEMATEL Table

Ri	Ci	Ri+Ci	Ri-Ci	Identify
9.60121	7.77735	17.37856	1.82386	Cause
10.15997	9.32735	19.48732	0.83262	Cause
8.99685	8.98674	17.98359	0.01011	Cause
7.79210	8.04429	15.83639	-0.25219	Effect
10.17074	12.26877	22.43950	-2.09803	Effect
8.60491	9.19118	17.79609	-0.58628	Effect
9.66036	9.39044	19.05080	0.26991	Cause

Figure 2

Casual Relation Diagram of the Barriers of E-Scooter Key Indicators



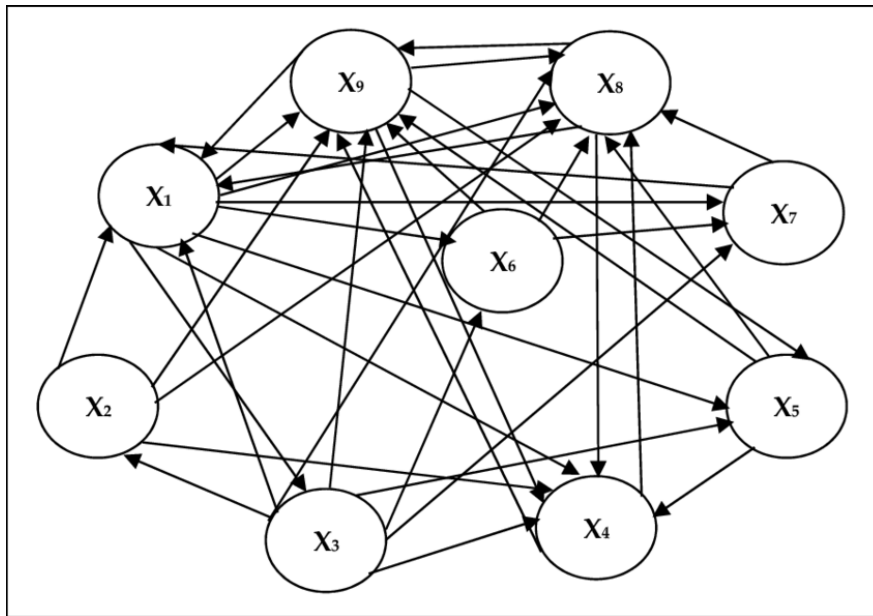
Step 6: Prepare the impact relationship diagram between the different factors by calculating the following:

- Threshold value $\alpha = \text{average } t_{ij}$
- Any t value that is above the threshold values means that there is an impact of "i" on "j"

A sample impact relationship diagram can be seen in Figure 3.

Figure 3

Sample Impact Relationship Diagram



3.16 Data Collection

The aim of this study was to determine and examine the obstacles to shared mobility in Dubai. Email questionnaires were used for data gathering because of the experts' hectic schedules. This approach was used to guarantee thorough feedback from a variety of specialists who might not be able to attend in-person discussions. The present study utilises a quantitative methodology, drawing on the perspectives of experts to verify and elaborate on

the obstacles to shared mobility that were found in previous research studies. The email survey approach was used to enable experts from many sectors and organisations to participate. Email surveys were selected because of their adaptability and capacity to reach a large number of people without being limited by schedule difficulties. With this approach, specialists can answer whenever it is not convenient for them, guaranteeing careful and comprehensive input.

3.17 Sample of the Study

Experts in shared mobility, such as specialists, engineers, and Dubai policymakers, made up the target population. Those with substantial expertise and experience in shared mobility systems and urban transportation in Dubai were chosen using a purposive sample technique. Ten specialists in all were asked to take part in the process of identifying the barriers and assigning a DEMATEL scale rating to them. This sample size was considered enough to provide manageability in data processing while obtaining a variety of insights.

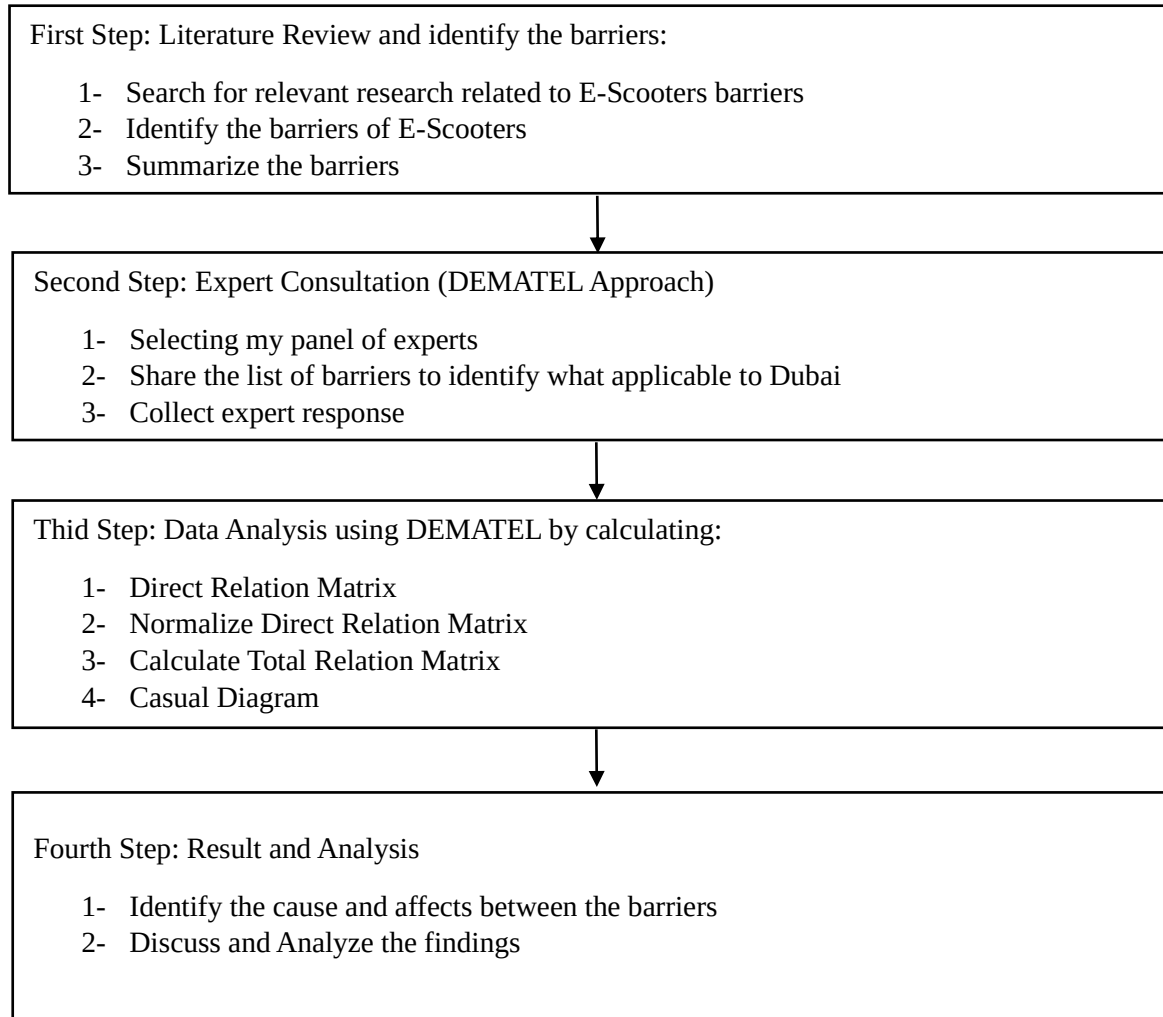
3.18 Data Analysis

This study's main goal was to determine and examine the obstacles to shared mobility in Dubai, using the knowledge of experts to confirm and elaborate on obstacles found in the literature review. This goal was accomplished by utilising an organised strategy that combined data analysis with the DEMATEL method. Using matrices and diagrams, the DEMATEL technique provides a thorough and organised means of illustrating the structure of complex causal relationships. It aids in determining the cause-and-effect connections between variables and in measuring their strength. This approach is especially helpful in domains like transportation, where it is necessary to examine a variety of interconnected barriers.

Chapter 4: Data Analysis and Result Discussion

4.1 Introduction

This study explores the obstacles to e-scooter adoption in Dubai using a thorough methodology that incorporates knowledge from previous research and expert discussions. A comprehensive literature analysis was performed using databases like Google Scholar and the BUiD library resources to find relevant studies examining factors influencing the use of e-scooters. The important variables and components were then identified to give a basic grasp of the complexity related to the adoption of e-scooters. Furthermore, acknowledging the need for local context and knowledge, experts from many transportation-related fields in Dubai were contacted. To reduce the obstacles particular to Dubai's distinct socioeconomic and infrastructure environment by consulting with specialists from governmental organisations and transportation agencies.

Figure 4*Summary of the Steps Taken for the Methodology***4.2 Discussion and Analysis**

Ten experts were invited to participate in this study in order to further our understanding and validate our findings. They provided evaluations and perspectives on the barriers that had been discovered by narrowing down these barriers. After gathering all their responses 2 tables was created, one with all the agreed barriers, and the second table with the barriers that not all the experts agreed on. the second table were shared with the experts and asked them to select

from the barriers; after getting their response, they all agreed to 7 barriers that are applicable to Dubai out of the 15 barriers that were shared with the experts (kindly refer to the Appendix A). The goal was to collect data from a variety of experts with various backgrounds and expertise, including chief engineers, operation engineers, senior engineers, and Emirates Transport planning engineers, etc. This made it possible for us to compile the viewpoints and opinions of various individuals with different experiences and priorities.

Table 3

Background of the Respondents

Job designation	<i>Years of experience</i>
Operation Engineer	3
ET Planning Engineer	6
Senior Engineer	3
Specialist	8
Analyst	5
Electrical Engineer	4
Civil Engineer	2
Officer	15+
Senior Inspector	10
Chief Engineer	10

Table 4*Summary List of Barriers*

List of barriers chosen by the experts	
1	Weather
2	Safety Concerns
3	Limited Availability
4	Lack of Awareness
5	Long Travel Distance
6	Being Independent
7	Limited Service Coverage

The list of barriers were put in a table and sent to the experts, and the participants were asked to rate the impact/influence of each barrier based on the Decision making trial and evaluation laboratory scale below in Table 5, where 0 represents no influence and 4 represents very high influence. The table that was shared with the experts is available in Appendix A.

Table 5*DEMATEL Scale*

Numeric Value	Definition
0	No influence
1	Very low influence
2	Low influence
3	High influence
4	Very high influence

After gathering the data, Microsoft Excel was used to analyse the data. Because we had 10 answers from each expert, the average value was calculated to combine them in one table; then, we calculated the Z-Matrix, D-Matrix, and T-Matrix:

Table 6

Z-Matrix

0.00	2.56	1.67	1.67	2.89	2.00	1.67
2.56	0.00	1.89	2.00	2.89	1.78	2.22
1.78	1.67	0.00	1.56	2.89	1.44	2.22
1.22	1.56	1.22	0.00	2.11	2.67	1.22
2.00	2.33	2.33	2.00	0.00	2.22	2.56
1.33	1.33	1.78	1.89	2.67	0.00	2.11
0.89	2.67	2.56	1.11	3.33	1.89	0.00

Table 7

Normalised direct relation matrix (D-Matrix)

0	0.190083	0.123967	0.123967	0.214876	0.14876	0.123967
0.190083	0	0.140496	0.14876	0.214876	0.132231	0.165289
0.132231	0.123967	0	0.115702	0.214876	0.107438	0.165289
0.090909	0.115702	0.090909	0	0.157025	0.198347	0.090909
0.14876	0.173554	0.173554	0.14876	0	0.165289	0.190083
0.099174	0.099174	0.132231	0.140496	0.198347	0	0.157025
0.066116	0.198347	0.190083	0.082645	0.247934	0.140496	0

Table 8

Total Relation Matrix (T-Matrix)

1.056171	1.423681	1.327386	1.200739	1.836833	1.372893	1.383506
1.275629	1.338304	1.410907	1.281153	1.933827	1.433209	1.486945
1.103236	1.296223	1.142639	1.123161	1.733816	1.262655	1.335114
0.937435	1.124176	1.070429	0.885266	1.479641	1.1785	1.116651
1.243454	1.485088	1.437314	1.281151	1.759073	1.457659	1.506998
1.031998	1.222672	1.208556	1.0981	1.652475	1.115237	1.275868
1.129428	1.437204	1.38951	1.174721	1.873099	1.371033	1.28536

The D values (sum of rows) and R values (sum of columns) were then calculated:

Table 9

Sum of Rows and Columns

D	R
9.601209422	7.777352
10.15997295	9.327349
8.996845935	8.986741
7.792098352	8.044292
10.17073599	12.26877
8.604907496	9.191185
9.660355151	9.390441

After calculating the D and R Values, the influence (D+R) and relationship (D-R) values were calculated to find the casual diagram.

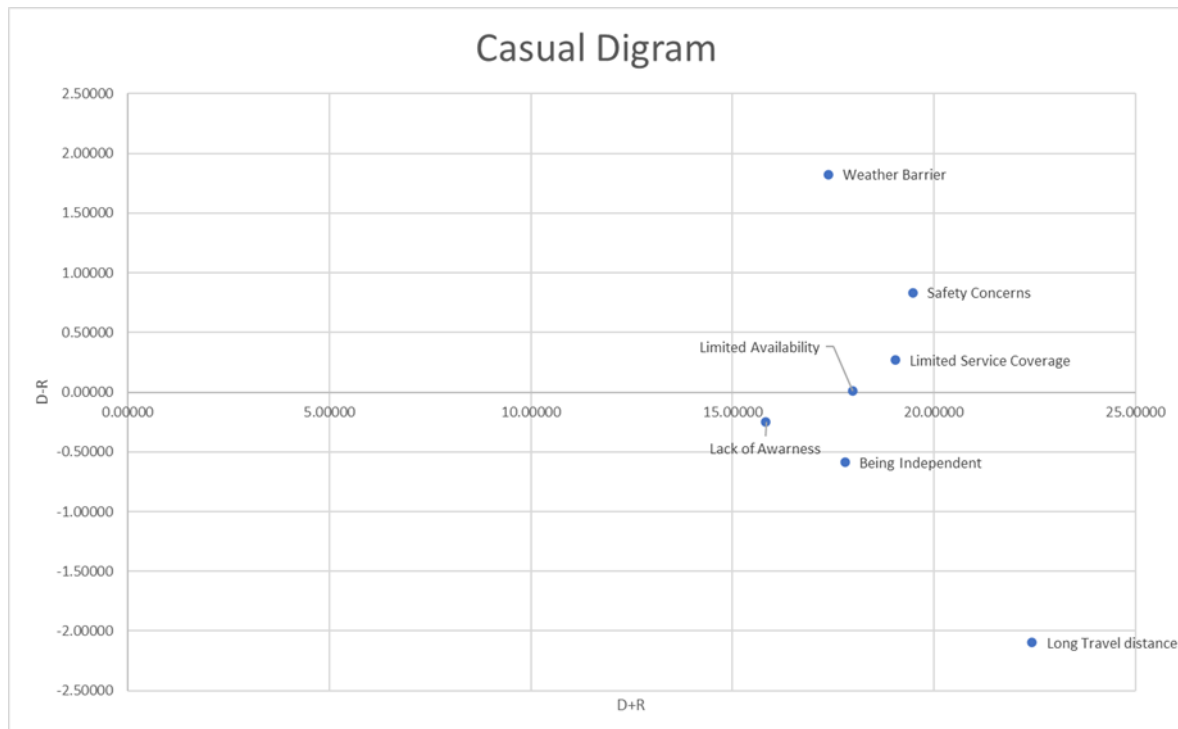
Table 10

Summary of the Influence & Relationship Values

Barriers	Ri	Ci	Ri+Ci	Ri-Ci	Identify
Weather Barrier	9.60121	7.77735	17.37856	1.82386	Cause
Safety Concerns	10.15997	9.32735	19.48732	0.83262	Cause
Limited Availability	8.99685	8.98674	17.98359	0.01011	Cause
Lack of Awareness	7.79210	8.04429	15.83639	-0.25219	Effect
Long Travel Distance	10.17074	12.26877	22.43950	-2.09803	Effect
Being Independent	8.60491	9.19118	17.79609	-0.58628	Effect
Limited Service Coverage	9.66036	9.39044	19.05080	0.26991	Cause

Figure 5

Causal Diagram

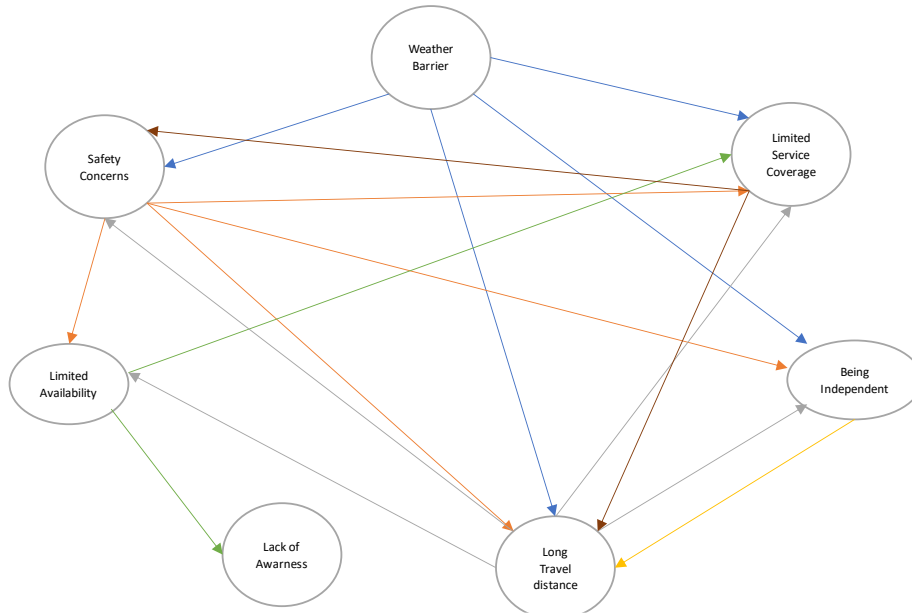


The threshold values were calculated and the result were summarised, as shown in Table 8. The threshold value was **1.326247**. The impact relationship diagram was drawn to provide a graphical representation in Figure 5.

Table 11

Threshold Value

	<i>Weather Barrier</i>	<i>Safety Concerns</i>	<i>Limited Availability</i>	<i>Lack of Awareness</i>	<i>Long Travel Distance</i>	<i>Being Independent</i>	<i>Limited Service Coverage</i>
<i>Weather Barrier</i>	1.056171	1.423681	1.327386	1.200739	1.836833	1.372893	1.383506
<i>Safety Concerns</i>	1.275629	1.338304	1.410907	1.281153	1.933827	1.433209	1.486945
<i>Limited Availability</i>	1.103236	1.296223	1.142639	1.123161	1.733816	1.262655	1.335114
<i>Lack of Awareness</i>	0.937435	1.124176	1.070429	0.885266	1.479641	1.1785	1.116651
<i>Long Travel Distance</i>	1.243454	1.485088	1.437314	1.281151	1.759073	1.457659	1.506998
<i>Being Independent</i>	1.031998	1.222672	1.208556	1.0981	1.652475	1.115237	1.275868
<i>Limited Service Coverage</i>	1.129428	1.437204	1.38951	1.174721	1.873099	1.371033	1.28536

Figure 6*Impact Relationship Diagram***4.3 Findings and Result**

The study successfully identified several key barriers, namely weather barriers, safety concerns, limited availability, lack of awareness, long travel distances, desire for independence, and limited service coverage. The DEMATEL analysis offered an in-depth understanding of the causal connections between these obstacles, emphasising the most important variables and their interactions. According to the DEMATEL analysis, weather barriers have a major causal relationship with several other barriers, such as limited service coverage, safety concerns, and long travel distances. The severe weather in Dubai, especially the heat and sandstorms, presents significant obstacles to shared transportation. These circumstances may worsen the discomfort of large travel distances, and decrease service availability and dependability. Another important causal indicator that surfaced was safety

concerns, which had a substantial impact on long travel distances, the desire for independence, and the availability of limited service. User trust and inclination to use shared mobility services are significantly influenced by safety. One major obstacle that was found to be affecting the utilisation of e-scooters in particular was the need for independence. The preference of many consumers for the independence offered by private automobiles influences their inclination to embrace shared mobility options such as e-scooters, which are viewed as less personal and more social. It can be helpful to change preferences to implement incentive programmes like discounts, loyalty plans, or special treatment for shared mobility users in order to encourage the use of shared mobility.

Chapter 5: Conclusion

In summary, this study has examined the obstacles preventing e-scooters from being widely adopted in Dubai. Through a comprehensive review of the literature and empirical research utilising the DEMATEL approach, we have effectively determined and evaluated the principal obstacles relevant to the Dubai setting. Policymakers, urban planners, and other stakeholders involved in the deployment and control of e-scooter systems can benefit greatly from the insights provided by this study. Decision-makers can effectively prioritise their efforts and resources in tackling the identified barriers by using the research's findings as a basis. Through understanding of these obstacles, specialists can come up with focused approaches for overcoming challenges like infrastructure constraints, safety concerns, regulatory structures, and public acceptance problems. Furthermore, via the involvement of specialists in the process, we have made sure that the barriers that were identified are relevant and applicable to the local context of Dubai. The four top barriers that were found are "Weather Barrier", "Safety Concern", "Limited Availability", and "Limited Service Coverage"; by focusing on these causes there is a chance that the usage of shared e-scooters increases. These results are especially helpful as Dubai works to improve its shared transportation projects that are sustainable. Policymakers can adopt focused initiatives to enable a more seamless integration of e-scooters into the city's transportation network by concentrating on minimising the highlighted obstacles. Dubai's goal of creating a sustainable and effective shared mobility ecosystem will be greatly aided by developing solutions to alleviate weather-related concerns, boosting the availability of e-scooters, expanding service coverage, and improving infrastructure to assure safety. A few suggestions that can help policymakers in how to tackle these barriers are to shield users and scooters from inclement

weather; construct weather-resistant infrastructure, such as covered walkways and dedicated parking spaces with shelter; instruct the public through extensive safety education campaigns about how to use e-scooters safely, including donning helmets and observing traffic laws; employ data analytics to locate e-scooters in high-demand locations, such as those close to commercial districts, residential neighbourhoods, and public transportation hubs; and finally, in order to make sure that the e-scooter network is in line with plans for public transit and urban development initiatives, cooperate with local authorities to identify and resolve coverage gaps.

5.1 Research Limitation

The absence of studies done in the Middle East, especially those that concentrate on addressing the obstacles found, is a major drawback of this analysis. Insufficient data accessibility makes it difficult to fully comprehend the dynamics and complexities of the challenges encountered. As a result, not all potential obstacles that are relevant to Dubai or the larger Middle Eastern context may be adequately captured by the findings. It is essential to recognise that, as a result of the challenges associated with data collecting, there may be additional obstacles that are either unexplored or inadequately represented in this study. As a result, when interpreting the results, consideration should be taken to recognise that the barriers that have been found may not be fully comprehensive and that they may not be applicable to Dubai or other Middle Eastern environments.

5.2 Research Implication and Future Work Recommendation

The research results, obtained by utilising the DEMATEL approach, offer significant perspectives for professionals and decision-makers operating in Dubai. This study helps stakeholders concentrate their attention and resources on addressing the most important

roadblocks preventing advancement in their respective sectors by identifying specific challenges. This research has implications for strategic decision-making processes, as it can direct resource allocation towards overcoming the barriers that have been discovered. Professionals and decision-makers can create focused interventions and policies meant to promote sustainable development and progress in Dubai by giving priority to these barriers. It is crucial to recognise that not all potential obstacles may have been covered by this study, and that more investigation is required to look into other potential elements contributing to the issues experienced in Dubai. Subsequent investigations ought to strive to broaden the range of study, revealing novel obstacles and carrying out more comprehensive evaluations to augment our comprehension of the intricate dynamics involved. In closing, this study provides a solid basis upon which future research can build to further our understanding and inspire more effective tactics for overcoming obstacles and promoting good change in the region. It also acts as a valuable starting point for addressing progress barriers in Dubai.

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Appendix A

I am currently conducting a Decision-Making Trial and Evaluation Laboratory (DEMATEL) analysis to understand the factors influencing the barriers to adopting E-Scooter (shared mobility) in Dubai.

	Weather Barrier	Safety Concerns	Limited Availability	Cultural and social pressure	Long Travel distance	Being Independent	Limited Service Coverage
Weather Barrier	0						
Safety Concerns		0					
Limited Availability			0				
Cultural and social pressure				0			
Long Travel distance					0		
Being Independent						0	
Limited Service Coverage							0

DEMATEL Scale

Numeric Value	Definition
0	No influence
1	Very low influence
2	Low influence
3	High influence
4	Very high influence

To maintain confidentiality and privacy, we have decided not to mention any individual or company names in the final report. To enhance the credibility and depth of our research, I kindly request each of you to provide your job designation and years of experience in the industry. This information will be used solely for research purposes and will not be disclosed in any public document.

Job Designation (you can also explain your background in shared mobility) **Years of Experience**

Identifying the Barriers to E-Scooter Adoption in Dubai

Kindly Choose from the below list if the mentioned barriers are applicable in Dubai. You can choose multiple barriers by mentioning the number below:

List of barriers that prevent people from using E-scooters

- 1- Weather Barrier: The UAE's summers can be unbearably hot, which deters some people from using bicycles or walking. temperature and air quality are significant aspects that influence an individual's willingness to utilize shared mobility. Factors such as precipitation, wind, heat, and poor air quality limit the broader acceptance of shared bicycles.
- 2- Safety Concerns:& Health Concerns about the safety of e-scooters, both for riders and pedestrians, can be a significant barrier. Accidents, lack of helmets, and inadequate safety measures may deter people from using e-scooters. Fear of getting injured/ not safe mobility to use
- 3- People will not use an E-scooter because it doesn't provide them fitness advantages compared to using a bicycle.
- 4- Limited Availability: If e-scooters are not readily available or accessible in all areas of Dubai, potential users may be discouraged from incorporating them into their daily commute. trouble finding one when needed, battery not always charged
- 5- Lack of Awareness: Some people may not be aware of the existence of e-scooter services, how to use them, or their benefits. A lack of awareness can hinder the adoption of this mode of transportation
- 6- Cultural and social pressure: If shared mobility options are perceived as less prestigious or inconvenient, cultural norms and social pressures may discourage people from using them. Cultural attitudes towards new modes of transportation can influence their adoption. If there is a social stigma or lack of acceptance for e-scooters, people may be hesitant to use them
- 7- Long Travel distance: it may discourage people from using an E-scooter if they work far away and using an E-scooter will delay them.
- 8- Low income: people who are poor and live in a poor area will not use an E-scooter.
- 9- Being Independent: People prefer to own their car rather than use an E-scooter as a shared mobility.
- 10- Governance and Policy: no support from the government.
- 11- Regulatory Restrictions: Dubai may have specific regulations or restrictions regarding the use of e-scooters, including where they can be ridden and parked. This can discourage people from using e-scooters.
- 12- Infrastructure Challenges: The lack of dedicated e-scooter lanes or proper infrastructure for safe e-scooter use can be a barrier. Without proper facilities, riders may feel unsafe or find it inconvenient to use e-scooters.
- 13- Cost: The cost of renting or buying e-scooters, as well as associated fees, can be a barrier for some individuals, especially if more affordable or traditional transportation options are available
- 14- Limited Service Coverage: If shared e-scooter services are not available across the entire city or in key locations, potential users may find them inconvenient or impractical.
- 15- Age Restrictions: If there are age restrictions for using shared e-scooters, it may limit the demographic of potential riders

Definition of each barrier

- 1- **Weather Barrier:** The UAE's summers can be unbearably hot, which deters some people from using bicycles or walking. temperature and air quality are significant aspects that influence an individual's willingness to utilize shared mobility. Factors such as precipitation, wind, heat, and poor air quality limit the broader acceptance of shared bicycles.
- 2- **Safety Concerns:** Concerns about the safety of e-scooters, both for riders and pedestrians, can be a significant barrier. Accidents, lack of helmets, and inadequate safety measures may deter people from using e-scooters. Fear of getting injured/ not safe mobility to use
- 3- **Limited Availability:** If e-scooters are not readily available or accessible in all areas of Dubai, potential users may be discouraged from incorporating them into their daily commute. trouble finding one when needed, battery not always charged
- 4- **Cultural and social pressure:** If shared mobility options are perceived as less prestigious or inconvenient, cultural norms and social pressures may discourage people from using them. Cultural attitudes towards new modes of transportation can influence their adoption. If there is a social stigma or lack of acceptance for e-scooters, people may be hesitant to use them
- 5- **Long Travel distance:** it may discourage people from using an E-scooter if they work far away and using an E-scooter will delay them.
- 6- **Being Independent:** People prefer to own their car rather than use an E-scooter as a shared mobility.
- 7- **Limited Service Coverage:** If shared e-scooter services are not available across the entire city or in key locations, potential users may find them inconvenient or impractical

Survey 1	Weather Barrier	Safety Concerns	Limited Availability	Cultural and social pressure	Long Travel distance	Being Independent	Limited Service Coverage
Weather Barrier	0	3	2	4	4	2	3
Safety Concerns	3	0	3	3	4	2	1
Limited Availability	1	1	0	1	2	1	2
Cultural and social pressure	2	2	1	0	3	3	1
Long Travel distance	3	1	2	3	0	3	1
Being Independent	0	2	0	1	2	0	2
Limited Service Coverage	1	1	1	1	4	1	0

Survey 2	Weather Barrier	Safety Concerns	Limited Availability	Cultural and social pressure	Long Travel distance	Being Independent	Limited Service Coverage
Weather Barrier	0	2	2	2	2	1	4
Safety Concerns	4	0	3	1	2	3	2
Limited Availability	3	4	0	3	4	2	3
Cultural and social pressure	2	3	2	0	1	4	1
Long Travel distance	1	2	1	2	0	2	4
Survey 3	Weather Barrier	Safety Concerns	Limited Availability	Cultural and social pressure	Long Travel distance	Being Independent	Limited Service Coverage
Being Independent							
Weather Barrier Coverage	1 0	3 4	4 0	0 0	4 3	2 1	0 0
Safety Concerns	3	0	4	0	4	1	4
Limited Availability	0	2	0	1	3	1	4
Cultural and social pressure	0	0	1	0	2	3	0
Long Travel distance	4	4	4	2	0	3	4
Being Independent	2	0	4	3	4	0	4
Limited Service Coverage	0	4	3	0	4	2	0

Survey 4	Weather Barrier	Safety Concerns	Limited Availability	Cultural and social pressure	Long Travel distance	Being Independent	Limited Service Coverage
Weather Barrier	0	4	4	1	4	3	4
Safety Concerns	3	0	3	2	3	2	3
Limited Availability	3	2	0	2	3	2	4
Cultural and social pressure	2	4	2	0	2	1	4
Long Travel distance	3	2	3	3	0	2	4
Being Independent	1	3	3	1	2	0	3
Limited Service Coverage	3	4	3	4	4	3	0

Survey 5	Weather Barrier	Safety Concerns	Limited Availability	Cultural and social pressure	Long Travel distance	Being Independent	Limited Service Coverage
Weather Barrier	0	2	2	4	1	1	1
Safety Concerns	2	0	1	4	2	1	1
Limited Availability	2	2	0	2	1	1	1
Cultural and social pressure	3	1	1	0	2	3	1
Long Travel distance	2	2	2	1	0	1	1
Being Independent	3	1	1	3	3	0	1
Limited Service Coverage	1	3	3	1	4	3	0

Survey 6	Weather Barrier	Safety Concerns	Limited Availability	Cultural and social pressure	Long Travel distance	Being Independent	Limited Service Coverage
Weather Barrier	0	1	1	2	2	3	1
Safety Concerns	1	0	2	3	1	2	1
Limited Availability	3	3	0	1	3	1	1
Cultural and social pressure	2	1	2	0	3	2	1
Long Travel distance	1	2	1	1	0	2	2
Being Independent	1	2	1	2	2	0	1
Limited Service Coverage	1	2	2	1	3	1	0

Survey 7	Weather Barrier	Safety Concerns	Limited Availability	Cultural and social pressure	Long Travel distance	Being Independent	Limited Service Coverage
Weather Barrier	0	0	0	2	2	1	1
Safety Concerns	0	0	0	2	2	1	1
Limited Availability	0	0	0	2	2	1	1
Cultural and social pressure	0	0	0	0	1	0	1
Long Travel distance	0	0	0	0	0	0	0
Being Independent	0	0	0	0	0	0	0
Limited Service Coverage	0	0	0	0	0	0	0

Survey 8	Weather Barrier	Safety Concerns	Limited Availability	Cultural and social pressure	Long Travel distance	Being Independent	Limited Service Coverage
Weather Barrier	0	4	4	0	4	3	1
Safety Concerns	4	0	1	3	4	4	3
Limited Availability	4	1	0	2	4	4	4
Cultural and social pressure	0	3	2	0	2	4	2
Long Travel distance	4	4	4	2	0	4	3
Being Independent	3	4	4	4	4	0	3
Limited Service Coverage	1	3	4	3	3	3	0

Survey 9	Weather Barrier	Safety Concerns	Limited Availability	Cultural and social pressure	Long Travel distance	Being Independent	Limited Service Coverage
Weather Barrier	0	3	0	0	4	3	0
Safety Concerns	3	0	0	0	4	0	4
Limited Availability	0	0	0	0	4	0	0
Cultural and social pressure	0	0	0	0	3	4	0
Long Travel distance	0	4	4	4	0	3	4
Being Independent	2	0	3	3	4	0	3
Limited Service Coverage	0	4	3	0	4	2	0