MASTER IN MANAGEMENT

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DISSERTATION

DOES E-HAILING CONTRIBUTE TO A MORE SUSTAINABLE URBAN MOBILITY? EVIDENCE FOR LISBON

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SUPERVISOR: PROF. PATRÍCIA C. MELO

JURY:

PRESIDENT: PROF. MARIA EDUARDA MARIANO AGOSTINHO SOARES

RAPPORTEUR: PROF. MARIYA GUBAREVA

SUPERVISOR: PROF. PATRÍCIA SOFIA COELHO DE MELO

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ABSTRACT

With the normalisation of e-hailing in transportation systems, it becomes important to understand whether these recent services are contributing to making urban mobility more sustainable by reducing the levels of car use and car ownership. While the idea of transitioning from private car ownership to shared car usage is central to the concept of shared mobility, a current concern in many cities is the potential for e-hailing services to increase, rather than decrease, the number of cars and car-based trips. This work analyses the impacts of the e-hailing sector on the transport system using individual level data from a survey carried out in Lisbon, particularly it investigates the extent to which e-hailing is substituting or complementing other travel modes (i.e. taxi, public transport, private car or active travel). The work also gives a more aggregate overview of the evolution of the e-hailing sector in comparison to the evolution of the taxi sector and public transport. The findings suggest that there is strong a substitution effect between e-hailing and both taxi services and public transport. Considering the trips made by frequent users of e-hailing, these would have otherwise been done by taxi (39%), public transport (35%), private car (13%) or active travel (9%). The main conclusion is that there is a strong scope for substituting taxi services and public transport, and a much smaller scope for substituting private car trips and active travel. Furthermore, only 2% of the trips would not have been done at all, that is, the scope for induced travel appears to be minimal. By providing policymakers with valuable insights on the effect of e-hailing on the use of other travel modes in Lisbon, this work contributes to addressing Sustainable Development Goals (SDGs) 11 (Sustainable Cities and Communities), 10 (Reduced Inequalities), and 13 (Climate Action) of the 2030 Agenda for Sustainable Development.

Keywords: E-hailing, Public Transportation, Urban Mobility, Sustainability

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AML: Lisbon Metropolitan Area

AMT: Authority for Mobility and Transport

IMT: Institute for Mobility and Transport

MaaS: Mobility as a Service

PT: Public Transportation

RHA: Ride-hailing Applications

SDG: Sustainable Development Goal

TVDE: Individual and Paid Transportation of Passengers in Uncharacterized Vehicles Through Electronic Platform (Transporte individual e remunerado de passageiros em veículos descaracterizados a partir de plataforma eletrónica)

CHAPTER 1 – INTRODUCTION

1.1 Research problem and motivation

A great part of all worldwide green gas emissions is related to travel mobility and transportation. The transportation sector is the fastest-growing source of global emissions, representing 21% of total emissions (Kwakwa et al., 2023; Shiying Wang & Mengpin Ge, 2019), and a significant source of fossil energy consumption, as road transport alone accounts for nearly half of global oil consumption (Dai et al., 2023) and 75% of total transportation emissions in 2018 (Ritchie, 2020). According to ITF (2017), the demand for urban passenger transportation is projected to grow significantly between 2015 and 2050, from 50 to 120 billion passenger-kilometers, which corresponds to an increase of around 140% over this 35-year period. Furthermore, motorised mobility is expected to experience a greater increase in demand, corresponding to an increase of 94% between 2015 and 2050. Consequently, the negative externalities of the transportation sector are not expected to reduce.

Shared mobility services are revolutionizing urban mobility. In the last decade, e-hailing services have become a very popular option for travelling in cities. Before e-hailing entered the urban transportation passenger market (Uber was founded in 2009 in California USA, Ola Cabs in 2010, in Mumbai, India, Yandex Taxi in 2011, in Moscow, Russia), door-to-door on demand trip services were dominated by taxi providers (Vega-Gonzalo et al., 2023). Since then, e-hailing has spread quickly worldwide due to the high acceptance of the general public, driven by a widespread smartphone usage, the development of GPS navigation systems, and also the standardisation of mobile and digital payment systems. These services stand out from public transportation and taxi mainly due to their flexibility. It is very simple to request trips through smartphones and, unlike public transport systems, they practically have no route nor time constraints. Whilst traditional ride-hailing services, like the taxi, often operate in much lesser digital environments, e-hailing offers the same service, but accessed through digital platforms on the web. These platforms connect passengers with available drivers for desired routes, most of the times at pre-established prices and payment (Tirachini, 2020). These features make e-hailing more flexible, convenient and most of the times more affordable than the traditional taxi service, thus attracting a large portion of its users, contributing to the immense popularity of companies such as Uber and Bolt within the passenger transportation market. These services seem to be very popular among a certain profile of

consumers, particularly the younger and better educated, and also those who tend to adopt new technologies more easily (Ahmed & Hyland, 2023; Alemi et al., 2018), as well as car-free or car-less households (Tirachini, 2020).

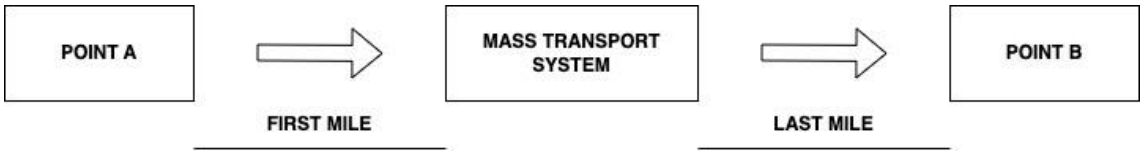
E-hailing services offer various advantages over other travel modes such as public transportation and taxi services, notably increased flexibility and lower waiting times (ITF, 2017). The fact that e-hailing services can offer door-to-door trips, at nearly any time of the day, enables these services to fulfil so-called first and last mile (see Figure 1) connections, feature that public transportation often cannot provide. This aspect positions e-hailing services as potential complementary solutions to existing public transportation services (Flor et al., 2022; Hall et al., 2018). Yet, despite the many advantages they bring, it is crucial to acknowledge the potential negative impacts that may arise in cities where their operation is extensive, especially when comparable advantages could be achieved through more sustainable modes, thereby avoiding increased road congestion and other undesirable and adverse outcomes.

There is a wide variety of potential positive and negative effects of e-hailing services on the environment: lower car ownership, new land uses due to less necessity of supplying parking; attracts public transportation users, increases energy consumption (Khavarian-Garmsir et al., 2021)**,** yet there is no consensus on the effect of e-hailing on the urban mobility system. To move towards greener cities, it is of central importance that these services contribute to a reduction in individual car ownership and car use, complementing the existing public transportation networks, for example, by operating in low-preforming or/and costly routes or/and specific time periods (ITF, 2017). In contrast, if app-based ride-hailing services substitute mainly public transportation and active travel trips (any form of human-powered transportation, such as walking or cycling), the overall effect will be adverse, with greater traffic congestion and environmental costs for society.

Another remarkable and central topic refers to the social implications of e-hailing services, in particular issues relating to accessibility and equity. The higher user costs of e-hailing services, compared to public transportation, pose concerns about the equitable access for lower income individuals, both in cities and suburban regions. This price disparity, in the case of e-hailing substituting public transportation and therefore impacting the development of their networks, impacts the ability of economically disadvantaged people to access more affordable options, forcing them to spend a larger proportion of their income with transport, which in turn can reduce their capacity to access

other economic and social goods and services such as jobs, education, health, etc. (Silver et al., 2023).

FIGURE 1 - FIRST AND LAST MILE CONNECTIONS



The local context where these services operate is likely to influence their outcome on the sustainability of the urban mobility system. One important challenge faced by transport authorities and local policy makers is the design of an institutional and regulatory framework which can integrate e-hailing services (and other so-called shared mobility services, such as car or bike sharing) with other modes of travel and the wider public transportation system.

1.2 Objective and research question

This study aims to add evidence for Portugal, particularly for Lisbon, both on the evolution of e-hailing services compared to traditional ride-hailing services (i.e. Taxi services) and public transportation, and on the degree of substitution or complementarity between e-hailing and other modes of transport to assess whether the contribution of the former to sustainable mobility is positive or negative. The main research question is: *are e-hailing services contributing to a more sustainable urban mobility system*?

1.3 Definition of main concepts

E-hailing refers to the process of digitally booking conventional regulated taxis through apps, combining the traditional taxi services' reliability with the convenience and ease of modern ride-hailing technology. This innovation disrupts the traditional door-to-door transportation sector by providing users with more flexible and efficient options for hailing rides (Vega-Gonzalo et al., 2023). It is often claimed that e-hailing services integrate a wider set of transportation modes designated as shared mobility. One can relate the emergence of shared mobility, and of e-hailing services, to the wider idea and paradigm of the so-called sharing economy. The sharing economy is charactered by consumers granting each other temporarily access to under-utilized physical products

(Frenken et al., 2015; Meelen & Frenken, 2015) or even skills and time (Botsman, 2013), with consumers for potential money exchange, which results in a consumer-to-consumer business model. It follows that the key concept of car sharing system would be, by definition, to separate car access from car ownership by making cars accessible for people who do not own a car, thus, enabling them to access one from a shared fleet on demand.

Current e-hailing services do not generally conform to these principles, with some exceptions as for instance platforms like *BlaBlaCar*, in which people publish their rides and others can pay them to join the trip. Having this in mind, at least two factors which would need to be different for companies like Uber or Bolt (the ones that operate in Portugal, as of March 2024) to be considered as sharing economy: in the case that the drivers would have done the trips anyway and if the vehicles utilized were their own under-utilized physical asset, which is also not the case since operators buy fleets with the only purpose to be used in this activity.

Shared mobility includes shared e-scooters, shared e-bikes, shared mopeds, etc. In contrast to e-hailing, the latter three cases are designed as shared micromobility. This refers to lightweight, human or battery powered vehicles that can be used as an alternative to traditional transportation modes to perform mainly short distances, for instance first and last mile connections (Bozzi & Aguilera, 2021). Similarly to e-hailing, the rise of micromobility has been propelled by the technological progresses of the last decades, as nowadays there are numerous shared-micromobility services powered by smart app-based systems that are able to locate, rent, and access these vehicles. These developments contribute to the popularity of these services by making them easily accessible and convenient. Users can access micromobility shared services through a web-app displaying real-time information about the vehicles available for their desired trips: types of vehicles, geo-location, availability, price of usage, limits, parking locations, etc. Users select the vehicle (most commonly e-scooters and bicycles) they want from the ones available, unlock them, and start the ride. As these services are offered on demand, the length of the ride is unknown upfront, so the payment happens at the end of the trip, in opposite of the e-hailing services.

Another related concept is Mobility as a Service, or MaaS. There is no agreement on the exact definition of MaaS. Perhaps the best definition we can provide is that provided by Arias-Molinares & García-Palomares (2020), which highlights the main features of a MaaS system. The definition is as follows: “In general, when defining MaaS, the different

authors attempted to highlight its core elements: a unique single platform (app or website), real-time information on all available modes in the city (public and private), multimodal transportation (intermodal journey planners), technological integration to plan, book and pay for mobility needs, and personalized bundled mobility packages according to user's particular requirements". E-hailing complies only with a few features of a MaaS system.

1.4 Contributions

To the best of our knowledge, this is the first study attempting to examine the effect of e-hailing on urban travel mobility in Portugal. By adding evidence on crucial topics within this subject, such as interpretations of the evolution of e-hailing market in comparison to taxi and public transport markets, as well as an analysis of the degree of substitution and complementary effects across different transport modes, this study contributes to filling a gap in the existent literature. As the first study of this kind for Portugal, it is expected to offer valuable insights for policymaking and transport planning that aim at promoting more sustainable transport solutions.

1.5 Organization of the study

This work follows a coherent structure designed to enhance readability and comprehension of the reader, in which each chapter and paragraph explores important topics, organized in the best way for developing robust and logical lines of reasoning. It is organized as follows: An introductory chapter, where motivations and objectives, key-concepts, and expected contributions are presented, is followed by a literature review that focuses the main subjects of e-hailing services, exploring their popularity and consequently implications. This is complemented by the third chapter, that provides a comprehensive and detailed oversight of the legal framework under which e-hailing services operate in Portugal, highlighting the main its main disparities from the traditional ride-hailing legislation. Chapter four outlines the empirical methods, data sources and the different types of data used in chapter five, that compiles the various analyses and the discussion of the results. Lastly, chapter 6 provides the conclusions of the study, acknowledges its limitations, and suggests avenues for future research.

CHAPTER 2 – LITERATURE REVIEW

This chapter aims to explore the existing literature on the multidimensional impacts of e-hailing services on urban mobility, public health, social equity, and formulation of public policies. This analysis covers the dynamics of interaction of these services with various other modes of transportation, including public transportation, taxi and private vehicles, shedding light into the potential complementary and substitution effects, congestion, pollution, and an oversight of potential compromising phenomena of the Sustainable Development Goals (SDGs) 11 and 13. It also delves into the social implications brought by these relatively recent services, in particularly accessibility, affordability and labour issues. Lastly, institutional challenges and policy interventions pertaining to the integration of e-hailing into urban transportation systems are examined, with a focus on initiatives aimed at enhancing sustainability by mitigating environmental impacts. The review aims to contribute to a deeper understating of the dynamics surrounding e-hailing services and their role in shaping contemporary urban mobility panoramas.

2.1 Impacts on travel mobility, congestion, and public health

One of the most discussed topics in the literature, due to its significant interest, particularly within the context of sustainability and urban mobility, is how e-hailing services interact with public transport systems. This is usually addressed by analysing the scope for complementary or substitution effects of e-hailing over other modes of transportation. Therefore, the literature on this topic is extensive and provides evidence for both types of effects, although less for the complementary. While e-hailing services have recognized potential to complement other transportation systems, explicit statements regarding this are rare. Some authors argue that there are instances where complementary effects between ride-hailing applications (RHA) and public transportation (PT) can be observed. For example, Hall et al. (2018) and Sadowsky & Nelson (2017) have noted cases where RHAs support and enhance the use of PT services. However, Chalermpong et al. (2023), in their extensive literature review, found limited evidence to support this assertion. Many other studies suggest a different trend. Diao et al. (2021), Gehrke et al. (2019), Kong et al. (2020), Qiao & Gar-On Yeh (2023), and Rayle et al. (2016) indicate that RHAs often substitute PT services, drawing users away from public transport. This substitution effect poses significant challenges to sustainability goals. For instance,

China's proposal at the United Nations General Assembly aims to achieve peak carbon dioxide emissions by 2030 and attain carbon neutrality by 2060 (Qiao & Gar-On Yeh, 2023).

While e-hailing services may substitute other more sustainable travel modes, resulting in more cars in circulation, another significant consideration is whether they help reduce levels of car ownership. Even though there is some investigation on this, significant connections are rarely established (Chalermpong et al., 2023; Rayle et al., 2016). Consequently, it is conceivable that these systems could contribute to a higher number of private vehicles on the streets, potentially exacerbating congestion and pollution levels. Furthermore, the scenario may persist even if RHA decreases car ownership, as the intensive use of private vehicles could offset the reductions in ownership. Some people may even buy private cars with the purpose of using them for e-hailing (Tirachini, 2020). In addition, the fact that most of the drivers cruise around the densely populated areas, waiting for ride requests or travel to pick-up and drop-off their passengers, leads not only to slow down traffic but also to increased greenhouse gas emissions as well as air and noise pollution and higher temperatures, raising major concerns for public health issues.

2.2 Social Impacts

As the popularity of e-hailing continues to rise, there is growing recognition of its broader social and equity implications, also because this activity is mainly led by private companies, naturally with profit interests (Tirachini, 2020). It is very important to understand how e-hailing intersects with these issues. Qiao & Gar-On Yeh (2023), achieved many interesting and relevant findings from the perspective of affordability. On one hand, that residents in higher-income neighbourhoods tend to rely on e-hailing services as a substitute for car travel, whereas those in lower-income areas use it as a substitute for taxi and public transport travel, suggesting that e-hailing might be contributing to transportation disparities since it may serve different travel needs and preferences based on income levels. On the other hand, they argue that e-hailing services provide an on-demand travel option for low-income individuals, complementing public transit and potentially breaking mobility constrains for those without private vehicles, offering mobility benefits to underserved population, enhancing accessibility and travel options. Still related to the income level, e-hailing does not exclude lower-income communities, unlike traditional taxi services, according to a large, detailed dataset of 6.3

million Lyft trips in Los Angeles (Brown, 2019). Other studies indicate that the same happens in New York City (NYC), for instance, Atkinson-Palombo et al. (2019) that studied the *Surprising and Oversized* usage of ride sourcing Services in NYC Poor Neighbourhoods. Furthermore, e-hailing showed the capacity of serving rural and suburban areas besides the metropolitan centres. Brown (2019), however, points out to the potential exclusion of individuals without the means to access the service, like a smartphone or a digital payment method.

With respect to reduced mobility passengers in e-hailing, each country applies their own different regulations. As this study focuses on the Portuguese territory, this section will relate to the Portuguese guidelines, established in Law n.º 45/2018. As we will elaborate on later, there is an article in the Portuguese law that legislates this activity dedicated to the reduced mobility situation, aimed at ensuring their accessibility. To summarize, the law mandates that e-hailing platforms offer users the option to request vehicles capable to transport individuals with mobility issues and their accompanying aids, with a waiting time not exceeding 30 minutes, for the same price as any other journey. However, e-hailing platform operators express concerns regarding the obligation to serve passengers with reduced mobility, arguing that it should be public transportation's duty to safeguard their right to transportation, as the scarcity of adapted vehicles in the domestic market poses significant obstacles to the business, complicating efforts to recover investments in such specialized vehicles (IMT, 2022).

Under the subject of social implications of e-hailing systems, it is crucial to assess the examination of labour and working conditions of the drivers, especially given the rise of the *gig economy* and its impact on employment dynamics. This relatively new business model brings up a variety of both positive and negative considerations to be made on drivers' activity. According to the biggest e-hailing companies, the main advantage is that working for them allows a flexibility that compares to the drivers being their own bosses, since they work as many hours as they want, when they want (Amorim & Moda, 2020; Geitung, 2017). Furthermore, by increasing jobs opportunities with low entry barriers, this activity also facilitates the entry of the lower class and marginalized communities in the labour markets (Geitung, 2017).

In opposite, many studies from across the globe highlight significant driver dissatisfaction due to poor working conditions, including hours, rights, and wages (Holtum et al., 2022), which is unsurprising as regulators have also been increasingly

concerned about these issues (Tirachini, 2020). For being independent workers, the drivers are not under the same legal frameworks as those regular employees. Consequently, they do not receive the same rights and protections, which stems from a lack of government regulation (Geitung, 2017). The almost utopian job, that gives a sense of autonomy and entrepreneurship and flexibility (Holtum et al., 2022), advertised by companies like Uber and Bolt, turn out to be extremely demanding and risky for the drivers, most of whom, again, are subject to long working hours, poor conditions and exposed to external hazards. This atmosphere results in concerning states of insecurity, anxiety and burnout, which are particularly prevalent among migrant workers, who in the wake of globalization, precariousness, and lower bargaining power, disregard the low rates remuneration in favor of non-monetary factors (Holtum et al., 2022).

Often, very subtle control mechanisms are implemented by the companies that "rule" their drivers even not having any responsibility over them, since they are not their employees. The remuneration model employed by Uber further illustrates this control, with drivers' compensation consisting solely of a variable portion determined by the app, leaving them heavily reliant on companies' algorithmic calculations (Amorim & Moda, 2020). The design of the e-hailing apps serves as a tool for remote control over drivers' presence, performance, and work locations, effectively minimizing responsibilities while exerting significant control over its workforce and shifting all risks into the drivers (Geitung, 2017). Therefore, despite the perception of flexibility, these companies maintain a tight control over their drivers, dictating their actions and exerting significant influence over their work lives.

2.3 Institutional challenges and public policies

In order to enhance the overall efficiency and sustainability of urban mobility systems, researchers and policymakers have been exploring strategies for integrating e-hailing services with public transportation. However, despite showing promising outcomes, these initiatives often suffer from short and limited durations, highlighting the preliminary nature of such experiments conducted by companies and public authorities. Rather than substituting specific public transport services with ride services, a lot of these projects aim at promoting the idea of merging ride services and public transportation trips to the general public, for example, through the creation of formal partnerships (ITF, 2017). An example occurred, for instance, in Altamonte Springs, a low-density city in Florida, that

started a formal partnership with Uber in which 20% of the cost of every trip that was taken within the city limits would be discounted for the consumer. This percentage would be even higher, of 25%, in case the trip had its beginning or end in the local rail station, to promote integration with public transportation. Another example took place in Clemente, California. In 2016 the Orange County Transportation Authority felt the necessity of better allocating resources of two fixed bus routes used in some of the low-density neighbourhoods, since there were very few riders. This led to an exclusive partnership with Lyft, in which riders would benefit from reduced prices on their journeys, by using a promotion code upon the ride requests made from or to the old bus stations. The city council also recognised that users without smartphones would not be able to take advantage of such program, so they helped the residents to qualify for purchasing subsidized government smartphones (ITF, 2017). These current pilot projects demonstrate the efficacy of city partnerships with e-hailing companies to offer subsidised mobility to specific demographics such as seniors and low-income citizens (Tirachini, 2020). Moreover, studies suggest the potential for partnerships of this nature to extend services to low population density areas, providing last-mile solutions for public transport users (Vega-Gonzalo et al., 2023).

Similarly to the formal partnerships discussed, another very relevant pilot experiments towards greener cities and sustainable transportation systems are car-free days, as an increasing number of cities plan to decrease the use of private car in city centres, aiming for a car-free future (Nieuwenhuijsen & Khreis, 2016). A reduction of 40% in NO2 levels has been observed during these experiments across the cities, which has been proven to be beneficial to people's health (Nieuwenhuijsen & Khreis, 2016). Urban areas with reduced private car usage, not only benefit from lower levels of air and noise pollution and temperatures, as they are also an open doorway to increasing number of green spaces, and more pedestrian-oriented infrastructures, that lead to higher levels of physical activity. Together, these benefits improve public health, and result in lower premature mortality and morbidity levels, therefore, cities adopting these policies are likely to provide direct and indirect health benefits for their citizens.

Another common policy that governments can take to prevent high sustainability damage, is to give incentives for e-hailing companies to shift towards electric-powered fleets. It has been found that it is an effective measure towards a low carbon transportation system, especially when combined with clean energy, such as solar, wind or hydropower.

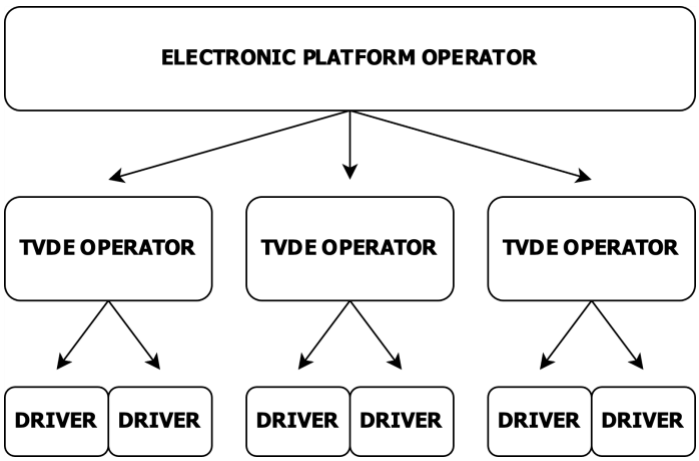
In such cases, electric vehicles can significantly reduce transportation emissions (Tirachini, 2020; Tu et al., 2019). There is an example of an Uber pilot program that offer additional payments to drivers using electric vehicles more in seven different North American cities, incentivising them to adopt EV's (Rodriguez, 2018). In contrast, there are some studies that point out that switching to EV's may not always be advantageous, since, even though their emissions are very low while driving, the case inverts when they are charged with electricity generated from fossils fuels such as coal (Tirachini, 2020). Furthermore, the shift towards electric cars in e-hailing, does not prevent the intensive use of cars. A study conducted by Milev et al. (2021) in Scotland, analysed a hypothetical situation in which every car in Scotland would be replaced with an electric car, and concluded that this scenario is expected to have a positive impact on the environment. They estimated that the carbon emissions would fall by approximately 33.7%, and that the cleaner the energy used to power the batteries, the greater the decrease. This observation, albeit not directly correlated with e-hailing activity, lends credence to the beneficial nature of the transition, as suggested by numerous studies, thereby potentially mitigating the scepticism surrounding the subject.

CHAPTER 3 – OVERVIEW OF THE LEGAL FRAMEWORK OF E-HAILING IN PORTUGAL

3.1 E-hail riding services in Portugal

In Portugal, e-hailing services are designated by the term TVDE (i.e., Transporte Individual e Remunerado de Passageiros em Veículos Descaracterizados a partir de Plataforma Eletrónica). The activity of the electronic platforms and TVDE operators can be performed by legal persons established or represented within the Portuguese territory, upon proving that they fulfil the requirements for access to the activity (IMT, 2021). Their activity in Portugal is regulated by the Law n.º 45/2018, and organized according to three economic agents (as shown below, in Figure 2): electronic platform operators, TVDE operators and TVDE drivers. Electronic platforms are electronic infrastructures that provide the intermediation service between users and TVDE operators, electronic platform operators are the entities that own them, subject to licensing by the relevant authority, Institute for Mobility and Transport (IMT), and operate according to their own business model. TVDE operators are the licensed companies that own vehicles for the provision of the services and establish the labour contracts with the certified TVDE drivers. TVDE drivers are the individuals, employed by the TVDE operators, who provide transportation services. They are also subject to licensing and must meet specific criteria determined by the law.

FIGURE 2 - THE THREE ECONOMIC AGENTS OF TVDE ACTIVITY



The current legislation governing e-hailing activity in Portugal is the Law n.º 45/2018**,** published in the 1st November of 2018 and often called "Uber Law". This law has

remained unchanged since its first and only enactment, although it is planned to be revised in 2024, after several delays. At the time the law was approved, there were fewer than 18 000 TVDE drivers, whereas in the beginning of 2024, on the 6th February, there were more than 70 000 certified drivers, corresponding to an increase of 288.89%.

The emergence of TVDE as a primary competitor to traditional taxi services poses significant challenges and threats to the latter. The latest official data available refers to 2021 and states that there were 21 902 taxi drivers operating (IMT, 2023), almost 15% fewer than in 2018. Meanwhile, the number of TVDE drivers follows the exact opposite trend, in the same interval of time, the number increased by approximately 100%, and from 2018 to February 2024 by 288,89%, as said. 126%. Given the notorious similarities in the service offerings provided to consumers, that result in a strong competition between TVDE and taxi services, it is important to consider the main differences between the regulatory regimes applicable to each market (i.e., *Regime Jurídico de Transporte Individual de Passageiros* for TVDE in contrast to the *Regime Jurídico de Transporte Público de Passageiros* for Taxis; in English, legal regime for individual passenger transport, and legal regime for public passenger transport, respectively). The following paragraphs provide an overview of the Uber law, and compare it to the law regulating the taxi public service (i.e., Decree-Law n.º 101/2023). Appendix 1 provides a summary of the main differences by putting side-to-side the requirements applicable to each type of service. Table 1 offers a comparative overview of the regulatory authorities governing each regime that are referred throughout this chapter, often with no specification, as in the respective legislation. This table serves to highlight the regulatory framework differences between both regimes, providing context for understanding their operational environments.

TABLE 1 - REGULATING AUTHORITIES FOR EACH REGIME

TVDE	Taxi
Autoridade da Mobilidade e dos Transportes	*Autoridade da Mobilidade e dos Transportes*
Autoridade para as Condições do Trabalho	*Autoridades de transportes*
Autoridade Tributária	*Comissão Nacional de Proteção de Dados*
Comissão Nacional de Proteção de Dados	*Guarda Nacional Republicana*
Guarda Nacional Republicana	*Instituto da Mobilidade e dos Transportes*
Instituto da Mobilidade e dos Transportes	*Polícia de Segurança Pública*

Instituto da Segurança Social	*Polícia Municipal*
Polícia de Segurança Pública	

3.2 General Requirements

The access to the taxi or TVDE markets follow similar requirements established in the Decree-Law n.º 101/2023 – Article 4º and in Law n.º 45/2018 – Articles 2º and 3º. The main difference lies in the possibility for taxi drivers to operate as individuals, while TVDE operators must always be legal entities. There is also a difference in relation to the duration of the operator's license: for taxis, the license is valid for 5 years since issued, whilst for TVDE it is valid up to 10 years. In both cases, after expiring, the license can be renewed for additional periods of five years as long as the requirements of accessing the activity are still met. Another difference to highlight is that the drivers training requirements are significantly different; while a taxi driver must undergo 125 hours of training, a TVDE driver only needs to undergo 50 hours, making it 150% more time-consuming task for the taxis. The prices for these trainings are determined by the entities providing them, as they are not regulated by law. However, we observe that the taxi driver training is generally higher than the TVDE. Table 2 shows a short comparison of the average prices of both training courses (obtained from the respective websites, on 01/02/2024), from some training entities in Portugal, where the average price is 159.76% higher for the taxi. The drivers certifications converge on the issuance fees (30€, to be charged by IMT), and duration: 5 years for both, with possibility of renewing for additional 5 years periods, if suitability requirements are still met, and renewal training was approved (Law n.º 6/2013; Ordinance n.º 251-A/2015)

TABLE 2 - TRAINING COSTS COMPARISON

Training Entities	TVDE	Taxi
ACP	€225.00	
SEGURANÇA MÁXIMA	€198.00	€550.00
Transform	€220.00	€740.00
Academia do Profissional	€250.00	
FDF		€450.00
Average Price	€223.25	€580.00

Transport authorities hold the responsibility of determining the maximum number of operating taxis within municipalities (Law n.º 101/2023 – Article 15º). Conversely, there are no such restrictions imposed on TVDE services. This fundamental disparity between the two services raises significant questions about the broader operation of e-hailing, particularly concerning its alignment with sustainability objectives, and its potential impact on the substitution of taxi services and public transport systems. Another example of such restrictions is the limitation of the number of e-scooters, following an agreement between Lisbon city hall (CML) and the 5 e-scooter operators, which determined that each of them can have 1 500 e-scooters from November to March, and 1750 on the other months, meaning that there are never more than 8 750 operating in the city (CML, 2023). Even though Lisbon city hall has the same idea for the TVDE (Raposo, 2023), since they operate, it has never been imposed any limitation in this sense, anywhere in the country.

Article 12 of the Uber law covers the requirements for the vehicles and establishes that they must be light-passenger vehicles, up to 9 seats including the driver, and their age must not exceed 7 years. The regulations apply uniformly to all vehicles, regardless of their fuel type. In contrast, vehicles operating as taxis, are subject to highly specific regulations, outlined in Ordinance n.º 451/2023. For instance, they must have similar exterior and technical characteristics, such as the painting or number of doors and seats, minimum distance between car axles, the taximeters, among other features, and be no more than 10 years old.

The requirements for providing information to regulatory and transport authorities diverge notably between the two sectors. Nevertheless, amidst these disparities, they both incorporate requirements designed to uphold regulatory oversight. Taxi operators, as per Article 25 - 3º, are obligated to inform the transport authority regarding the resumption of taxi transport activity after any suspension and must communicate all changes to the respective articles of incorporation, namely changes in administration, direction, or management, according to Article 8 – 2º. Conversely, TVDE have different communications standards: electronic platforms and TVDE operators must annually send to IMT either the criminal record certificate of the members of the respective management or administrative bodies or authorise access to those documents (Article 4 – 4º, Article 18 – 4º). Moreover, stipulated in Article 30 – 4º, they are required to send monthly to Authority for Mobility and Transport (AMT), reports that must include comprehensive details pertaining to their operational activities, encompassing specific data such as the

total number of trips conducted, billing amounts, and the corresponding intermediation fees charged, among others.

The pricing rules applied to the taxi and TVDE markets also follow very different approaches. Since taxis provide a service under the regime of public transport of passengers, they are subject to a regulated system of tariffs, that needs to be approved by the AMT, which in turn establishes the general rules for pricing according to the types of service. The municipal bodies of transport authorities can fix specific tariffs for their territories, and the taxi operator is obliged to display the tariff applied in a manner that the passenger can easily verify it. The tariffs can be: route dependent, for selected itineraries; intermunicipal, in case of agreements; location-dependent when journeys involve major travel generation centres, such as airports; include seasonal fares, in regions with strong touristic attractions; vary for festive dates such as Christmas, New Year or municipal holidays; travel bundles in combination with monthly public transport tickets or shared mobility services; progressive fares (Decree-Law n.º 101/2023 – 20º).

The pricing of TVDE services (Law n.º 45/2018 – 15º) is defined in one of two very distinct ways. Revenue is either possible through the application of one or more rates on the length of the trips and/or their duration, or through the application of a price determined prior to contracting the service, that does not depend on the time spent or kilometres travelled. Under the first approach, the final price must include every cost associated with it as well as displaying its exact formula. The final price might use a dynamic rate, which cannot exceed a 100% mark-up on the average price charged by that operator for the services it provided in the immediately preceding 72 hours. In what concerns the payment methods accepted, taxis can accept different means, such as cash or bank cards, or electronic methods (AMT, 2020). Regarding the TVDE, the payment must be processed and registered through the electronic platform, and only digital means of payment are accepted. The electronic platform operators can charge a fee not superior to 25% of the total value of the trips. At the end of each trip, a receipt must be sent to the email of the user, with information about the trip, such as unique reference code, pick-up and drop-off locations, distance travelled, time, total price with taxes and rates breakdown.

3.3 Rules applying to operations

There are also crucial differences in the rules applied to the operations, i.e., journeys. The journeys always begin with a service request from the users, which in the case of taxis can be done through the following means: pick-up on the public highway, passenger in dedicated taxi ranks, or via booking platforms (Decree-Law n.º 101/2023 – 24º). No requests can be refused, unless they imply travelling on roads that are impassable due to difficult access, or in places that pose a notorious danger to the safety of vehicle, passenger or driver, or in case the services are hired by passengers with behaviour suspected of being dangerous. In the case of TVDE (Law n.º 45/2018 – 5), and in contrast with taxis, the only way passengers can access the service is via online booking platforms. The refusal of request rules (Law n.º 45/2018 – 8) are the same with the exception that requests from out of the platforms must be denied.

Besides the limitation in number of vehicles by municipalities, taxi services are also subject to geographical constraints stipulated by local authorities, which restrict their circulation beyond the determined areas, except when agreements are forged between local authorities to extend the services to additional localities (Decree-Law n.º 101/2023 – 13º). In contrast, TVDE operators enjoy unrestricted nationwide operational privileges, absent of such limitations. This difference brings significant market access disparities, since TVDE can enjoy this flexibility and capitalize on high-affluence regions during peak seasons. Even though Taxi may also take advantage of the inter-municipality agreements, these benefits depend on if they exist and in what terms, thus it will only affect a very small minority of drivers.

Law n.º 45/2018 – 6, establishes that platforms are obliged to always provide users the possibility of asking for a vehicle capable of transporting reduced mobility passengers, ensuring a maximum wait of 15 minutes, extendable by additional 15 minutes in exceptional situations, justified by the electronic platforms. Furthermore, the price calculation must be the same as it would be for the normal service. It's also mandatory to take guide dogs for that travel with blind or wheel-chaired people. If the platform is not able to immediately fulfil the trip, it must automatically inform the passengers about alternative service providers. In the Taxi legislation there is no objective obligation to transport passengers with reduced mobility, even though Article 30 – 2 makes mandatory to transport wheelchairs, assistance dogs and other mobility aids for with reduced

mobility passengers, in suitable vehicles. No further mention to reduced mobility passenger is made.

Another distinction is that taxis enjoy access to bus lanes, since they operate under the legal framework of passenger public transport, which is not the case of TVDE. Also, local authorities define specific parking places and taxi ranks (Decree-Law n.º 101/2023 – 12º), while there are no dedicated parking spots for e-hailing. This may generate harmful outputs, since, as suggested by Khavarian-Garmsir et al. (2021), the search for parking generates wasteful driving and consequently, higher congestion.

The reassessment of the law ruling e-hailing services is crucial to address the various challenges faced in this disruptive and rapidly evolving market. It is especially important that policymakers ensure the rights of the workers, and a more environmental and socially responsible urban transport system.

CHAPTER 4 – DATA AND EMPIRICAL METHODOLOGY

4.1 Data Sources

The empirical analyses use different types of data, which can be divided into aggregate-level data and microlevel data; they are described in the sections below.

4.1.1 Aggregate level data

The main source of aggregate-level data is the IMT final evaluation report of the TVDE sector, published in September of 2022 (IMT, 2022). This document evaluated the performance of the e-hailing services in the first three years after the enactment of the Law n.º 45/2018, provides comprehensive details into various aspects of the TVDE sector, including licensing procedures for platform and TVDE operators, the certification process for drivers, recommendations for legislative adjustments aimed at improving service quality, but most important to this study, a selection of quantitative data about the sector. The quantitative data provided in the report can be divided into four parts: A) Data about the economic agents that have economic activity in Portugal (namely TVDE drivers, TVDE operators and Electronic Platform Operators); B) Data about the trips provided by TVDE; C) Data on the taxes and other monetary contributions from the activity of supervising; and D) Data about the complaints received by IMT from TVDE users. The data published in the report, however, is considerably limited in scope (i.e., aggregate sector), time (i.e. only some years or quarters), and geography (i.e., no details for Lisbon specifically). To overcome this limitation, we contacted both IMT and AMT to request access to more detailed information, which was declined. We provide further details on the limitations regarding data access below, in section 6.3.

Other IMT reports were used in the data collection process for this study. Specifically, the Mobility and Transport Statistical Directory (IMT, 2021) , published every year since 2016 with the purpose of yearly disseminating a comprehensive set of data regarding mobility and transportation sectors in Portugal. Most importantly, the report of the number of TVDE and TAXI drivers for 2018, 2019, and 2020. The number of Taxi drivers was obtained from the following edition of the report, which did not encompass any values for TVDE drivers (IMT, 2023). Thus, for the remaining years, where official data lacks, we had to obtain information from other sources, notably from media news sources. For instance, the number of TVDE drivers for 2021, 2022 and 2023 was obtained from three different Portuguese news agencies, with well established reputations – *Observador*,

SIC Notícias, Agência Lusa and Diário de Notícias. One additional report (TML, 2023) published by the transport authority overseeing public passenger transport services within the Lisbon metropolitan area (TML), was used to obtain data about the demand for different types of public transportation in the Lisbon Metropolitan Area (AML). Finally, *IMT Online*, an online service that enables individuals and companies to handle requests typically processed at IMT facilities and that offers a variety of information for that purpose, namely regarding the TVDE regime, and AMT's online transport observatory provided access to information on the list of TVDE operators by municipalities, which allowed to understand how they are distributed across the country, in comparison with, for instance, the distribution of taxi contingents.

4.1.2 Individual level data

In addition to the aggregate data mentioned above, the study uses microlevel data from an individual level data obtained from a survey carried out in 2022 as part of the MASTI (Mobility as a Service and Socio-Territorial Inequalities) research project[1], which studies the relationship between Mobility as a Service (MaaS) and Socio-Territorial Inequalities. The survey was carried out in three municipalities of Lisbon Metropolitan Area with different socioeconomic profiles, notably: Lisbon, Cascais and Vila Franca de Xira. Cascais represents a medium-to-high income municipality whereas Vila Franca de Xira is a medium-to-low income municipality. The sampling strategy considered the distribution of the population according to gender and age groups in the municipalities where the survey was conducted. The participants filled out the questionnaires in person and online. The survey collected data on travel behaviour with a special focus on the potential and actual use of shared mobility and includes one section about the use of e-hail riding services (i.e., TVDE). The questions in the survey provide information on the origin and destination of each trip, travel time, mode choice and individual demographic and socioeconomic characteristics. We focus on the data for Lisbon municipality only, to be coherent with the remaining analyses in this work. There are 449 valid responses among those who report to use, or have used, e-hail riding services. The data obtained from the survey allows us to describe the profile of the users of TVDE services, the frequency of use, the trip purposes, as well as the alternative travel modes which would have been used if e-hail riding services were not available. In order to enhance readability

[1] https://masti.fa.ulisboa.pt/

and interpretations, we aggregated original the original responses into new categories. This correspondence is shown in Appendix 2.

4.1.3 Data access limitations

As previously mentioned, numerous attempts to access official data for e-hailing services, reported by the Electronic Platform Operators to AMT and IMT, were made throughout the development of this study. This data, which we anticipated would be readily provided by these public entities, would have allowed us to do more detailed analyses of the e-hailing market and a more refined assessment of its complementary or substitution effects on the use of other travel modes. Consequently, the characterization of the e-hailing sector was done using the very limited data publicly available, notably the report produced by IMT evaluating the TVDE sector in Portugal (IMT, 2021), *IMT Online*, and AMT's online transport observatory. As described earlier, it was necessary to complement the limited official data available with information from non-academic and non-official sources, notably the media. An effort was made to ensure the reliability and accuracy of the data with this supplementary nature.

4.2 Empirical Methods

As mentioned previously, this study uses both aggregate-level and individual level data for the empirical analyses. The first type of data was used to provide an overview of the evolution of key indicators for the TVDE, taxi, and public transportation sectors. This analysis allows us to make some conjectures with regards to possible trends in mobility patterns but does not allow to investigate the scope for substitution or complementarity between transport modes. To investigate this topic, we develop several descriptive empirical analyses using frequency tables on the microlevel data obtained from the MASTI project. In both cases, the empirical methodology consists of descriptive statistics.

CHAPTER 5 - RESULTS AND DISCUSSION

5.1 Aggregate Level Analysis

Even though we did not get access to the data that would allow us to estimate TVDE and Taxi markets evolution in the best way, a comparison between the number of drivers and the demand of different transportation modes, provides valuable insights into the market state and evolution. This data is shown below, in Table 3.

TABLE 3 - AGGREGATE LEVEL DATA

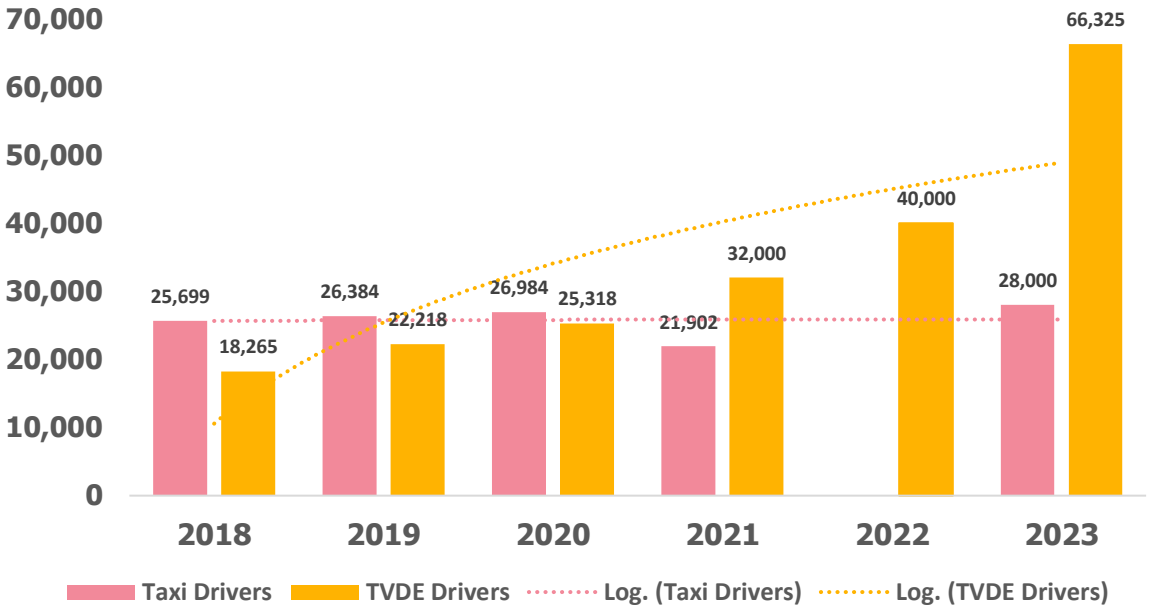
Variable / Year	2018	2019	2020	2021	2022	2023
TVDE Trips (10^3)		36 238	29 562			
TVDE Trips (3Q) (10^3)		27 178	22 172	29 373		
Taxi Drivers	25 699	26 384	26 984	21 902		28 000 [1]
TVDE Drivers	18 265	22 218	25 318	32 000 [2]	40 000 [3]	66 325 [4]
Demand Train (10^3)	108 369	127 560	81 254	90 697	133 668	
Demand Metro (10^3)	169 150	183 073	90 567	83 716	136 726	
Demand Ferry (10^3)	17 735	19 349	10 793	10 687	15 833	
Demand Bus (10^3)	125 684	139 496	79 289	91 207	126 919	

Demand variables Source (Provisional values for 2022): AMT's observatory for mobility and transport, and TML's annual report 2022 (TML, 2023)

Additional sources: source 1, source 2, source 3, source 4

The introduction of these services has been marked by exponential growth across the globe, resulting in substantial disparities compared to traditional ride-hailing. The number of TVDE drivers (see Figure 3) is significantly higher, around 136%, and exhibits a consistent upward trend, in stark contrast to the taxi sector. To trace a clearer perspective of the situation in Lisbon Metropolitan area, for 2021, there were 20 960 TVDE drivers (65.5% of the total) and 4 646 licenses emitted for Taxi, meaning that for 1 Taxi, there could be up to 4.5 TVDE. As of 2023, the tendency is still that the number of TVDE drivers raise significantly faster than the Taxi, as the graph indicate.

FIGURE 3 - TAXI | TVDE DRIVERS EVOLUTION

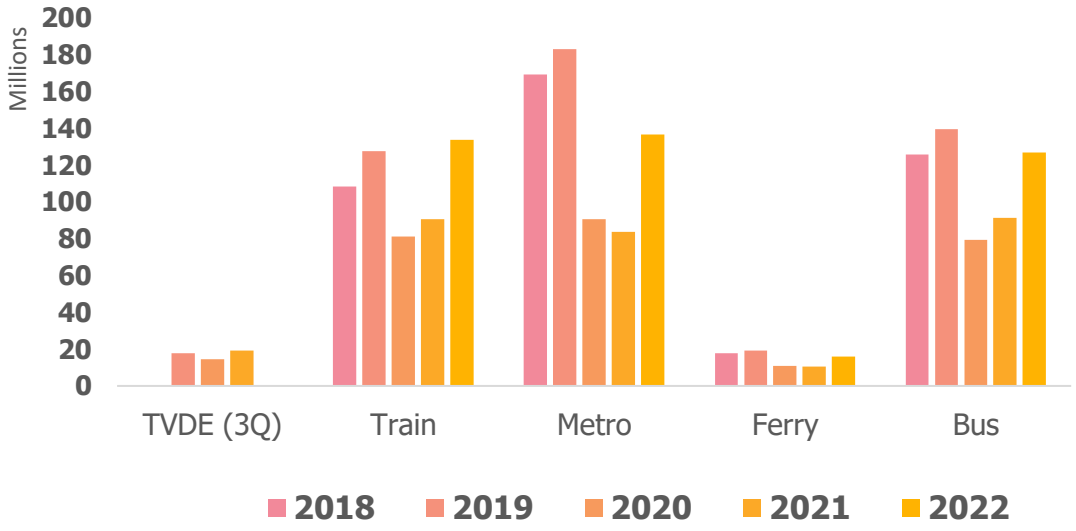


To analyse the differences in demand for different transportation modes we had to calculate values for TVDE based on the assumption that the percentage of TVDE drivers was the same as it was in 2021 (65.5%), since we only have this data for the whole Portuguese territory in the rest of the years in study. This demand for TVDE is also only reflecting the first three quarters of each year, due to lack of official data for the entire year of 2021. This way we were able to calculate and compare the demand for TVDE modes to public transportation (see Figure 4).

Due to the various restrictions arising from the Covid-19 pandemic lived in 2020 and 2021, we naturally observe a great drop in the demand for all modes. The largest, of 50.5%, happened in 2020 for the metro system. Bus and ferry transportation also dropped very significantly, i.e., 44%, 43%, respectively. The decline of the demand for trains was slightly lower but still very significant (36.6%). Conversely, the drop in the number of TVDE trips was considerably lower at 18.42%. In the first months of 2021, restrictions started to be withdrawn and people's lives started to have some normality, therefore we observe that the demand for all these services also started to recover to pre-Covid-19 levels. However, only TVDE and train services have registered (in 2021 and 2022, respectively) greater demand levels than those in 2019. Bus, Ferry, and Metro systems have demand levels inferior to 2019. As a matter of fact, while other transports modes experienced and heavy drop from 2019 to 2021, TVDE was able to increase its demand.

This indicates a very high growth trend when compared to any of the other transport modes.

FIGURE 4 - DEMAND FOR DIFFERENT TRANSPORTATION MODES IN AML



5.2 Microlevel Analysis Using Individual Survey Travel Data

Before carrying out any analysis, the microlevel database was first filtered to only display answers from respondents residing in Lisbon municipality. It was further filtered to exclude any missing values to the question "How frequently do you use, or have used, TVDE systems (Uber, Bolt, etc..)?". The final sample size contains 449 individuals. The answers to the question allow grouping individuals according to the frequency of TVDE use into *Frequent Users* and *Non-frequent Users*. Frequent Users refer to the respondents that use TVDE systems at least once a week (i.e., *Every day*, *3 to 5 days a week*, *1 to 2 days a week*). Non-frequent Users refer to all the remaining respondents who use TVDE only occasionally (i.e., *Twice a month*, *Less than once a month*, *I only used it once*). The analyses carried out are presented for the full sample of respondents, and also separately for the two groups of TVDE users, i.e., *Frequent Users* and *Non-frequent Users*.

Below, Table 4 shows the absolute and relative frequencies of the answers, separated by these groups.

5.2.1 Profiles of TVDE users

TABLE 4 - DEMOGRAPHIC AND SOCIOECONOMIC FACTORS BY TYPE OF USER

		Non-frequent Users		Frequent User		Total	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Gender	Feminine	136	51.32%	90	48.91%	226	50.33%
	Masculine	128	48.30%	93	50.54%	221	49.22%
	Other	1	0.38%	1	0.54%	2	0.45%
	Total	265	100.00%	184	100.00%	449	100.00%
Age	Less than 25	56	21.13%	47	25.54%	103	22.94%
	25 to 34	52	19.62%	54	29.35%	106	23.61%
	35 to 44	54	20.38%	38	20.65%	92	20.49%
	45 to 54	61	23.02%	25	13.59%	86	19.15%
	55 to 64	19	7.17%	11	5.98%	30	6.68%
	65 or more	23	8.68%	9	4.89%	32	7.13%
	Total	265	100.00%	184	100.00%	449	100.00%
Education Level	Basic School	33	12.45%	15	8.15%	48	10.69%
	Secondary School	103	38.87%	87	47.28%	190	42.32%
	Higher Education	129	48.68%	82	44.57%	211	46.99%
	Total	265	100.00%	184	100.00%	449	100.00%
Household Income	I prefer not to say	105	39.62%	68	36.96%	173	38.53%
	Less than €1.000	23	8.68%	19	10.33%	42	9.35%
	€1.000 - €1.999	37	13.96%	28	15.22%	65	14.48%
	€2.000 - €3.999	76	28.68%	47	25.54%	123	27.39%
	€4.000 or more	24	9.06%	22	11.96%	46	10.24%
	Total	265	100.00%	184	100.00%	449	100.00%

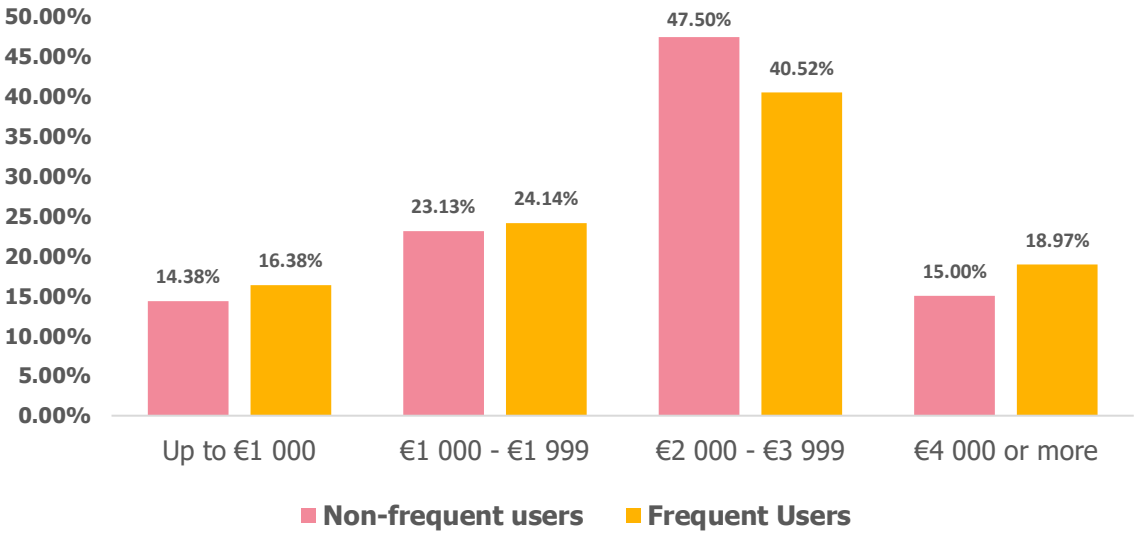
Thanks to the comprehensive nature of the questionnaire, we are able to explore many interesting topics, and analyse various aspects of the population's demographics and socioeconomic factors. Through this process, we aim to infer valuable insights about the users of these services. Before analysing each demographic and socioeconomic factors, a quick note goes to the fact that 59.02% of users are non-frequent users, and 41.08% use the service at least once a week. General satisfaction with the service is very positive (98.67%). Out of the total population of 449 respondents, only 6 indicated a negative level of satisfaction.

There are some tendencies that we can observe from many of these values. There is a balanced gender distribution in this population, with no significant disparity between male and female respondents. For the ages distribution we observe similar frequencies up to 54 years, after which there is a notable decline, comprising only 13.8% of the total population. This discrepancy intensifies from non-frequent users (15.85%) to frequent users (10.87%). The frequency of users aged up to 34 years-old ranges from 40.75% to 54.89% across non-frequent and frequent users, respectively, suggesting that TVDE services are more popular among younger population.

Data for the education level indicates that a substantial proportion of this population, 46.99%, has higher education, which denotes a predominately educated demographic. Frequent users tend to have higher education levels, although not necessarily superior, which could be justified by the fact that a part of them may not be aged enough to. This is understandable since TVDE have truly competitive prices compared to Taxis, allowing them to reach a large portion of the population beyond just higher-educated classes (and thus, with higher incomes)

Household income values follow a relatively even distribution across the population. Although, it is important to highlight that around 39% preferred not to answer this question, reflecting the sensitivity of the question. If we exclude those who chose not to disclose their income, there is a significant emphasis (45%) on the households getting from €2 000 to €3 999 monthly, equivalent to €24 000 to €47 988 annually. Considering that the average yearly income (2021) in Portugal is €11 089 (Eurostat, 2023), with an average household size of 2.9 persons, the average yearly income in our sample amounts to approximately €32 160, placing this percentage of users within middleclass households. This factor varies inconsistently across our groups (refer to Figure 5). Frequent users have higher frequencies in all classes except the €2 000 to €3 999. This, together with the fact that, in the highest class, there is an 26.46% increase from non-frequent to frequent users, complicates the identification of any clear trend.

FIGURE 5 - HOUSEHOLD INCOME BY TYPES OF USERS



5.2.2 Frequency of use of TVDE and trip purposes

For this analysis, we classify each travel motive as occasional or habitual, depending on their nature. We recognize that there is room for different interpretation in this categorization, therefore, we describe our rationale: Habitual motives include those closely tied to daily routines, so we consider the following: *Way back home*, *Go to collective transport*, *Go to work*, *Drop-off/Pick-up family (school)*, *Drop-off/Pick-up family (work)* and *Working tool*. Motives related to work are considered as habitual as working is something that is deeply integrated with routines, which is also the case of school, or going back home. Along the same lines of thought, we extend the classification to *Drop-off/Pick-up family (school)*, *Drop-off/Pick-up family (work)*. As for *Go to collective transport*, that may raise more uncertainties, we also include it in the habitual category, under the assumption that non-frequent users of TVDE (where it is more popular) use public transportation more frequently than frequent users. However, it is worth noting that this is a motive with scarce relevance, as it only was only pointed out 4 times by the respondents. Occasional motives encompass activities that do not occur as regularly, such as *leisure*, and *personal matters* (exemplified in the questionnaire as a medical appointment. These and the remaining activities, do not follow a consistent routine and may occur sporadically. For instance, going to the gym a few times a week or attending appointments regularly may be part of a routine but are not as frequent as daily commutes to work or school. Below, Table 5 shows the absolute and relative frequencies of the motives, separated by these groups.

TABLE 5 - TRIP PURPOSES FOR TVDE BY TYPE OF USER

	Non-frequent Users		Frequent User		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Leisure	109	41.13%	62	33.70%	171	38.08%
Personal matters	86	32.45%	41	22.28%	127	28.29%
Way back home	31	11.70%	38	20.65%	69	15.37%
Go to work	19	7.17%	27	14.67%	46	10.24%
Other	3	1.13%	5	2.72%	8	1.78%
Meals	4	1.51%	2	1.09%	6	1.34%
Working tool	3	1.13%	3	1.63%	6	1.34%
Go to collective transport	4	1.51%	0	0.00%	4	0.89%
Drop-off/Pick-up family (other)	3	1.13%	1	0.54%	4	0.89%
Drop-off/Pick-up family (work)	1	0.38%	2	1.09%	3	0.67%
Fun (No certain destination)	0	0.00%	2	1.09%	2	0.45%
Drop-off/Pick-up family (school)	1	0.38%	1	0.54%	2	0.45%
Shopping	1	0.38%	0	0.00%	1	0.22%
Total	265	100%	184	100%	449	100%
Habitual	59	22.26%	71	38.59%	130	28.95%
Occasional	206	77.74%	113	61.41%	319	71.05%
Total	265	100%	184	100%	449	100%

A substantial percentage (71.05%) of respondents report to use TVDE for occasional purposes: personal matters, leisure, among other options that denote sporadic usage. 28.95% report to use TVDE for habitual purposes. We observe a large gap among groups, where non-frequent users travel 22.26% of the times for habitual purposes, while in frequent users, this value is of 38.59%. Consequently, occasional usage declines in frequent users. From all the options, the ones that stood out among both groups of respondents converged: *Go to work, Way back home, Personal matters,* and *leisure* (91.98% of the total). In our consideration, the first two classify as habitual purposes, as explained in the beginning of this section. It is important to note that in journeys motivated by habitual purposes, the substitution effect for other modes is significantly higher, since daily or regular commutes often become deeply ingrained habits for individuals, making them more receptive and willing to find the most convenient, cost-efficient, and overall suitable transportation solution. Thus, when new modes with added value for users become available, there is a high likelihood of adopting them for their

regular journeys, amplifying the potential of substitution effect. In contrast, the lack of habitual behaviour and the lower frequency of occasional journeys, reduces the motivation to explore alternative transportation modes, which in turn, reduces the potential substitution effect.

Lastly, it is particularly intriguing to note that only 0.89% of respondents indicated using TVDE as a way reach collective transportation systems. This is because, in the same survey, to the question *"Do you consider TVDE as a good mode to reach collective transportation (bus, train, metro, ferry, etc.)?"* 84.22% answered positively, and only 15.76% did not recognise this potential.

5.2.3 Scope for substitution or complementarity between TVDE and other travel modes

The answers to the question "What alternative would you use if TVDE did not exist?" provides the possibility to assess better the potential substitution and complementary effects of TVDE over other modes. Below, Table 6, displays the distribution of the responses.

TABLE 6 - ALTERNATIVE MODE TO TVDE BY TYPE OF USER

	Non-frequent Users		Frequent User		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Taxi	131	49.43%	71	38.59%	202	44.99%
Public Transport	53	20.00%	65	35.33%	118	26.28%
Private Car	58	21.89%	24	13.04%	82	18.26%
Active Travel	12	4.53%	16	8.70%	28	6.24%
Other	6	2.26%	5	2.72%	11	2.45%
Would not go	5	1.89%	3	1.63%	8	1.78%
Total	265	100%	184	100%	449	100%

The scope for induced travel seems to be small, since only 2% of the trips would not have been done at all. The greater impact is therefore on modal transfer. Overall, the transportation mode most affected by TVDE seems to be Taxis (44.99% of respondents). This effect is stronger for the non-frequent TVDE users (49.3%) than for frequent TVDE users (38.59%). This result is in line with expectations, since TVDE services are a direct competitor to Taxi services. This clear substitution effect arises from the similarities between the two transportation modes with the advantage of TVDE legal framework

giving e-hailing operators more opportunities to capture passengers, as discussed in Section 3.

The second transportation mode most affected by TVDE services is public transport: overall, 26% of the respondents reported that they would have made their TVDE trip using public transport. The figure is considerably higher for frequent users of TVDE services (35%), compared to non-frequent users (20%). This suggests a potential strong substitution effect between public transport and TVDE services, where weekly trips (i.e. made several days per week) which could be made by public transport are made using TVDE services. This result can also be interpreted as an intention of people to use public transport if the services are attractive enough. Moreover, if we refer to Table 5, we see that the percentage of people using TVDE to reach public transportation is almost null, and even though we would also need the percentage of people using TVDE from public transportation hubs to their destinations (i.e., last mile), this is a very clear indicator that they are not serving as a complementary solution to public transport.

The third mode of transportation most affected by TVDE is the private car, but with considerably lower rates of substitution: only 13.04% of frequent users would have made their TVDE trip using a private car. The value for non-frequent users is much higher, at nearly 22%, suggesting that it is more common for TVDE to replace infrequent car trips than frequent car trips: this further reduces the scope for substituting private car trips by TVDE car trips.

We also observe a low percentage of respondents indicating that they would have done the trip using active travel (i.e. walking or cycling) as an alternative to TVDE e-hailing: 9% for frequent users against 5% for non-frequent users. This suggests that active travel modes are not widely perceived as suitable substitutes for TVDE services. A variety of factors could explain this result, for instance the typically shorter distance of these trips, especially walking. Improving cycling infrastructure in Lisbon may help increase the potential for TVDE trips to be made using bicycles, notably shared e-bicycles, which can cover longer trip distances (even up to 10 km) at competitive speeds to TVDE (and private car for that matter), by improving the objective and subjective feeling of road safety. It is perhaps surprising that no respondent referred to shared micromobility solutions (e.g. e-scooters; although very few, bicycles might have been included in the response of active travel) if TVDE was not available. The reluctance to use shared micromobility services may have in common the same reasons referred above for cycling, i.e. poor road safety.

A question in the MASTI survey, "Why do you not use shared micromobility systems?", allows us measure precisely this. There were 135 missing values and 75 responses indicated that they were not aware of such systems. Below, Table 7, displays the remaining observations.

TABLE 7 - REASONS FOR NOT USING SHARED MICROMOBILITY

	Frequency	Percent
Feel insecure	122	51.05%
Not comfortable	47	19.67%
Expensive fares	27	11.30%
Not close to home/destination	20	8.37%
Others	14	5.86%
Do not work when I need	5	2.09%
Too slow	4	1.67%
Total	239	100.00%

Indeed, we observe that, when inquired, 51.05% claimed that they do not feel safe using Micromobility systems, and 19.67% claimed that they are comfortable, which may as well result from poor infrastructures. Therefore, the improvement of these infrastructures could serve as a significant incentive for non-users of Micromobility to try the systems, and potentially start using them more often, instead of opting for less sustainable alternative transportation modes.

CHAPTER 6 – CONCLUSIONS

6.1 Main findings

The empirical analyses of this study consisted of four analyses – i.e., aggregate mobility trends, TVDE user profile, TVDE trips purposes, and the scope for substitution or complementarity between TVDE and other travel modes. Considering our main research question - i.e., *are e-hailing services contributing to a more sustainable urban mobility system*? -, the results reveal a potentially strong substitution effect between e-hailing and both Taxi services (i.e., 39% of frequent TVDE users) and public transportation (i.e. 35% of frequent TVDE users), as these were the two transportation modes most cited as alternatives to journeys made using TVDE services by respondents, particularly frequent users of TVDE services. Additionally, we do not find any evidence of a potential complementarity effect between TVDE and public transportation, since only 0.89% of respondents said that they use TVDE to reach public transport services. The potential substitution of private car trips is substantially lower in frequent users (i.e., only 13%).

These findings suggest that the contribution of e-hailing for sustainable urban transport systems is likely to be negative, that is, it does not seem to be a solution to reduce car dependency in Lisbon and the negative effects of car use (e.g., congestion, environmental costs, public health costs, etc.). It may also increase the need to subsidize public transportation by reducing the demand for public transport services. From an environmental point of view, increasing reliance on individual transportation contributes to increased congestion and higher carbon emissions, heat-islands, road collisions, noise and air pollution. This in turn undermines the efforts aimed at fostering sustainable mobility and addressing climate change, as per SDG 11 and SDG 13, respectively. Furthermore, this can increase social inequalities by limiting access to affordable and inclusive transportation modes, especially for vulnerable communities who must rely on public transport, potentially isolating them, thereby contravening SDG 10.

6.2 Implications for Policy Making

We examined the differences between e-hailing, taxi, and public transportation. It was found that there is a huge discrepancy in the dimensions of taxi and e-hailing markets. While acknowledging the attractiveness of e-hailing services to certain demographic segments - younger and better educated, who also exhibited higher usage frequencies, we attribute much of this contrast to the legal frameworks governing each sector. The first

RHA appeared in Portugal in 2014, the law that governs TVDE was introduced in 2018, and up to March 2024, no update had been made, even though a revision of the law has been announced several times. The law that legislates the Taxi was updated in 2023. This lack of action by the government in updating and adapting legislation to the current situation creates a significant imbalance in market opportunities, particularly evident in the absence of controls over the proliferation of TVDE vehicles, in contrast with the taxi sector, resulting in a market characterised by unfairness and lack of regulatory parity. Additionally, it is an open door to what has been found in the literature exacerbating labour precarity among drivers and perpetuating socioeconomic disparities. We also conclude that TVDE services are the ones with highest relative increase in demand, and the only mode of transport which was able to recover from the Covid-19 pandemic effects as early as of 2021, despite the ongoing impact.

The challenges posed for policy making are crucial for fostering a fair and sustainable transportation ecosystem, and it must start by adapting the legislation to the current situation, since there needs to be a control over the predominance of TVDE vehicles to achieve fair market opportunities for all transportation modes, while safeguarding the rights and working conditions of drivers. Additionally, efforts must be done to incentivize the integration of TVDE systems with existing public transportation. Even though respondents indicated that they did not use TVDE as a complement, there is potential for this complementary relation, since 84.22% indicated that they considered TVDE as a great way of accessing public transportation. This gives an indication to transport authorities and policymakers that pilot projects incentivizing these connections (e.g. vouchers when origin or destination is transportation hub) may be effective in Lisbon, and likely to generate positive results and increasing TVDE usage as a complement to more sustainable modes of transport. As discussed in the literature review, these initiatives are not novel and have been successfully done elsewhere.

6.3 Limitations

As mentioned before, during this study, numerous attempts were made to obtain data for empirical analysis. As discussed previously, Uber and Bolt, the two platforms operating in Portugal at present, and are legally obliged to report, on a monthly basis, various metrics to IMT and AMT (i.e., Number of drivers registered on the platforms, Number of vehicles registered on the platforms, Number of kilometres travelled, Number

of trips, Number of trips intended for passengers with reduced mobility, Average waiting time to access the service, Drivers' total working time, Number of complaints received, Price of the services provided). AMT refused to provide any of this data, citing concerns over the sensitivity of the data due to the limited number of electronic platform operators (i.e., only two), since *operators would easily calculate indicators from the other platform*. After reiterating that this data would be used exclusively for the purpose of this dissertation, offering to sign confidentiality terms, and proposing that the data was sent without referencing the platforms or operator to diminish the consequences of what could be its irresponsible usage, the request was again denied without further consideration. IMT was contacted several times to a variety of e-mail addresses and physically at its headquarters, but never answered. In one of the in-person visits, it was possible to speak on the phone to an engineer that worked in the transport department and who provided a more specialised email address for the matter, from which we also never got an answer. Despite the presumption that public organizations would readily provide such data, the unexpected reluctance of these entities poses a challenge to the empirical analysis.

6.4 Further Investigation

This study marks an initial effort to understand how the widespread adoption of e-hailing services in Portugal is affecting various aspects of transportation. As mentioned, unfortunately, we could not make the most sophisticated market analysis possible due to the lack of official data. Additionally, the size of our survey sample prevented us from using advanced statistical methods with significance to strengthen our conclusions. However, formal proposals from IMT for making more comprehensive data reporting mandatory by the electronic platforms have been made, which marks the potential of further, more robust analyses, depending on the availability of IMT and AMT of providing this sort of data in the future.

One potential area for further study is the assessment of substitution and complementary effects through the examination of factors such as usage during peak hours, and strategic locations. This study, as a starting point, lays the groundwork for future research using more appropriate data and analytical methods, in order to have a deeper understanding of the implications of the e-hailing usage in Portugal.

ACKNOWLEDGEMENTS

This work benefited from individual travel survey data produced as part of the project MASTI (Mobility as a Service and Socio-Territorial Inequalities), financed by national funds through FCT - *Fundação para a Ciência e a Tecnologia, I.P.*, under the grant number PTDC/GES-TRA/3353/2020 (http://doi.org/10.54499/PTDC/GES-TRA/3353/2020).

REFERENCES

Ahmed, T., & Hyland, M. (2023). Exploring the role of ride-hailing in trip chains. Transportation, 50(3), 959–1002. https://doi.org/10.1007/s11116-022-10269-w

Alemi, F., Circella, G., Handy, S., & Mokhtarian, P. (2018). What influences travelers to use Uber? Exploring the factors affecting the adoption of on-demand ride services in California. Travel Behaviour and Society, 13, 88–104. https://doi.org/10.1016/j.tbs.2018.06.002

Amorim, H., & Moda, F. (2020). Work by app: Algorithmic management and working conditions of Uber drivers in Brazil. Work Organisation, Labour & Globalisation, 14(1), 101–118. https://doi.org/10.13169/workorgalaboglob.14.1.0101

AMT. (2020). *O Transporte em Táxi em Portugal*. https://www.amt-autoridade.pt/media/2558/sintese-mercado-taxi-portugal-junho2020.pdf

Arias-Molinares, D., & García-Palomares, J. C. (2020). The Ws of MaaS: Understanding mobility as a service from a literature review. *IATSS Research*, *44*(3), 253–263. https://doi.org/10.1016/j.iatssr.2020.02.001

Assembleia da República. (2013). Lei n.o 6/2013. Diário Da República n.o 15/2013, Série I de 2013-01-22. https://diariodarepublica.pt/dr/detalhe/lei/6-2013-257176

Assembleia da República. (2018). Lei n.o 45/2018. Diário da República n.o 154/2018, Série I de 2018-08-10, 3972–3980. https://diariodarepublica.pt/dr/detalhe/lei/45-2018-115991688

Atkinson-Palombo, C., Varone, L., & Garrick, N. W. (2019). Understanding the Surprising and Oversized Use of Ridesourcing Services in Poor Neighborhoods in New York City. *Transportation Research Record: Journal of the Transportation Research Board*, *2673*(11), 185–194. https://doi.org/10.1177/0361198119835809

Botsman, R. (2013). *The sharing economy lacks a shared definition. Fast Company*. http://www.fastcoexist.com/3022028/the-sharing-economy-lacks-a-shared-definition#1

Bozzi, A. D., & Aguilera, A. (2021). Shared E-Scooters: A Review of Uses, Health and Environmental Impacts, and Policy Implications of a New Micro-Mobility Service. *Sustainability*, *13*(16), 8676. https://doi.org/10.3390/su13168676

Brown, A. (2019). Redefining Car Access: Ride-Hail Travel and Use in Los Angeles. *Journal of the American Planning Association*, *85*(2), 83–95. https://doi.org/10.1080/01944363.2019.1603761

Chalermpong, S., Kato, H., Thaithatkul, P., Ratanawaraha, A., Fillone, A., Hoang-Tung, N., & Jittrapirom, P. (2023). Ride-hailing applications in Southeast Asia: A literature review. *International Journal of Sustainable Transportation*, *17*(3), 298–318. https://doi.org/10.1080/15568318.2022.2032885

CML. (2023). *Acordo de Colaboração CML/Operadores de Mobilidade*. https://www.lisboa.pt/fileadmin/atualidade/noticias/user_upload/Acordo_de_Colaborac__a__o_OperdoresTrot_09_01_23.pdf

Cruz, M. (2021, October 31). Três anos de "lei Uber" com perto de 32 mil motoristas e alguns problemas no setor. *Observador*. https://observador.pt/2021/10/31/tres-anos-de-lei-uber-com-perto-de-32-mil-motoristas-e-alguns-problemas-no-setor/

Dai, J., Alvarado, R., Ali, S., Ahmed, Z., & Meo, M. S. (2023). Transport infrastructure, economic growth, and transport CO2 emissions nexus: Does green energy consumption in the transport sector matter? *Environmental Science and Pollution Research*, *30*(14), 40094–40106. https://doi.org/10.1007/s11356-022-25100-3

Diao, M., Kong, H., & Zhao, J. (2021). Impacts of transportation network companies on urban mobility. *Nature Sustainability*, *4*(6), 494–500. https://doi.org/10.1038/s41893-020-00678-z

Eurostat. (2023). *Income inequality across Europe in 2021*. https://ec.europa.eu/eurostat/web/products-eurostat-news/w/DDN-20230113-1

Flor, M., Ortuño, A., & Guirao, B. (2022). Ride-hailing services: Competition or complement to public transport to reduce accident rates. The case of Madrid. *Frontiers in Psychology*, *13*, 951258. https://doi.org/10.3389/fpsyg.2022.951258

Frenken, K., Meelen, T., Martijn, A., & van de Glind, P. (2015, May 20). Smarter regulation for the sharing economy. *The Guardian*. https://www.theguardian.com/science/political-science/2015/may/20/smarter-regulation-for-the-sharing-economy

Gehrke, S. R., Felix, A., & Reardon, T. G. (2019). Substitution of Ride-Hailing Services for More Sustainable Travel Options in the Greater Boston Region. *Transportation Research Record: Journal of the Transportation Research Board*, *2673*(1), 438–446. https://doi.org/10.1177/0361198118821903

Geitung, I. (2017). Uber drivers in Cape Town: Working conditions and worker agency in the sharing economy. http://urn.nb.no/URN:NBN:no-63066

Gomes, J. (2022, December 22). Maioria dos países da UE, incluindo Portugal, não garantem todos os direitos a trabalhadores das plataformas digitais. *Observador*. https://observador.pt/2022/12/04/maioria-dos-paises-da-ue-incluindo-portugal-nao-garantem-todos-os-direitos-a-trabalhadores-das-plataformas-digitais/

Hall, J. D., Palsson, C., & Price, J. (2018). Is Uber a substitute or complement for public transit? *Journal of Urban Economics*, *108*, 36–50. https://doi.org/10.1016/j.jue.2018.09.003

Holtum, P. J., Irannezhad, E., Marston, G., & Mahadevan, R. (2022). Business or Pleasure? A Comparison of Migrant and Non-Migrant Uber Drivers in Australia. *Work, Employment and Society*, *36*(2), 290–309. https://doi.org/10.1177/09500170211034741

IMT. (2021). *Anuário Estatístico da Mobilidade e dos Transportes*. https://www.imt-ip.pt/sites/IMTT/Portugues/IMTT/relatoriosectoriais/Documents/2020_Anu%C3%A1rio%20Estat%C3%ADstico%20Mobilidade%20Transportes_Final.pdf

IMT. (2022). *Avaliação do regime TVDE*. https://www.imt-ip.pt/sites/IMTT/Portugues/Noticias/Documents/2022/Relatorio%20TVDE_28.12.2021_Final.pdf

IMT. (2023). *Anuário Estatístico da Mobilidade e dos Transportes*. https://www.imt-ip.pt/sites/IMTT/Portugues/IMTT/relatoriosectoriais/Documents/Anu%C3%A1rio+Estat%C3%ADstico+Mobilidade+Transportes_2021.pdf

International Transport Forum. (2017a). *ITF Transport Outlook 2017*. https://doi.org/10.1787/9789282108000-en

International Transport Forum. (2017b). *Shaping the Relationship Between Public Transport and Innovative Mobility*. *34*. https://doi.org/10.1787/7a1f7b89-en

James Holtum, P., Irannezhad, E., Marston, G., & Mahadevan, R. (2022). Business or Pleasure? A Comparison of Migrant and Non-Migrant Uber Drivers in Australia. *Work, Employment and Society*, *36*(2), 290–309. https://doi.org/10.1177/09500170211034741

Khavarian-Garmsir, A. R., Sharifi, A., & Hajian Hossein Abadi, M. (2021). The Social, Economic, and Environmental Impacts of Ridesourcing Services: A Literature Review. *Future Transportation*, *1*(2), 268–289. https://doi.org/10.3390/futuretransp1020016

Kong, H., Zhang, X., & Zhao, J. (2020). Is ridesourcing more efficient than taxis? *Applied Geography*, *125*, 102301. https://doi.org/10.1016/j.apgeog.2020.102301

Kwakwa, P. A., Adjei-Mantey, K., & Adusah-Poku, F. (2022). The effect of transport services and ICTs on carbon dioxide emissions in South Africa. *Environmental Science and Pollution Research*, *30*(4), 10457–10468. https://doi.org/10.1007/s11356-022-22863-7

Meelen, T., & Frenken, K. (2015). Stop Saying Uber Is Part Of The Sharing Economy. Fast Company, 1–7. http://www.fastcoexist.com/3040863/stop-saying-uber-is-part-of-the-sharing-economy

Milev, G., Hastings, A., & Al-Habaibeh, A. (2021). The environmental and financial implications of expanding the use of electric cars—A Case study of Scotland. *Energy and Built Environment*, *2*(2), 204–213. https://doi.org/10.1016/j.enbenv.2020.07.005

Ministério da Economia e da Solidariedade, & Ministério do Emprego e Segurança Social. (2018). Portaria n.o 251-A/2015. Diário Da República n.o 160/2015, 1o Suplemento, Série I de 2015-08-18. https://diariodarepublica.pt/dr/detalhe/portaria/251-a-2015-70042507

Ministério do Ambiente e Ação Climática. (2023). Portaria n.o 451/2023. Diário Da República n.o 246/2023, Série I de 2023-12-22. https://diariodarepublica.pt/dr/detalhe/portaria/451-2023-812826260

Nieuwenhuijsen, M. J., & Khreis, H. (2016). Car free cities: Pathway to healthy urban living. Environment International, 94, 251–262. https://doi.org/10.1016/j.envint.2016.05.032

Número de motoristas TVDE triplicou em cinco anos, queixas (também) aumentaram. (2023, January 11). *Sic Notícias*. https://sicnoticias.pt/economia/2023-11-01-Numero-de-motoristas-TVDE-triplicou-em-cinco-anos-queixas--tambem--aumentaram-c2e7dda2

Presidência do Conselho de Ministros. (2023). Decreto-Lei n.o 101/2023. Diário Da República n.o 211/2023, Série I de 2023-10-31. https://diariodarepublica.pt/dr/detalhe/decreto-lei/101-2023-223575032

Qiao, S., & Gar-On Yeh, A. (2023). Is ride-hailing competing or complementing public transport? A perspective from affordability. *Transportation Research Part D: Transport and Environment*, *114*, 103533. https://doi.org/10.1016/j.trd.2022.103533

Raposo, F. (2023, October 23). Quantos TVDE já circulam por Lisboa? Ninguém sabe, mas Câmara quer definir limites. *A Mensagem*. https://amensagem.pt/2023/10/23/quantos-tvde-ja-circulam-por-lisboa-ninguem-sabe-camara-quer-definir-limites/

Rayle, L., Dai, D., Chan, N., Cervero, R., & Shaheen, S. (2016). Just a better taxi? A survey-based comparison of taxis, transit, and ridesourcing services in San Francisco. *Transport Policy*, *45*, 168–178. https://doi.org/10.1016/j.tranpol.2015.10.004

Ritchie, H. (2020). Cars, planes, trains: where do CO2 emissions from transport come from? *Our World in Data* https://ourworldindata.org/co2-emissions-from-transport?ref=sparrow#article-citation

Rodriguez, M. (2018). Why Uber Is Paying Drivers More to Go Electric | *Fortune*. https://fortune.com/2018/06/20/uber-drivers-switch-electric-cars/

Sadowsky, N., & Nelson, E. (2017). The Impact of Ride-Hailing Services on Public Transportation Use: A Discontinuity Regression Analysis. *Economics Department Working Paper Series*, 28. https://digitalcommons.bowdoin.edu/econpapers/13/

Santos, S. (2023, September 24). Setor do táxi contrai em Portugal mas condutores sentem regresso do público. *Diário de Notícias*. https://www.dn.pt/dinheiro/setor-do-taxi-contrai-em-portugal-mas-condutores-sentem-regresso-do-publico-17069188.html/

Shiying Wang, & Mengpin Ge. (2019). Everything You Need to Know About the Fastest-Growing Source of Global Emissions: Transport | World Resources Institute. *World Resources Institute*. https://www.wri.org/insights/everything-you-need-know-about-fastest-growing-source-global-emissions-transport

Silver, K., Lopes, A., Vale, D., & Da Costa, N. M. (2023). The inequality effects of public transport fare: The case of Lisbon's fare reform. *Journal of Transport Geography*, *112*, 103685. https://doi.org/10.1016/j.jtrangeo.2023.103685

Tirachini, A. (2020). Ride-hailing, travel behaviour and sustainable mobility: An international review. *Transportation*, *47*(4), 2011–2047. https://doi.org/10.1007/s11116-019-10070-2

TML. (2023). *Relatório de Atividades e Contas 2022*. https://www.tmlmobilidade.pt/wp-content/uploads/2021/12/Relatorio-e-Contas-2022.pdf

Tu, W., Santi, P., Zhao, T., He, X., Li, Q., Dong, L., Wallington, T. J., & Ratti, C. (2019). Acceptability, energy consumption, and costs of electric vehicle for ride-hailing drivers in Beijing. Applied Energy, 250, 147–160. https://doi.org/10.1016/j.apenergy.2019.04.157

Vega-Gonzalo, M., Aguilera-García, Á., Gomez, J., & Vassallo, J. M. (2024). Traditional taxi, e-hailing or ride-hailing? A GSEM approach to exploring service adoption patterns. Transportation, 51(4), 1239–1278. https://doi.org/10.1007/s11116-022-10356-y

APPENDICES

APPENDIX 1 - SUMMARY OF TVDE AND TAXI ENTITIES OBLIGATIONS

Dimensions in Analysis	Obligations of TVDE's and Electronic Platform's Operators Decree-Law 45/2018		Obligations of Taxi's Operators Decree-Law 101/2023	
Accessing the market	Arcticle 2 - 1º	The activity of TVDE operator is carried out in Portuguese territory by legal entities that carry out individual paid passenger transport, under the terms and conditions set out in this law.	Article 4 - 1º	The activity of taxi operator can only be carried out by companies, including sole traders, cooperatives and individual establishments with limited liability, licensed for this purpose by the Institute of Mobility and Transport
	Arcticle 3 - 1º	The start of activity as a TVDE operator is subject to licensing from IMT	Article 4 - 2º	The license to carry out the activity of taxi operator is embodied in a non-transferable permit, issued for a period of five years and renewable for equal periods, upon proof that the requirements for access to the activity remain met.
	Article 3 - 8º	The license is issued for a period not exceeding ten years, and may be renewed for periods additional period of five years, as long as the requirements for access to the activity are maintained.	Article 3 - 1º	The licensing request for the purposes of accessing the activity is requested by the interested party from the IMT
			Article 3 - 2º	The IMT analyzes the request and issues the respective decision within 30 days of its submission
Communications	Article 4 - 4º	TVDE operator must annually send to IMT the criminal record certificate of the the members of the respective , management or administrative bodies, or authorise their access	Article 8 - 2º	Taxi operators must communicate to IMT all changes to the respective articles of incorporation, namely changes in administration, direction or management
	Article 9 - 3º	Mergers of TVDE operators must be communicated to the Mobility and Transport Authority (AMT)	Article 25 - 3º	The resumption of taxi transport activity resulting from its suspension must be communicated by the taxi operator to the transport authority
	Article 18 - 4º	Operators of electronic platforms must annually send to IMT the criminal record certificate of the the members of the respective administrative, management or administrative bodies, or authorise their access		
	Article 30 - 4º	required to send monthly to the AMT, until the end of the month following the report, information relating to the activity carried out, namely the number of trips, the amount billed individually and the respective intermediation fee actually charged		
Tariffs and Pricing	Article 15 - 3º	The EPO can charge na intermediaition fee, which cannot be higher than 35% of the trip value.	Article 20 - 1º	Subject to a tariff regime defined by regulation, to be approved by the AMT, which establishes the general rules for price formation depending on the types of service
	Article 15 - 4º	Before and during any trip, the EP must clealry display to the user: the price calculation formula, showing every parameter such as applicable taxes and tariffs by time and distance, and na estimation of the price for the desirede trip, based on the route requested and on the factors that make up the calculation formula	Article 20 - 2º	Transport authorities may set specific tariffs applicable to their territory, through their own regulations, approved by decision of the competent executive body and communicated to the AMT.
	Article 15 - 5º	Service providers may apply a dynamic tariff, which cannot be higher than the value resulting from the application of a 100% increase factor to the average value of the price charged for services provided in the immediately previous 72 hours by that operator.	Article 20 - 4º	The taxi operator must keep it posted in the vehicle, in a visible place by the passenger, the tariff in force. (among the various provided for in the previous paragraph)
	Article 15 - 6º	The electronic platform must also provide for any itinerary, a proposal pre-determined fixed price, which, in case of acceptance by the user, corresponds to the price to be charged in the end of the service regardless of the distance traveled or the time spent.		
	Article 15 - 7º	Payment for the service is processed and recorded through the electronic platform, and only payment via electronic means.		
Information Display / Transparency	Article 15 - 4º	Before and during any trip, the EP must clealry display to the user: the price calculation formula, showing every parameter such as applicable taxes and tariffs by time and distance, and na estimation of the price for the desirede trip, based on the route requested and on the factors that make up the calculation formula	Article 20 - 4º	The taxi operator must keep the current tariff posted in the vehicle, in a visible place that can be easily consulted by the passenger
	Article 17 - 8º	The relevant information for acessing activity must be available on the electronic platform for consultation by any interested party, with the exception of the indication of the holders of the administrative, management or and social pact	Article 22 - 2º	The platforms of taxi services must display estimations of final pricing to the consumer, accrding to the rules of the established tariffs.
Data Reporting	Article 30 - 4º	Required to send monthly to the AMT, until the end of the month following the report, information relating to the activity carried out, namely the number of trips, the amount billed individually and the respective intermediation fee actually charged		

APPENDIX 2 - CORRESPONDENCE BETWEEN ORIGINAL AND AGREGGATED CATEGORIES

	Possible answers from MASTI questionnaire	Category
Gender	Feminine	Feminine
	Masculine	Masculine
	Non-binary	Other
	I prefer not to say	Other
Household Income	I prefer not to say	I prefer not to say
	No income	Less than €1.000
	Less than €706	Less than €1.000
	€706 to €999	Less than €1.000
	€1.000 to €1.999	€1.000 - €1.999
	€2.000 to €2.999	€2.000 - €3.999
	€3.000 to €3.999	€2.000 - €3.999
	€4.000 to €5.999	€4.000 or more
	€6.000 to €7.999	€4.000 or more
	more than €8.000	€4.000 or more
Education Level	No formal education	- no observations -
	Other	- no observations -
	1st Cycle of Education	Basic School
	2nd Cycle of Education	Basic School
	3rd Cycle of Education	Basic School
	High School	Secondary School
	Post-secondary	Secondary School
	Higher (Bachelor, Master, PhD)	Higher Education
Reasons	Drop-off/Pick-up family (other)	Occasional
	Drop-off/Pick-up family (school)	Habitual
	Drop-off/Pick-up family (work)	Habitual
	Shopping	Occasional
	Fun (no destination)	Occasional
	Working tool	Habitual
	Other	Occasional
	Meal	Occasional
	Leisure	Occasional
	Go to collective transport	Habitual
	Personal matters	Occasional
	Way back home	Habitual
	Go to work	Habitual
Alternative	Would not go	Would not go
	Walk	Active Travel
	Bicycle	Active Travel
	Bus	Public Transport
	Underground / Tram	Public Transport
	Train	Public Transport
	Car (driver)	Private Car
	Car (passenger)	Private Car
	Taxi	Taxi
	Motorbike	Other

	Other	Other
REASONS FOR NOT USING MICROMOBILITY	Not aware of the systems	Not aware of the systems
	feeling of personal insecurity	Feel insecure
	Feeling of road insecurity	Feel insecure
	Not comfortable	Not comfortable
	Expensive fares	Expensive fares
	Not close to my home	Not close to home/destination
	Not close to my destination	Not close to home/destination
	They are too slow	Too slow
	Time unavailability	Do not work when I need
	Require credit card payment	Other
	Struggle using Apps	Other