FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION

THE DEGRADATION OF SUSTAINABLE BUSINESS MODELS: CUSTOMER MISBEHAVIOUR AND SHARED MOBILITY

By

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Credit Author Statement

This thesis is presented as a monograph and has been entirely written by the author, Andrés Camacho Donézar. Two individual studies have been submitted to peer-reviewed journals. One of them has been already accepted for publication and corresponds to Chapter 2, while the other is based on content from Chapters 1, 3, and 4. My contributions to these studies have been as follows:

Study 1 (corresponds to Chapter 2)

- Andrés Camacho: Conceptualization; Formal analysis; Investigation; Methodology; Writing - original draft; Writing - review & editing

Study 2 (based on Chapters 1, 3 and 4)

- Andrés Camacho: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Writing – review & editing; Writing – original draft.

Use of GenAI Statement

I used ChatGPT-4 to review and enhance the clarity and accuracy of the English in this thesis. ChatGPT-4 assisted in refining language, improving readability, and ensuring consistency throughout the document, under my supervision. All content, analysis, and arguments remain my own, with ChatGPT-4 solely employed as a tool to support effective communication. After using this tool/service, I reviewed and edited the content as needed and take full responsibility for the content of the publication.

Abstract

This dissertation investigates the evolution of Sustainable Business Models (SBMs), a topic that has received limited attention in the literature. Most studies focus on how conventional business models can evolve to become sustainable, tacitly assuming that SBMs remain static. Challenging this assumption, we examine the role of customer misbehaviour and vandalism as a key driver of business model evolution in Access-Based Services (ABS), a type of SBM. Focusing on shared mobility as a subset of ABS, this research explores the micro and macro-level impacts of misbehaviour. At the micro level, it analyses how business model adaptations in response to misbehaviour affect sustainability goals. At the macro level, it investigates how these behaviors hinder the transition to sustainable urban mobility, disrupting efforts to move beyond the car-dependent transportation regime. By integrating the Business Model Framework, the Triple Bottom Line approach, and the Multi-Level Perspective (MLP) on socio-technical transitions, the thesis adopts a multi-method approach.

This thesis comprises two distinct studies. Study 1 employs deductive quantitative analysis to examine the factors contributing to crashes in carsharing and their relationship with different forms of customer misbehaviour, such as speeding and alcohol abuse. The analysis is based on a unique dataset of 2.2 million carsharing trips and is complemented by interviews with key managers and users of the carsharing service. Study 2 adopts a qualitative approach, utilizing interviews with managers from electric carsharing, motosharing, scootersharing, and bikesharing services, along with archival data, to assess companies' strategic responses to misbehaviour. It explores how these adaptations reshape business models, ultimately impacting operators' ability to balance economic viability, environmental sustainability, and social responsibility. The evidence gathered is also analysed to examine how these transformations influence the broader role of shared mobility operators in challenging the car-dependent transportation regime in cities.

The findings reveal that SBMs evolve in response to interconnected changes in consumer behavior, industry lifecycle, shareholder priorities, technological advancements, and regulatory shifts. With the exception of public bikesharing schemes, most operators transition from offering "shared mobility for all" to "premium niche mobility solutions,"

highlighting the challenges misbehaviour poses for niche innovators striving to scale and replace the car-centric regime. We call this process, the degradation of SBM.

This thesis makes theoretical contributions to the literature on SBMs, customer deviance, and socio-technical transitions. It demonstrates that SBMs can degrade when they fail to uphold their sustainability goals while remaining economically viable. Furthermore, it highlights customer misbehaviour and vandalism, an overlooked factor in previous research, as a key driver of this degradation. Additionally, this study reveals that the strategies companies adopt to address misbehaviour are not static, as suggested by the literature, but rather evolve over time, shaped by internal factors such as management capabilities and external forces including technological advancements, regulatory changes, and industry competition. Finally, this thesis advances socio-technical transition theory by demonstrating how customer misbehaviour obstructs the scaling of niche innovations, limiting their ability to disrupt existing transportation paradigms.

Empirically, it provides unique insights through interviews with industry executives, who rarely discuss these issues openly, an extensive review of media and industry reports, and a large dataset of carsharing accidents covering 2.2 million trips in Madrid.

Keywords: *Customer misbehaviour, vandalism, business model, process, sustainability, shared mobility, transitions.*

Resumen

Esta tesis examina la evolución de los modelos de negocio sostenibles (SBM, por sus siglas en inglés), un tema que ha recibido poca atención en la literatura. Hasta la fecha, la mayoría de los estudios se centran en cómo los modelos de negocio convencionales pueden evolucionar para volverse sostenibles, asumiendo tácitamente que los SBM permanecen estáticos. La tesis pone en cuestión esta asunción, examinando el papel del mal comportamiento de los usuarios y el vandalismo como factores clave en la evolución de los modelos de negocio en los modelos de negocio de servicios basados en el acceso (ABS en inglés), un tipo particular de SBM.

Focalizándonos en la movilidad compartida como un tipo de ABS, esta investigación explora los impactos del mal comportamiento a nivel micro y macro. A nivel micro, analiza cómo las adaptaciones de los modelos de negocio en respuesta al mal comportamiento afectan los objetivos de sostenibilidad. A nivel macro, investiga cómo estos comportamientos dificultan la transición hacia una movilidad urbana sostenible, interrumpiendo los esfuerzos para superar el régimen de transporte centrado en el automóvil. La tesis adopta un enfoque multimétodo integrando el Business Model Framework, la Triple Bottom Line y el Multi-Level Perspective (MLP) para transiciones socio-tecnológicas.

La tesis incorpora dos estudios diferentes. El Estudio 1 utiliza un análisis cuantitativo deductivo para examinar los factores que explican los accidentes en el carsharing y cómo se relacionan con diferentes formas de mal comportamiento de los usuarios, como el exceso de velocidad y el consumo de alcohol. El análisis se basa en un conjunto de datos de 2,2 millones de trayectos de carsharing y se complementa con entrevistas a gerentes clave del proveedor y usuarios del servicio de carsharing. El Estudio 2 utiliza entrevistas con directivos de servicios de carsharing eléctrico, motosharing, scootersharing y bikesharing, junto con datos de archivo (noticias, páginas webs, informes sectoriales), para evaluar las respuestas estratégicas de las empresas ante el mal comportamiento y cómo esas respuestas hacen evolucionar su modelo de negocio afectando al triple objetivo de ser económicamente viables, ambientalmente sostenibles y socialmente responsables.

Los resultados revelan que los SBM evolucionan en respuesta a cambios interconectados en el comportamiento del consumidor, el ciclo de vida de la industria, las prioridades de los accionistas, los avances tecnológicos y cambios regulatorios. Con la excepción de las empresas públicas de bikesharing, la mayoría de los operadores pasan de ofrecer "movilidad compartida para todos" a convertirse en "soluciones de movilidad de nicho premium", destacando los desafíos que el mal comportamiento representa para los innovadores de nicho que intentan escalar y reemplazar el régimen centrado en el automóvil. Hemos denominado a está evolución, la degradación de los SBM.

Esta tesis realiza contribuciones teóricas a la literatura sobre SBM, el mal comportamiento del consumidor y las transiciones socio-tecnológicas. Demuestra que los SBM pueden degradarse cuando no logran mantener su promesa de objetivos sostenibles, al mismo tiempo que ser rentables económicamente. Además, muestra que el mal comportamiento de los usuarios, un factor que no ha sido estudiado en este contexto, es un impulsor clave de esta degradación. También revela que las estrategias que las empresas adoptan para abordar el mal comportamiento no son estáticas como sugiere la literatura, sino que evolucionan con el tiempo, influenciadas por factores internos, como las capacidades de gestión, y elementos externos, como los avances tecnológicos, los cambios regulatorios y la competencia en la industria. Finalmente, la tesis avanza en la teoría de transiciones al demostrar cómo el mal comportamiento dificulta la escalabilidad de las innovaciones de nicho.

Empíricamente, ofrece perspectivas de entrevistas con ejecutivos del sector que rara vez discuten estos temas abiertamente, una amplia revisión de medios y una base de datos única sobre accidentes en carsharing de 2,2 millones de viajes en Madrid.

Palabras clave: *Comportamiento del consumidor, vandalismo, proceso, modelo de negocio, sostenibilidad, transiciones.*

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Permissions and Data Protection

All necessary authorizations for the use of data in this study have been obtained, adhering rigorously to data protection regulations and measures as mandated by Spanish and European law.

Stringent measures were implemented to ensure the confidentiality, integrity, and ethical handling of all data collected and analysed throughout this research process. All informants involved in this study have provided signed informed consent, confirming their voluntary participation and understanding of the study's purpose and procedures. The ethical and legal frameworks governing data protection were upheld at every stage, safeguarding the rights and privacy of all individuals involved in this study. No identification is provided throughout the document with the exception of Study 1 where a specific shared mobility operator is mentioned. The author has obtained the corresponding permissions to use the data, duly anonymized, and provide the name of the company.

Introduction

1. Research topic

The sharing economy is a socio-economic model that centres on shared access to resources, enabling individuals and companies to collaboratively consume or provide goods and services without requiring ownership (Botsman & Rogers, 2010). This model prioritizes access over ownership, promoting a resource-efficient, sustainable economy that fulfils consumer needs in innovative ways, often organized as digital platforms (Gerwe & Silva, 2020; Hossain, 2020). The sharing economy has experienced substantial growth, impacting sectors from transportation to housing and reflecting shifts in consumer values and expectations (Martin, 2016). This concept aligns with Sustainable Business Models (SBMs), which aim to generate economic, social, and environmental value by engaging multiple stakeholders and the adherence to a long-term perspective (Bocken et al. 2013; Geissdoerfer et al., 2018; Mignon & Bankel, 2023). Although sustainable business models (SBMs) are designed to balance economic, environmental, and social value, companies often face trade-offs among these dimensions in practice (Stål, Riumkin, & Bengtsson, 2023; Svensson et al., 2018). A related but distinct concept appears in the literature on social enterprises—organizations primarily driven by a social mission but that rely on market-based approaches to sustain their operations (Mair & Martí, 2006; Santos, 2012). In this context, scholars highlight the risk of "mission drift," which refers to the tendency of these organizations to lose sight of their social objectives as financial pressures mount (Fowler, 2000; Jones, 2007).

Like any other business model, SBMs ongoingly change (Demil & Lecoque, 2010; Foss & Saebi, 2018). Despite the calls for better understanding of business model evolution (Wirtz et al., 2016), research on the evolution of SBM is scant. Whereas many studies have examined how business models innovate towards sustainability (Bocken & Gerardts, 2020; Mignon & Bankel, 2022; Zollo et al., 2013), they have largely overlooked the transformations that SBMs experience once established (Cosenz et al., 2019; Moggi & Dameri, 2021). Studying the “fine-tuning process” of SBM (Demil & Lecoque, 2010) is especially relevant to understanding whether and how their promise to create triple value is sustained (Schneider & Clauß, 2020). Indeed, the difficulties in balancing economic, social and environmental benefits is one of the major challenges for embedding sustainability in business models (Crane et al., 2014; Evans et al., 2017; Reuter, 2021). The literature on business model evolution also shares an optimistic assumption that evolution is always for good: changes to the business model are

thought to enable fit with the environment, so that the business model architecture gains quality over time (Climent & Haftor, 2021; König et al., 2022). Yet, this assumption has been problematized, as there is missing empirical evidence to uncritically sustain that changes in the business model are necessarily beneficial for firms and their stakeholders (Foss & Saebi, 2018). In the case of SBM, business model evolution may strengthen the triple value creation of the business model or do the opposite: it may compromise its potential to create, deliver and capture tri-value (Snihur & Bocken, 2022).

Aiming to extend this nascent stream on SBM evolution, this thesis focuses on an understudied driver of business model evolution: customer misbehaviour. We include under customer misbehaviour any form of damage to corporate assets that can be committed by consumers and non-consumers alike (van Vliet, 1992) thus including vandalism as a form of misbehaviour. Customer misbehaviour is an important threat in Access-Based Services, a popular SBM that consists of providing temporary access to products and delivering functionality rather than ownership (Mignon & Bakel, 2022) to make services accessible to growing populations, use resources more efficiently and reduce environmental impacts (França, Broman, Robert, Basile & Trygg, 2017).

We focus on shared mobility, a subset of Access-Based Services (ABS) where customer misbehaviour and vandalism are widespread (Jin et al., 2020; Gong & Zhang, 2023). As an ABS, shared mobility services provide users with temporary access to transportation options such as carsharing, bikesharing, motosharing, and scootersharing (Bardhi & Eckhardt, 2012). This model supports sustainable urban transportation by reducing reliance on private vehicles, with the potential to lower carbon emissions and ease traffic congestion (Köhler et al., 2019; Medina-Molina & de la Sierra Rey-Tienda, 2022). Shared mobility is recognized as a key innovation for disrupting and transforming the current car-centric regime, alongside advancements in green vehicle technologies and demand management strategies aimed at reducing overall transport volumes (Nykvist & Whitmarsh, 2008). It is associated with numerous benefits, including complementing public transit systems, enhancing energy efficiency, reducing urban air pollution, increasing the adoption of renewable fuels, decreasing congestion, and improving accessibility (Sarasini & Langeland, 2021; Deschaintres, Morency & Trepanier, 2025).

There are numerous examples of how misbehaviour has affected shared mobility operators across the whole spectrum and in different geographies. For instance, the Paris-based carsharing service Autolib was discontinued due to persistent customer misconduct (Carriat et al., 2018). Similarly, BMW shut down its ReachNow carsharing service in Brooklyn after facing extensive vehicle damage and high maintenance costs (Flamm, 2018). In bikesharing, the Chinese company Wukong closed soon after launching because 90% of its bicycles were either stolen or vandalized (BBC, 2017). The UK experienced a similar trend, with three bikesharing companies ceasing operations within a year, primarily due to vandalism (McIntyre & Kollewe, 2019). Electric scooter-sharing services have also faced substantial setbacks, with widespread vandalism such as theft, arson, and scooters being thrown into lakes in cities like San Francisco and Sunderland, leading to service discontinuations (BBC, 2023; YLE, 2023; The Guardian, 2018). Motosharing companies have reported significant losses as well, particularly from the theft of batteries and helmets (El Mundo, 2022; Business Insider, 2018).

This thesis examines the consequences of misbehaviour at two levels. At the micro level, it explores how shared mobility business models have evolved to address customer misbehaviour, expanding our understanding of the continuance of the triple mission of Sustainable Business Models (SBMs) and offering key theoretical insights and recommendations for other access-based sustainable models, such as product-service systems (Mignon & Bakel, 2022). At the macro level, the thesis investigates how the changes in shared mobility operators' business models, induced by customer misbehaviour and vandalism, affect the broader adoption of these services as part of the transition toward a more sustainable urban transportation system.

2. Research objectives and questions

The primary objective of this research is to analyse how shared mobility operators (a type of SBM) evolve in response to customer misbehaviour and vandalism, and to explore the implications for the broader societal transition toward sustainable urban mobility. To achieve this overarching goal, the study addresses five research questions that progress from specific to more general issues. It begins by examining the phenomenon within one particular form of shared mobility, carsharing, focusing on the role of misbehaviour in accidents. The analysis then expands to include bikesharing, motosharing, and scootersharing, aiming to develop a broader understanding of misbehaviour across the shared mobility sector.

The first research question examines the extent to which the factors that typically explain car accidents also account for accidents in carsharing. It further explores whether customer misbehaviour—such as aggressive driving or alcohol abuse—can ultimately explain these incidents. To answer RQ1, the study analyses a dataset of 2.1 million trips from a carsharing operator in Madrid and complements the quantitative findings with interviews conducted with executives and users of the platform.

RQ1: To what extend does customer misbehaviour explain accidents in carsharing?

The second research question examines the types of customer misbehaviour in shared mobility services. To address RQ2, this research draws on literature on customer misbehaviour and vandalism, expanded with insights from studies on misbehaviour in Access-Based Services (ABS). The objective is to identify the main forms of misbehaviour and assess their prevalence across different shared mobility modes.

RQ2: What are the main types of misbehaviour encountered in shared mobility services?

The third research question explores how shared mobility companies adapt their business models to mitigate the adverse effects of customer misbehaviour. Using Richardson's (2009) Business Model Framework, this analysis focuses on adjustments made by companies to manage misbehaviour across their value propositions, service delivery mechanisms, and value capture strategies. Moreover, we contend that a cross-sectional perspective would provide a shallow understanding of how misbehaviour is addressed. For that reason, we also adopt a processual approach to understanding business model evolution.

RQ3: In what ways do shared mobility companies adapt their business models to mitigate the adverse effects of customer misbehaviour and vandalism? How do these strategies change through time?

The fourth research question investigates how customer misbehaviour and vandalism impact the economic, social, and environmental sustainability objectives of shared mobility business models. The study employs the Triple Bottom Line framework (Elkington, 1997) to explore how negative customer behaviours force companies to make trade-offs between profitability and sustainability goals, affecting their ability to provide accessible, inclusive and environmentally conscious services.

RQ4: How do customer misbehaviour and vandalism impact the economic, social, and environmental sustainability objectives of shared mobility business models?

Finally, the fifth research question evaluates the broader implications of customer misbehaviour for the societal transition toward sustainable urban mobility. Using Geels' (2002) Multi-Level Perspective, this analysis explores the extent to which companies' business model adaptations impact their ability to scale from the niche and how these adaptations interact with regime-level forces, such as regulation, company shareholding structures, and the availability of specialized technology for shared mobility operators. By examining these dynamics, the study aims to identify key barriers to the adoption and scalability of shared mobility services.

RQ5: How does customer misbehaviour and vandalism influence the broader societal transition to sustainable urban mobility?

3. Methodology

This research employs a multi-method approach to comprehensively address its objectives, consisting of two main studies. Study 1 adopts a deductive approach, analyzing carsharing accidents using a unique dataset of 2.2 million trips provided by a major carsharing operator in Madrid. The quantitative analysis addresses Research Question 1 (RQ1) by identifying factors contributing to carsharing accidents and exploring potential links to customer misbehaviour. To supplement the findings and enhance external validity, interviews were conducted with key managers and customers, providing valuable context and interpretation. Study 2 takes an inductive, multi-case approach with a processual perspective to address the remaining research questions. It draws on interviews with managers of shared mobility operators, industry experts, and customers, as well as archival data, to examine the strategic adaptations companies implement over time in response to vandalism and misbehaviour. This study investigates the consequences of these adaptations, shedding light on how companies evolve their strategies to navigate these challenges.

The combination of quantitative and qualitative methods facilitates an in-depth exploration of both the impacts of misbehaviour at the company level (micro-level) and the long-term implications for the shared mobility industry (macro-level). This mixed-method design ensures

robustness in addressing the research questions and provides a nuanced understanding of the interplay between customer behaviour, business model adaptation, and the broader societal transition toward sustainable mobility.

4. Key findings and contributions

The thesis identifies key findings at two levels. At the micro level, we identify three stages in the evolution of business models that illustrate how companies in this industry have responded to customer misbehaviour: Market reach, Profitability and Downsize-Diversification-Decline. Our study shows that, in an effort to curb customer misbehaviour, these SBMs evolved from offering "a green shared mobility solution for all" to becoming "premium niche mobility solutions," as operators increasingly prioritize financial viability over accessibility, inclusivity and affordability, an evolution we refer to as the degradation of SBM. The only exception is public bikesharing, which followed a different trajectory, likely due to the support of public subsidies.

At the macro level, our study suggests that these changes limit the sector's potential to advance sustainable mobility. At the niche level, the degradation of business models restricts the widespread adoption of shared mobility services. Additionally, as the service becomes more cumbersome to use, it discourages both existing users and potential new adopters, further constraining its growth. Additionally, regressive trends at the regime level, exacerbated by misbehaviour, further complicate the industry's growth. These challenges include new regulations introduced by local authorities to manage the initial chaos caused by scooters and motosharing, the slow response from manufacturers and technology providers in delivering fit-for-purpose, affordable mobility solutions, and the financial expectations of private shareholders, who demanded rapid returns on investment. Together, these factors undermine the scalability and long-term viability of shared mobility services.

This thesis offers substantial theoretical and empirical contributions to separate literatures. Theoretically, this research enriches the literature on Sustainable Business Models (SBMs) by developing a conceptual framework that explains the evolution of shared mobility business models over time. It demonstrates that SBM can degrade when they are unable to maintain the promise of tri-value formation. Moreover, we show that customer misbehaviour, an

overlooked factor in past work, is a crucial driver of this degradation. Our work invites to reconceptualize the consumer roles that underpin business model transformation. Existing literature on business model evolution portrays consumers as either accepters or rejecters of value propositions (Clausen and Fichter, 2019; Priem et al., 2018). We extend this understanding by showing that consumers-as-harmers can also drive business model evolution. Additionally, by addressing the interconnected roles of technology, regulation, and deviance, the research provides a nuanced understanding of the factors driving trade-offs within SBMs beyond shareholder pressures to maximize profits.

The thesis also extends existing customer deviance frameworks by demonstrating that the strategies companies adopt to address misbehaviour are not static but evolve over time. This perspective highlights how these strategies develop in response to internal factors such as management capabilities and business objectives, and external elements like technological advancements, regulatory shifts and industry competition, an aspect often overlooked in the literature. This thesis also reveals that the process of addressing customer misbehaviour is circular rather than linear, as typically depicted in this literature (Fombelle et al., 2020). The cumulative effects of companies' strategies lead to significant changes in business models, modifying the affordances available to customers. These changes influence the triggers driving customer deviance, creating a feedback loop between management strategies and customer behaviour. In the context of Access-Based Services (ABS), this research uncovers additional affordances beyond those identified in the existing literature, such as lack of ownership, minimal supervision, and interpersonal anonymity. Moreover, in shared mobility contexts, this study highlights four additional affordances that further enable misbehaviour: the 24/7 availability of vehicles on public streets, the difficulty of identifying perpetrators, specific pricing schemes, and vehicle type.

Finally, this thesis advances socio-technical transition theory by examining how customer misbehaviour impedes the scalability of niche innovations and delays regime-level transformations in the shift toward a more sustainable urban transportation system. It highlights how unfavourable regulations, shareholder pressure for rapid financial returns, and an unprepared supply chain create additional barriers to reducing dependence on the car-centric transportation paradigm.

Empirically, the thesis provides rich qualitative evidence through in-depth interviews with industry executives and experts, uncovering insights into issues that are rarely discussed openly. This qualitative analysis is complemented by a comprehensive review of press articles, websites, and industry reports. Furthermore, the quantitative analysis of carsharing accidents, based on a unique dataset of 2.2 million trips in Madrid, extends prior research by examining carsharing incidents in a new geographical and contextual setting. Importantly, the research introduces a novel factor for consideration: the impact of the number of previous trips completed on the platform.

5. Structure of the thesis

The thesis is organized into six chapters, each addressing a specific component of the research (see Figure 1).

Chapter 1 provides a comprehensive literature review on customer misbehaviour and vandalism, with a particular focus on ABS and shared mobility. This chapter explores the underlying drivers of customer deviance, its types, existing countermeasures for misbehaviour, and the unique challenges shared mobility operators face.

Chapter 2 presents Study 1, which utilizes a dataset of 2.2 million carsharing trips in Madrid to analyse accidents as a proxy for customer misbehaviour. This chapter investigates factors influencing accidents, such as driver demographics, time patterns, and prior experience on the carsharing platform, to identify potential behavioural patterns linked to customer deviance. Quantitative insights are further enriched by perspectives from company managers and customers providing a foundation for understanding behavioural dynamics in shared mobility services.

Chapter 3 introduces the conceptual frameworks that underpin Study 2. It explores the concept of the business model and its evolution over time. Richardson's (2009) Business Model Framework is presented as a tool for analyzing changes in value proposition, value creation and delivery, and value capture in response to customer misbehaviour. The chapter then integrates the Triple Bottom Line (TBL) approach (Elkington, 1997) to assess the economic, social, and environmental dimensions of sustainability within shared mobility business models. Finally, it introduces the Multi-Level Perspective (MLP) on socio-technical

transitions (Geels, 2002), positioning shared mobility as a niche innovation with the potential to drive systemic change in urban transportation. Together, these frameworks establish the theoretical foundation for the empirical analyses conducted in Chapters 4 and 5.

Chapter 4 centres on Study 2 and the micro implications of misbehaviour in shared mobility. It employs a multi-case, longitudinal approach to investigate how shared mobility companies adjust their business models in response to customer misbehaviour and vandalism. Drawing from interviews with executives, industry experts and customers, this chapter examines business model adaptations at the micro level, focusing on modifications to value propositions, customer segmentation, and service delivery strategies as companies work to manage misbehaviour while striving to meet sustainability objectives. Supplementary sources, such as news articles, websites, and industry reports, are also used to triangulate and provide additional evidence. The findings underscore the complex trade-offs between economic, social, and environmental goals when confronting disruptive customer behaviours in a process that we call the degradation of SBMs.

and how

Chapter 5 is part of Study 2, but focuses on the macro consequences of misbehaviour in shared mobility, showing how measures taken by companies such misbehaviour can create barriers to transitioning toward a sustainable urban mobility model with reduced reliance on private vehicles.

Chapter 6 proposes a conceptual model that integrates both the micro and macro consequences of misbehaviour within the shared mobility context.

Finally, the conclusion section synthesizes the findings of the dissertation, highlighting the thesis's main contributions, practical implications, limitations, and suggestions for future research.

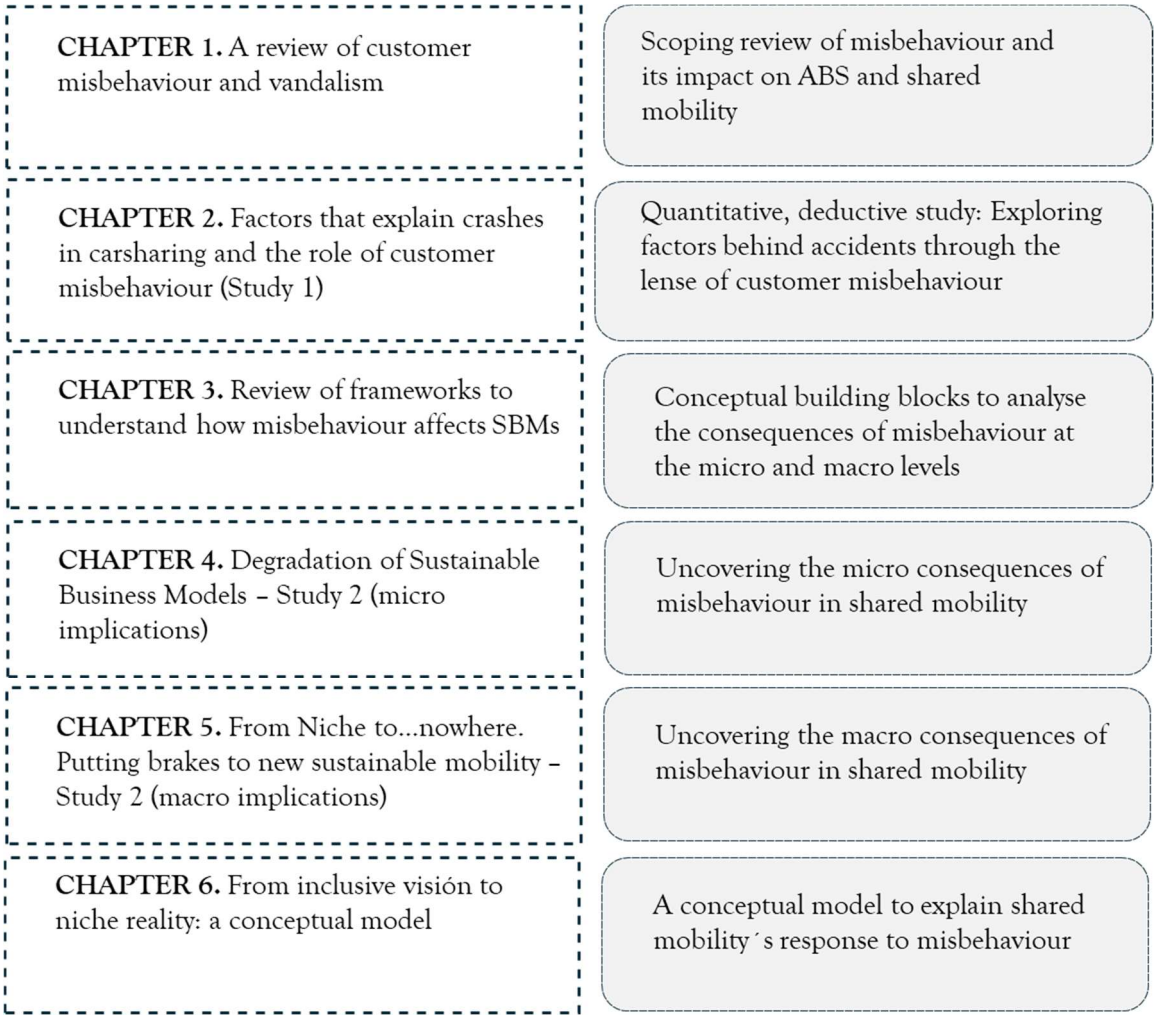


Figure 1. Structure of the thesis

Chapter 1. A review of customer misbehaviour and vandalism

This thesis builds upon a vast body of literature on customer misbehaviour and vandalism, with a focus on shared mobility services. To effectively frame the problem, we have conducted a scoping review that synthesizes extensive research on the motives and consequences of customer misbehaviour, as well as on prevention strategies and restorative measures. This approach highlights the underlying dynamics influencing user behaviour and underscores the unique challenges faced by Access-Based Services (ABS) in general, and shared mobility business models in particular.

1.1 An overview of the phenomenon

Over the past few years, an increased scholarly focus has been directed towards the phenomenon of customer misbehaviour, driven largely by its escalating incidence and ramifications (Fombelle et al., 2020; Lages, Perez-Vega, Kadić-Maglajlić, & Borghei-Razavi, 2023). The exploration of dysfunctional behaviours draws upon a wide range of social science disciplines including sociology, criminology, medicine, ethics, and education (Fullerton & Punj, 2004). However, primary investigations into customer misbehaviour are largely conducted within the fields of marketing and management, particularly through the lens of psychology—most notably social and organizational psychology (Fisk et al., 2009; Harris & Reynolds, 2004). This focus on misbehaviour is closely tied to marketing activities, which often promote a philosophy of consumption, encouraging consumers to buy more (Fullerton & Punj, 2004).

Customer misbehaviour represents a construct that includes a range of behaviours rather than being a single concept (Ang & Koslow, 2012). To date, the phenomenon has invoked a plethora of terminologies such as: Customer incivility; Dysfunctional customer behaviour; Customer deviant behaviours; Customer misbehaviour; Customer mistreatment; Customer revenge; Customer retaliation; Customer rage; and Customer aggression, which can be grouped under the label “the dark side of the customer” (Lages et al., 2023). This divergence of terms mirrors the broad spectrum of perspectives that have investigated this complex phenomenon, and the methodological approaches employed (Fisk et al., 2010).

Vandalism, can also be considered a type of misbehaviour that can be done by customers and non-customers alike. The concept, like customer misbehaviour, lacks a single, universally

accepted definition. Broadly defined by van Vliet (1992, p. 32) as "willful damage to or destruction of property owned by others," the concept of vandalism can vary significantly depending on the perspective taken. Moser (1992, p. 52-53) suggests several definitions based on different perspectives. From the point of view of the damage caused, vandalism is seen as the dilapidation or destruction of an environmental object. From an intention-based perspective, it is considered an intentional act aimed at damaging or destroying another's property. In this thesis, we will use the word "misbehaviour" to encompass both customer misbehaviour and vandalism. In this thesis, I adopt the definition of customer deviance provided by Fombelle et al. (2020, p. 387), who describe it as "any act by a customer in an online or offline environment that deprives the firm, its employees, or other customers of resources, safety, image, or an otherwise successful experience." These authors present a customer deviance framework that integrates triggers, behaviours, consequences, and strategies for managing deviance. Similar frameworks have been proposed by other scholars (Echeverri, Salomonson & Åberg, 2012; Fisk et al., 2010; Sommovigo, Setti, Argentero & O'Shea, 2019), each depicting misbehaviour as a linear process in which specific deviant actions arise from antecedents and are managed through targeted strategies. However, I argue that these strategies have broader implications for companies, extending beyond the immediate management of specific types of misbehaviour.

Building on Fombelle´s et al. (2020) and the work of Reynolds and Harris (2009), I have developed a basic framework that incorporates the consequences of the strategies beyond their effectiveness, showing the deviance process as a close loop (see Figure 2). Each of the strategies followed can be seen as incremental changes to the business model which in turn, can modify the very nature of what companies offer to their customers and their user experience, which also affects the triggers that originally unchained the negative behaviour. The following paragraphs discuss this framework in more detail by analysing each of the elements individually.

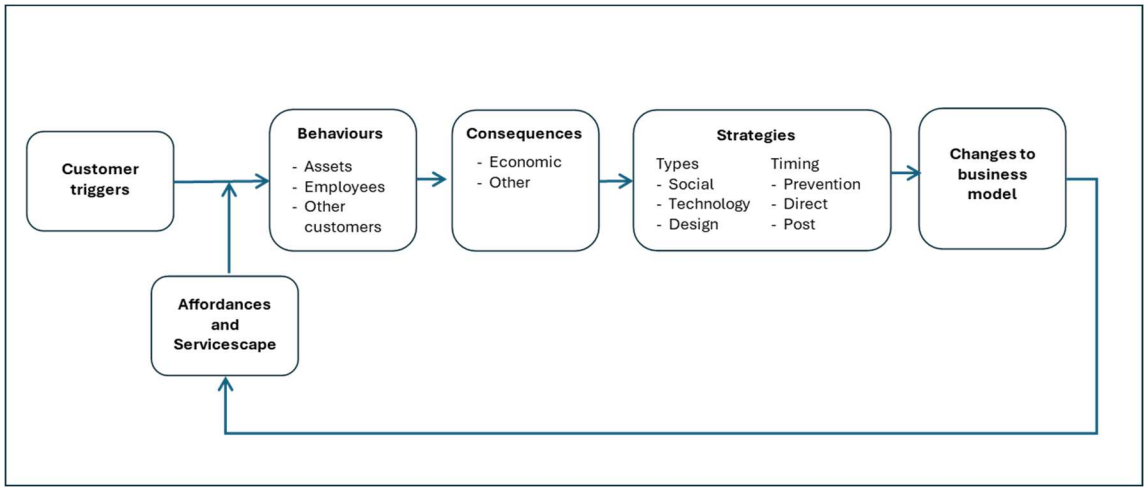


Figure 2. Expanded customer misbehaviour framework

Triggers of customer misbehaviour

Research on customer misbehaviour has primarily focused on identifying underlying motives, exploring individual antecedents that may drive various forms of deviant behaviour (Daunt & Harris, 2012; Reynolds & Harris, 2009). These antecedents often interact, influencing customer behaviour in complex and simultaneous ways (Fullerton & Punj, 2004). According to Fombelle et al. (2020), customer misbehaviour can stem from factors associated with either the customer or the company. Customer-driven motives commonly include financial gain, such as acquiring assets in monetary or physical form (Daunt & Harris, 2012; Fullerton & Punj, 2004); thrill-seeking (Fullerton & Punj, 2004); ego-related motives, such as fulfilling self-worth needs (Daunt & Harris, 2012); and anger or revenge against an organization or employee, often in response to perceived wrongdoing by the firm (Zourrig, Chebat, & Toffoli, 2009; Grégoire, Ghadami, Laporte, Sénécal & Larocque, 2018).

Company-driven factors, such as the nature of the product or service, the characteristics of the service exchange, and the physical environment, can either amplify or mitigate these individual triggers for misbehaviour (Bitner, 1992; Reynolds & Harris, 2009; Daunt & Harris, 2012; Schaefers et al., 2015). For instance, customers of temporarily accessed goods are often less inclined to care for them, leading to behaviours such as neglect, misuse, or even intentional damage (Bardhi & Eckhardt, 2012; Schaefers et al., 2015).

Furthermore, contextual factors such as the behaviour of other customers and the quality of service interactions also shape customer motives and influence the likelihood of misbehaviour

(Salomonson & Fellesson, 2014). In this context, the concept of affordances—defined as "the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used" (Norman, 1988, p. 9), may play a role in facilitating misbehaviour.

A typology of negative behaviours

Customer misbehaviour can target a firm's assets, its employees, or other customers (Fombelle et al., 2020). Misbehaviour directed at company assets encompasses actions that lead to financial or physical harm. Fullerton and Punj (2004) categorize these behaviours into those targeting merchandise (e.g., shoplifting, fraudulent returns), financial assets (e.g., credit card fraud), and physical or electronic premises (e.g., vandalism, database theft). Such actions erode the value of company assets, often incurring significant financial and operational costs. Misbehaviour directed at employees frequently involves verbal abuse, physical aggression, or harassment, especially in sectors where frontline staff engage directly with customers (Harris & Reynolds, 2003). In fields like retail, hospitality, and transportation, employees commonly face verbal insults, threats, and physical confrontations, leading to increased stress, burnout, and higher turnover rates (Fisk et al., 2010; Grandey, Dickter & Sin, 2004). Misbehaviour toward other customers is also common, manifesting as hostile actions such as cutting in line, creating disturbances, or engaging in confrontations over shared resources like seating or equipment (Daunt & Harris, 2012).

Consequences

The consequences of customer misbehaviour for companies are multifaceted, extending beyond economic losses to include adverse effects on service delivery, organizational performance, and employee well-being. While much of the literature has focused on the financial implications, such as increased operational costs and lost revenue (Fisk et al., 2010), recent research has highlighted additional, complex repercussions that impact various aspects of the organization (Harris & Reynolds, 2003; Lages et al., 2023). Economic impacts are frequently highlighted in studies on customer misbehaviour, as organizations often face direct costs related to repairs, replacements, and compensatory actions for other customers affected

by disruptive behaviours (Fisk et al., 2010). These financial burdens can also impede profitability, as companies must allocate resources to manage and mitigate misbehaviour rather than investing in growth-oriented initiatives (Daunt & Harris, 2012).

Additionally, customer misbehaviour can disrupt service delivery, leading to delays, reduced service quality, and even temporary shutdowns, all of which negatively affect customer experience and brand reputation (Harris & Reynolds, 2004). The detrimental effects of customer misbehaviour on employees are well-documented. Employees exposed to hostile or aggressive customer behaviours often report heightened levels of stress, burnout, and job dissatisfaction (Harris & Daunt, 2013; Harris & Reynolds, 2003). Grandey and colleagues (2004) indicate that frontline employees who frequently manage customer misbehaviour may experience emotional exhaustion and reduced morale, which can impair their ability to deliver high-quality service. Furthermore, customer misbehaviour can damage a company's reputation and brand equity. Frequent service disruptions and negative customer interactions reflect poorly on the business, leading to negative word-of-mouth and social media complaints, which can harm the company's reputation and erode customer trust (Fullerton & Punj, 2004; Schaefers et al., 2016). Persistent misbehaviour issues may eventually lead to stigmatization, causing certain customer segments to avoid the service due to its association with antisocial behaviours limiting market growth and hindering scalability (Harris & Reynolds, 2003).

Strategies to tackle misbehaviour

Strategies to address customer misbehaviour encompass social, technological, and design elements (Fombelle et al., 2020). These strategies are tailored to prevent, respond to, and minimize the impact of misbehaviour on employees, assets, and other customers. Social strategies involve fostering positive customer relationships and promoting social norms that discourage misbehaviour. These approaches rely on customer engagement, empathetic messaging, and training employees to manage potentially conflictual interactions (Bitner, Booms, & Mohr, 1994). By actively engaging with customers to instill social norms, firms create an environment that encourages accountability and ethical behaviour. Cialdini et al. (2006) distinguish between descriptive norms, which convey what people typically do, and injunctive norms, which communicate what is socially approved or disapproved. While descriptive norms reinforce widely accepted behaviours, injunctive norms, such as messages

that explicitly disapprove of theft, are particularly effective in curbing misbehaviour by evoking social disapproval. The success of these strategies lies not solely in the messaging but in how effectively they invoke societal expectations to guide behaviour. Also, when firms demonstrate attentiveness and fairness, they foster a bond that encourages ethical conduct, creating a cooperative service environment that reduces disruptive behaviours (Fisk et al., 2010; Harris & Daunt, 2013; Mitchell & Chan, 2002).

In addition to social strategies, firms can incorporate intentional design elements into their servicescape and modify their product or service offering to influence customer behaviour (Bitner, 1992). Specific situational or design features can either discourage or inadvertently encourage deviant behaviours in customers with certain personality traits, such as sensation seeking, impulsiveness, or aggression (Reynolds & Harris, 2009). For example, thoughtful servicescape design, such as clear signage, well-defined spaces, and layouts that encourage positive customer interactions, can reduce the likelihood of misbehaviour (Harris & Daunt, 2013). In digital contexts, the case of Spotify shows that improving convenience and adding value to services can help reduce misbehaviour, such as media piracy, by incentivizing users to become paying customers (Aguilar & Waldfogel, 2015).

Technological strategies combat customer misbehaviour through advanced monitoring, surveillance, and automated enforcement (Pieper & Woisetschläger, 2024). These strategies leverage real-time data analytics, GPS tracking, and AI-driven tools to swiftly detect and respond to deviant behaviours, providing firms with proactive means to discourage and address misconduct (Fombelle et al., 2020). With sophisticated technology, companies can better monitor customer interactions, track asset usage, and identify misbehaviour patterns, allowing timely interventions that reduce the occurrence of disruptive actions.

Importantly, these interventions can be deployed at various stages, before, during, and after an incident occurs. Ang and Koslow (2012) propose the Pre-Di-Post framework, which includes preventive measures, direct intervention during incidents, and post-incident management to handle customer misbehaviour effectively. This framework emphasizes understanding the root causes of misbehaviour to tailor appropriate preventive actions. At the prevention level, companies must evaluate the cost-and-benefit tradeoff associated with why customers behave badly (Wirtz & Kum, 2004). This evaluation considers the motivators (benefits), the inhibitors (perceived costs), and their associated personality and contextual

factors. For example, Harris and Reynolds (2003) suggest that when customers are aware of the consequences of misbehaviour, they are less likely to engage in it. Additionally, educating customers about acceptable behaviour (Bitner, Booms & Mohr, 2000) and actively engaging them in creating a respectful community fosters mutual understanding and cooperation. Related to this idea is the concept of value co-creation by which clients participate in the service, leading to more self-regulated behaviour (Prahalad & Ramaswamy, 2004).

Direct intervention strategies focus on measures taken when misbehaviour occurs. They typically involve frontline employees (Ang & Koslow, 2012). Echeverri, Salomonson, and Åberg (2012) explore the tactics used by frontline employees to manage customer misbehaviour, identifying three main types: routine, situational, and contextual. Routine tactics are immediate and dismissive, such as hanging up or referring to rules. Situational tactics involve a more balanced approach, resolving tensions by explaining or joking with the customer. Contextual tactics are highly reflective, considering the long-term impact and often involving giving extra service or relating to the customer's personal context.

Post-incident management typically entails legal actions against offenders (Ang & Koslow, 2012). Implementing penalties such as fines, service denial, or even legal action can serve as a deterrent. Fullerton and Punj (2004) note that consistent enforcement of such measures is key to their effectiveness. In severe cases, companies may ban repeat offenders from their premises or services. Reynolds and Harris (2009) argue that while this is a drastic measure, it is sometimes necessary to protect the broader customer base and employees.

With a comprehensive understanding of customer misbehaviour, its antecedents, and the various strategies companies use to mitigate its impact, the next section explores how these dynamics unfold within Access-Based Services (ABS). ABS presents a unique context where the affordances of the services, such as lack of ownership and interpersonal anonymity, combined with the characteristics of the servicescape, create distinct challenges for managing customer misbehaviour.

1.2 Customer misbehaviour in Access-based services

Access-based Services (ABS) are defined as “services that allow customers to access a good, physical facility, network, labor, or space for a defined period of time, in return for an access payment, while legal ownership remains with the proprietor, who is often the service provider”

(Bardhi & Eckhardt 2012; p881). ABS are not new as renting and leasing have long existed, yet they are gaining relevance due to changes in consumers' lifestyles and technological advancements (Schaefers et al., 2016). In fact, the trend towards accessing goods rather than owning them is seen, by many, as a major trend affecting society (Baumeister & Wangenheim, 2014). According to Belk (2014, p. 1599), "we just may be entering the post-ownership economy," which also promises to shake up established industries that rely on models of private ownership. Table 1 below includes a list of ABS companies in different industries.

Table 1. Examples of Access- Based services companies

ABS category	Companies
Car Sharing	Zipcar, DriveNow, Car2Go, BlaBlaCar, Share Now, Enterprise CarShare, Getaround, Ubeeqo
Bicycle Sharing	Capital Bikeshare, Citi Bike, Mobike, LimeBike, Ofo, Nextbike, Spin, BCycle
Motosharing	Cooltra, Acciona, Revel, Cityscoot, Muving, Coup, Yego
Electric Scooter Sharing	Bird, Lime, Voi, Spin, Scoot, Dott, Wind, Tier, Grin
Short-term Fashion Rentals	Bag Borrow, Steal, Rent the Runway, Le Tote, GlamCorner, Armoire, Style Lend, HURR Collective
Peer-to-Peer Car Sharing	RelayRides, Turo, Getaround, HyreCar, SnappCar, Drivy, JustShareIt
Home Sharing	Airbnb, Vrbo, HomeExchange, Homestay, FlipKey, Roomorama, Couchsurfing
Tool and Equipment Rentals	Home Depot Tool Rental, Peerby, Zilok, Rent-All, Flexshopper, Fat Llama, ToolMates
Peer-to-Peer Storage	Neighbor, Spacer, Stashbee, Storemates, Cubiq, Roost, Omni
Office Space Sharing	WeWork, Regus, LiquidSpace, Knotel, ShareDesk, Breather, Spaces, OfficeRnD
Luxury Goods and Accessories	Vivrelle, Fashionphile, The RealReal, Flont (jewelry), LUXnow, HauteVault, Switch, Style Theory

Source: the author, expanded from Schaefers et al. (2016)

ABS distinguish themselves from traditional rental or technology-based services through three key characteristics (Hazée et al. 2017). First, ABS demand high customer involvement with minimal service provider supervision. Second, ABS provide substantial interpersonal

anonymity, allowing customers to use products privately from other users or employees, unlike traditional services that involve public interaction or shared access (Bardhi & Eckhardt, 2012; Lamberton & Rose, 2012). Third, ABS often replace ownership, a predominant consumption mode in many cultures, resulting in limited customer rights and attachment to the accessed products (Bardhi & Eckhardt, 2012; Belk, 2014). These unique aspects influence customer relationships with the product, the service provider, and other users.

Consumer misbehaviour in the context of ABS is a well-documented issue that poses significant challenges for companies, yet it has received little attention in previous research (Jin, Zhou & Tian, 2022). ABS is particularly susceptible to customer misbehaviour due to its inherent affordances, including minimal supervision during service exchanges, high interpersonal anonymity, and the replacement of ownership with limited usage rights. These factors contribute to lower levels of psychological ownership and accountability, increasing the likelihood of misuse (Hazée et al., 2017).

The concept of ownership, or rather the lack thereof, plays a crucial role in understanding customer misbehaviour in ABS. Gong and Zhang (2023) underscore that the temporary access to goods without ownership transfer, which is characteristic of ABS, diminishes customers' sense of responsibility toward the products or services they use. Similarly, Bardhi and Eckhardt (2012) argue that the reduced psychological ownership in ABS environments contributes to an increased sense of anonymity and a corresponding decline in accountability, factors that are closely linked to a rise in customer incivility. When customers do not feel a sense of ownership, they are less likely to care for the accessed goods, leading to behaviours that might include neglect, misuse, or even deliberate damage. Schaefers and colleagues (2016) also highlight that misbehaviour in ABS often occurs in the absence of others allowing users to act without direct oversight. Hazée et al. (2017) point out that this lack of supervision not only fosters a perception of anonymity but also emboldens customers to engage in misbehaviour, knowing that the chances of being caught are low. This anonymity, whether perceived or real, further contributes to the likelihood of deviant behaviour (Pieper & Woisetschläger, 2024).

The literature on specific strategies that ABS companies can use to address customer misbehaviour is relatively sparse (Pieper & Woisetschläger, 2024). Most existing strategies fall into two broad categories: social strategies aimed at reducing the impersonal nature of these services and the sense of belonging, and technological strategies designed to enhance customer

control and oversight. From a social perspective, Schaefers et al. (2016) suggest that ABS providers can mitigate customer anonymity by fostering more personal relationships and cultivating a sense of community through brand investments. Moore (2011) found some evidence supporting the effectiveness of campaigns that appeal to good behaviour, such as those aimed at reducing incivility among public transport passengers. Among the technological solutions, the use of surveillance mechanisms, such as camera-based trash detection systems, has been identified as a potential deterrent by increasing the perceived risk of punishment for misconduct (Pieper & Woisetschläger, 2024).

While Access-Based Services (ABS) in general exhibit unique vulnerabilities to customer misbehaviour due to factors such as lack of ownership, interpersonal and minimal supervision, shared mobility services represent a specific subset of ABS that face additional, intensified challenges. The following section examines the distinctive features of shared mobility that exacerbate these risks and explores the broader implications of customer misbehaviour on the operational sustainability and profitability of these services.

1.3 The specific case of shared mobility

Shared mobility businesses like carsharing, bikesharing, motosharing, and scooter sharing exemplify ABS because they offer temporary access to transportation modes without the need for ownership. As previously explained, ABS face unique challenges in managing customer misbehaviour due to factors like the absence of ownership, high interpersonal anonymity, and limited supervision. These challenges are further amplified in shared mobility, a subset of ABS, where vehicles and other assets are continuously accessible in public spaces, making them more vulnerable to misuse and damage. As noted in the introduction, numerous shared mobility operators have encountered significant misbehaviour issues, with some ultimately being forced to cease operations. As we move into the discussion on shared mobility, it is important to examine how these challenges impact this sector, where customer misbehaviour and vandalism has a direct and significant effect on operational costs, service quality, and overall business viability. The following section will explore the specific issues faced by shared mobility operators, the consequences of customer misbehaviour, and the strategies employed to mitigate these risks

1.3.1 An overview of shared mobility

The mobility system is under transformation due to innovations in technology and social preferences (Sprei, 2018). In fact, a new acronym, ACES, is widely used to describe the four major ongoing developments that are driving change in an otherwise stable ecosystem for decades (Adler, Peer & Sinozic, 2019): autonomy of vehicles, connectivity, electrification, and shared ownership. Shaheen, Chan, Bansal, and Cohen define shared mobility "as the shared use of a vehicle, bicycle, or other low-speed mode that enables users to have short-term access to transportation modes on an 'as-needed ´ basis" (2015, p. 4). It includes many different types of existing services such as carsharing, personal vehicle sharing (Cohen and Kietzmann, 2014), scooter and moped scooter sharing (Aguilera-Garcia, Gomez & Sobrino, 2020); bikesharing; ride-hailing, ridesharing and on-demand ride services. Among this complexity, Castellanos, Grant-Muller and Wright (2022) propose a taxonomy for the different shared mobility services that are currently in the market (See Figure 3). It categorizes them based on key characteristics such as profit orientation (non-profit; for-profit), the nature of the shared resource (service; asset), and the organisational type (peer to peer; business to consumer; government to consumer). The focus of this study is on operators (companies as opposed to peer-to-peer) that offer their vehicles (assets) for sharing to individuals in exchange for a price. Specifically, this study examines carsharing, motosharing, scooter sharing, and bikesharing services.

Shared mobility services offer sustainable alternatives to private car use, helping reduce traffic congestion and lower greenhouse gas emissions (Pamidimukkala, Patel, Kermanshachi, Rosenberger & Tanvir, 2023). By enabling multiple users to access the same vehicle at different times, these services optimize road usage and decrease the overall number of vehicles on the road, alleviating urban congestion (Martinez, Pritchard & Crist, 2024). Also, the use of electric vehicles (EVs) further enhances environmental benefits by eliminating emissions, with additional reductions possible when powered by renewable energy (Hu & Creutzig, 2022).

			Transaction type		
			P2P (peer-2-peer)	B2C (business-2-consumer)	G2C (government to consumer)
Market orientation	Non-profit	Asset	N/A	Public vehicle sharing	Public vehicle sharing
		Service	Vehicle pooling	N/A	Public ride sharing
	For-profit	Asset	P2P vehicle-sharing P2P mobility asset sharing	Private vehicle-sharing	N/A
		Service	Ride-hailing/sharing	Microtransit/demand responsive transport	N/A

Figure 3. Typology of services in shared mobility

Although comprehensive statistics on shared mobility profitability are lacking, evidence suggests that the sector remains largely unprofitable (Gilbert, 2020). Research on the underlying causes of this financial struggle is limited, but existing studies identify several contributing factors. A primary issue is the high fixed costs associated with these business models (Le Vine & Polak, 2015), encompassing not only vehicle acquisition and maintenance but also the development and upkeep of technological infrastructure necessary for fleet management, user interfaces, and other operational functions. For instance, as Lagadic, Verloes, and Louvet (2019) note, the capital-intensive nature of carsharing—particularly given the need for ongoing fleet expansion and technological upgrades—imposes a substantial financial burden on operators. This challenge is compounded by often limited demand, especially in less densely populated areas, making profitability difficult to achieve. Customer resistance and non-adoption present additional hurdles. Despite growing interest in shared

mobility, a significant portion of the population remains hesitant to use these services due to concerns over reliability, convenience, and costs (Li, Long, Chen & Geng, 2017). Such concerns limit market penetration, thereby impeding the ability of operators to reach the economies of scale necessary for sustainable profitability.

1.3.2 Customer misbehaviour in shared mobility

Insights from grey literature indicate that customer misbehaviour is a significant obstacle to achieving profitability in shared mobility services, threatening the viability of these business models by driving up operational costs, reducing service quality and availability, and damaging both trust and reputation (Bardhi & Eckhardt, 2012). For example, the Paris-based carsharing service Autolib was discontinued after persistent issues with customer misconduct (Carriat, Clercq & Hudson, 2018). Similarly, BMW shut down its ReachNow carsharing service in Brooklyn due to extensive vehicle damage and high maintenance costs (Flamm, 2018). In bikesharing, the Chinese company Wukong closed soon after launch, as 90% of its bicycles were either stolen or vandalized (BBC, 2017). The UK has seen a similar trend, with three bikesharing companies ceasing operations within a year, largely due to vandalism (McIntyre & Kollewe, 2019). Electric scooter-sharing services have faced substantial setbacks as well, with widespread vandalism, including theft, arson, and scooters being thrown into lakes in cities like San Francisco and Sunderland, leading to service discontinuations (BBC, 2023; YLE, 2023; The Guardian, 2018). Motosharing companies have similarly reported considerable losses from the theft of batteries and helmets (El Mundo, 2022; Business Insider, 2018). Although specific data on the financial impact of misbehaviour on shared mobility is limited, the existing evidence suggests that it represents a considerable cost. For instance, cleaning and maintenance can account for about 20% of carsharing vehicle costs (Kearney, 2019), while insurance premiums, which reflect the risk of damage to vehicles, may add another 20% to operating expenses (Consultancy Asia, 2017).

The literature on strategies to mitigate misbehaviour in shared mobility services remains relatively nascent and limited (Gong & Zhang, 2023). The studies reviewed suggest that companies pursue strategies based on technology, punitive measures and service, and direct appeals to customers. From a technological standpoint, Pieper and Woisetschläger (2024) highlight the role of real-time monitoring systems, which aim to deter misconduct by increasing the perceived likelihood of detection. In terms of design strategies, Jin, Zhou, and

Tian (2022) emphasize the deterrent effect of sanctions, suggesting that punitive measures are effective in curbing customer misbehaviour. Social strategies that appeal directly to customers have also shown promise. Research by Peck, Kirk, Luangrath & Shu (2020) suggests that increasing psychological ownership of shared assets encourages consumers to act as stewards of these resources, while Schaefers et al. (2016) argue that fostering communal identification among customers can enhance their sense of responsibility toward shared goods. Srivastava (2011) adds that encouraging a strong customer-company identification and reducing anonymity among users can diminish the likelihood of misbehaviour contagion within the service. Beyond shared mobility, Moore (2011) provides an example from public transport, where launching a "considerate travel" campaign successfully shifted attitudes and behaviours toward reducing everyday incivilities. This broader evidence underscores the potential effectiveness of socially oriented strategies in promoting responsible customer behaviour across shared services.

While existing literature and grey literature provide valuable insights into the prevalence and impact of customer misbehaviour in shared mobility, as well as potential mitigation strategies, significant gaps remain. First, much of the research focuses on anecdotal evidence or isolated incidents, lacking a systematic analysis of how misbehaviour evolves over time and interacts with business models. The limited emphasis on the long-term consequences of misbehaviour on the sustainability and scalability of shared mobility services leaves critical questions unanswered. Furthermore, the proposed mitigation strategies, such as technological deterrents, punitive measures, and psychological ownership, have not been evaluated comprehensively within the unique operational and regulatory contexts of shared mobility.

1.4 Conclusions of the literature review

In this chapter, we conducted a scoping review to synthesize existing research on the motives and consequences of customer misbehaviour, along with prevention strategies and restorative measures. Our findings reveal that much of the literature conceptualizes misbehaviour as a linear process, where specific triggers lead to deviant behaviours that are addressed through company strategies. However, we argue that this process extends beyond simply addressing incidents. These strategies can have broader, lasting impacts, potentially reshaping business models and influencing the affordances of the product and the servicescape, thereby affecting

customer-driven antecedents of misbehaviour. While there is an extensive body of literature on customer misbehaviour in general, studies focused on Access-Based Services (ABS) and shared mobility remain limited. ABS models, and shared mobility in particular, present distinct vulnerabilities to customer misbehaviour due to characteristics such as lack of ownership, high levels of interpersonal anonymity, and limited oversight. In shared mobility, these vulnerabilities are heightened, as vehicles and assets are continuously accessible in public spaces, making them especially prone to misuse and damage.

The next chapter investigates factors contributing to crashes in carsharing, a specific mode of shared mobility—and examines whether misbehaviour might play a role. It also explores the influence of psychological ownership on accident rates, considering the typical lack of ownership inherent in Access-Based Services. Following this study, the subsequent chapters will analyse how companies' strategies for managing misbehaviour affect their business models and evaluate the broader implications for the shared mobility sector's capacity to challenge and potentially transform the traditional urban transportation system, which remains heavily reliant on private car use.

Chapter 2. Factors that explain crashes in carsharing and the role of customer misbehaviour – Study 1

In this study, I aim to analyse the factors contributing to crashes in carsharing, proposing that the factors behind these incidents can serve as a proxy for customer misbehaviour. Carsharing is defined by Mounce and Nelson (2019, p 26) as "a model where customers rent cars for short durations from operators who maintain a fleet". It falls under the Business-2-Consumer, for profit, asset-based category of shared mobility businesses in the classification proposed by Castellanos, Grant-Muller and Wright (2022) depicted in Figure 3. A notable innovation within this domain is the free-floating carsharing model, which permits users to reserve, operate, and return vehicles flexibly within a designated urban zone, leveraging mobile technology (Sprei, Habibi, Englund, Pettersson, Voronov & Wedlin, 2019).

Findings indicate that crashes are more prevalent among younger drivers and during nighttime, suggesting a pattern of misbehaviour potentially linked to risk-taking behaviours among younger generations. Additionally, the results reveal that infrequent users of the service are more prone to crashes, implying that a lack of association with the vehicle or service or experience driving an electric vehicle may lead to higher accident rates. This tendency appears to diminish as customers engage more intensively with the service.

2.1 Literature Review

Driving safety remains an ongoing concern. In 2021, Europe alone witnessed an estimated 19,800 fatalities due to road crashes, with 40% occurring in urban areas (European Commission, 2022). Notably, 12% of these fatalities implicated individuals aged between 18 and 24 years, a group that represents a mere 7% of the EU population. Beyond the tragic loss of human life, car crashes pose a substantial economic burden, estimated at €210 billion annually (European Commission, 2020). The problem is escalating in tandem with increasing urbanization (Kassu & Hasan, 2020). The advent of novel urban mobility paradigms, particularly carsharing, has recently drawn considerable scholarly attention due to their potential implications for driving safety (Arias-Molinares & García-Palomares, 2020; Lorig, Persson & Michielsen, 2023). Despite carsharing vehicles constituting a mere 0.1% of the total passenger cars in Europe (ING, 2018), the escalating utilization and fleet expansion of such services precipitate growing concerns regarding their role in urban traffic crashes. Additionally, insurance premiums to cover crashes represent a significant expense for

carsharing operators, accounting for at least 20% of their total cost base (Consultancy Asia, 2017).

The analysis of the factors that explain traffic safety in general has been a subject of study for the research community for many decades (Lord & Mannering 2010; Mannering & Bhat, 2014). In an oversimplification of a complex reality, factors can be classified into two groups: non-human and human factors (Evans, 1991; Haddon,1972). Tables 2 and 3 summarise the literature review.

Non-human factors are a group that covers a wide range of factors that include among others the design and status of the infrastructure, traffic characteristics, environmental conditions, and vehicle design. At the infrastructure level, Papadimitriou et al. (2019) develop a taxonomy of crash risk factors related to the road infrastructure. The factors that have a significant negative contribution to road safety (i.e., more crashes) are low curve radius, different junction types of gradients and uncontrolled rail-road crossing. The authors also find that other factors that are related to the status of the infrastructure, not the design, have an impact such as inadequate friction of the pavement and presence of work zones. Wang, Quddus and Ison (2013) focus on the impact of road curvature and number of lanes in the likelihood of crashes but finds no clear evidence. The work of Ewing and Dumbaugh (2009) explores how the built environment (development patterns and roadway design) is linked to traffic safety (crash frequency and crash severity). The conclusions may look a bit counterintuitive: denser urban areas seem to be safer than the suburbs, probably through the mediators of traffic volume and traffic speed.

Traffic characteristics refer to the movement of vehicles, notably speed and traffic conditions (Wang et al, 2013). Empirical studies generally support the hypothesis that higher speed in absolute terms leads to more crashes (Aarts & Van Schagen, 2006). This hypothesis holds true in both urban and rural areas (Taylor, Lynam & Baruya, 2000). The reasons that explain this relationship are not fully clear as it depends on a large number of different factors that interact with speed such as lane width, junction density, and traffic flow (Aarts & Van Schagen, 2006; Theofilatos & Yannis, 2014). Some authors though, claim that the influence of speed in car crashes is not that clear (Wang et al, 2013). In addition to absolute speed, evidence suggests that speed differences between vehicles are also related to an increase likelihood of crashes (Stipancic, Miranda-Moreno & Saunier, 2017). Traffic conditions refer both to the flow of

vehicles and the density of these vehicles in the infrastructure. Theofilatos and Yannis (2014, p 2) defines flow as "the number of vehicles passing a cross-section of a road in a unit time" and density as "the number of vehicles present per length of road at a given moment". The relationship has received less attention than speed (Wang et al., 2013). In their literature review, the authors conclude that their impact on road safety is mixed. However, in a more recent study using smartphone-collected GPS data in Quebec, Stipancic et al. (2017) find that more congestion leads to higher crash frequency. Their results show nevertheless a weak to moderate correlation.

Poor weather conditions appear to increase crash likelihood. In a meta-analysis of 376 studies published since 1967, Qiu and Nixon (2018) find that crash rates increase during precipitation of snow and rain, although the effect is decreasing in time. Improvements in traffic safety and road maintenance may explain this trend. Other authors also find that precipitation is generally associated with increased number of crashes, although not in all cases (Theofilatos et al., 2014). In the same article, the author analyses the impact of other weather variables such as low visibility, wind and air temperature. However, in these cases the evidence is mixed.

Finally, the physical characteristics of the vehicle have been analysed mainly through the prism of protecting its occupants (Tay, 2003), rather than in explaining the likelihood of a crash. For example, Wang et al (2013) indicate that vehicle design plays an important role in the number of the severity of an accident. Evidence suggests that the existence of airbags, ABS and lower centre of gravity of the vehicle itself improve safety. An indirect way in which the characteristic of the vehicle can have an impact in car crashes is through its effect on driving style. Paleti, Eluru and Bhat (2010) find that individuals driving vans are less likely to drive aggressively. The authors explain that this could be explained by the fact that drivers who acquire vans tend to have more familial and financial responsibilities. Research indicates a higher frequency of at-fault crashes involving electric vehicles, although the underlying reasons for this phenomenon remain unclear (McDonnell, Sheehan, Murphy & Guillen, 2024).

Table 2. Non-human factors that explain car crashes

Non-human factors	Authors
Road infrastructure	Papadimitriou et al. (2019); Wang, Quddus & Ison (2013)
Built environment	Ewing & Dumbaugh (2009)
Traffic speed and conditions	Aarts & Van Schagen (2006); Stipancic, Miranda-Moreno & Saunier (2017); Taylor, Lynam & Baruya (2000); Theofilatos & Yannis (2014); Wang et al. (2013)
Weather conditions	Qiu & Nixon (2018); Theofilatos et al. (2014)
Vehicle-related factors	McDonnell, Sheehan, Murphy, & Guillen (2024); Paleti, Eluru & Bhat (2010); Tay (2003); Wang et al. (2013)

Human factors are considered to be the most relevant factors contributing to crashes. Studies performed in the 1970s (Evans, 1996) showed that the road user was the sole or contributing factor in 94% of crashes in the US and 95% in the UK. The same appears to be true in more recent times. According to Dingus et al. (2016), driver-related factors are present in almost 90% of crashes.

Overall, human factors can be split into two groups: driving capabilities and driving behaviour, with the latter playing the most relevant role in explaining car crashes according to Sabey and Taylor (1980). Evans (1996) refers to driver behaviour as "what the driver chooses to do" and driver capability is defined as "what the driver can do". Petridou and Moustaki (2000) explore in detail the literature and propose a conceptual model with two main groups of variables: human factors that modulate risk taking while driving, equivalent to Evan´s "what the driver chooses to do", and human factors that reduce the capability to meet traffic contingencies ("what the driver can do" in Evans terminology). Among the well-examined human factors, age and gender emerge as pivotal (Mccartt, Mayhew, Braitman, Ferguson & Simpson, 2009), influencing both driving capabilities and driving behaviour. Concerning age, a substantial body of evidence indicates that younger drivers are at a heightened risk of crashes relative to their adult and senior counterparts. This disparity is attributed to factors such as inadequate driving skills or tendencies towards aggressive driving (Jonah, 1986; Rolison, Regev, Moutari & Feeney, 2018), a diminished perception of danger, and an increased propensity for risk-

taking behaviours (Factor, Mahalel & Yair, 2008). For younger drivers, this risk is further exacerbated during nocturnal journeys (Keall, Frith & Petterson, 2005). In terms of gender, men have been consistently found more likely to be involved in motor-vehicle crashes than women (Evans, 1991; Masie, Green & Campbell, 1997; Shinar, Schechtman & Compton, 2019; Yagil, 1998). However, research seems to suggest that women are closing the gap (Romano & Kelley-Baker, 2008). The temporal context of driving also plays a crucial role, with numerous studies indicating that nighttime driving significantly elevates crash risk (Keall, Frith & Patterson, 2005). Human factors such as alcohol consumption (Macinko, Silver & Bae, 2015) and driver fatigue (Horne & Reyner, 1999) are especially pertinent in this regard, often impacting younger drivers more severely (Shope & Bingham, 2008).

A less researched human factor is vehicle ownership. Existing studies suggest that lack of ownership may be one human factor that increases poor or risky driving, which is consistent with the economic principle of moral hazard (Tay & Choi, 2016), in which the agent takes on more risk because someone else bears the cost. The authors analysed 47,182 crashes involving taxi owners and non-owners in New York City and found that non-owners engage in riskier driving behaviour than owners. The same authors (2017) study differences in crashes between rental and non-rental cars in Korea. Using data from police records, the authors focus on human factors such as aggressive driving; poor driving; impaired driving; inattention and poor handling. They find a significantly higher contribution of several risk driving behaviours in rental car crashes, but no differences in roadway, vehicle, and environmental factors. The authors give three potential explanations for this: lower familiarity with the car and the road environment of rental drivers; differences in driver demography (users of rental cars tend to be younger); and differences in vehicle ownership: those who rent do not generally own cars and are less emotionally attached to a vehicle. Cantor, Celebi, Corsi and Grimm (2013) study service violations and crash rates of truck owners' operators *vs.* employee drivers. Using data from the US, the author finds that owner operators are associated with more driver and vehicle-out-of-service violations. A possible explanation is that it is a very competitive market, and operators exceed hours and tend to work beyond legal limits. However, they experience lower crash rates. No explanation is given by the author but probably the emotional attachment to the vehicle, a term employed by Tay and Choi (2017) and the financial burden of the repairment costs may play a role. These results align with Bardhi and Eckhardt (2012), who interviewed 40 carsharing users and found that carsharing consumers do not experience

perceived ownership and, consequently, avoid identification with the car. This limited identification may increase lead to more careless driving and an increased crash likelihood. This is because the carsharing model introduces a distinctive dynamic by dissociating vehicle use from ownership by permitting its users to reap the benefits of private vehicle utilization devoid of its concomitant costs and responsibilities (Costain, Ardron & Habib, 2012).

Although not mentioned explicitly, several studies apply the idea of psychological ownership (Bardhi & Eckhardt, 2012; Cantor, Celebi, Corsi & Grimm, 2013; Tay & Choi, 2016, 2017). The concept, introduced by Pierce, Kostova, and Dirks (2001), encompasses the feeling of possessiveness and attachment towards an object or resource. The importance of psychological ownership in ABS is a topic of interest in the literature of marketing. Access, as opposed to ownership, creates a distinct relationship between individuals and the objects they utilize (Rifkin, 2001), modifying the characteristics of the exchange. The positive influence of psychological ownership on consumer behaviour is evident. Belk (1988) coined the term "extended self" and argued that possessions significantly contribute to and reflect our identities, thus influencing consumer behaviour. In his book, Peck (2018) review the literature to explore different psychological approaches that enhance psychological ownership and promote stewardship of common goods. In a subsequent paper, Peck, Kirk, Luangrath and Shu (2021) design four field and laboratory experiments to demonstrate that increasing consumers' individual psychological ownership facilitates stewardship of public goods. Furthermore, Li and Atkinson (2020) discovered that consumers experience greater happiness when they have higher psychological ownership over an item after consumption.

Table 3. Human factors that explain car crashes

Human factors	Authors
Driving capabilities vs. driving behaviour (conceptual definitions)	Evans (1996); Petridou & Moustaki (2000); Sabey & Taylor (1980)
Age and experience	Factor, Mahalel & Yair (2008); Jonah (1986); Keall, Frith & Petterson (2005); McCartt et al. (2009); Rolison, Regev, Moutari & Feeney (2018)
Gender	Evans (1991); Masie, Campbell & Williams (1995); Romano, Kelley-Baker & Boas (2008) (1997); Shinar, Schechtman & Compton (2019); Yagil (1998)
Time of driving	Keall, Frith & Patterson (2005)
Alcohol consumption	Macinko, Silver & Bae (2015)
Driver fatigue	Reyner (1999); Shope & Bingham (2008)
Lack of vehicle ownership (moral hazard and risky driving)	Bardhi & Eckhardt (2012); Cantor, Celebi, Corsi & Grimm (2013); Costain, Ardron & Habib (2012); Tay & Choi (2016, 2017)

Despite the wide body of literature devoted to understanding car crashes, research focusing on crashes involving carsharing services remains notably limited, likely due to challenges in accessing pertinent data. Presently, only two studies have scrutinized the intersection between carsharing and road safety, each with distinct research aims. Dixit and Rashidi (2014) analysed self-reported data from users of GoGet, a carsharing service in Sydney. Their findings indicated a higher likelihood of crash involvement among drivers with a shorter driving license tenure, higher frequency of car usage, lack of personal car ownership, a history of past crashes, and a preference for lower insurance deductibles. Notably, this study also revealed a greater propensity for at-fault crashes among carsharing users who rarely drove or did not own cars, suggesting limited driving experience as a significant factor in carsharing-related crashes. In a separate study, Shaheen, Shen, and Martin (2016) employed company data from six carsharing operators to evaluate crash risks and insurance claims in the United States. This analysis, which calculated risk per mile and per insured vehicle year, differentiated by age and gender, revealed an elevated crash risk for drivers above 65 years when compared to other age groups and the national average. Additionally, the study found that teenagers and young drivers aged

18 to 25 years exhibited a marginally higher risk than adult drivers. Furthermore, the research indicated a generally lower crash risk for female drivers across nearly all age categories. These studies underscore the significance of human factors in elucidating car crashes, as delineated in the broader literature (Lord & Mannering, 2010; Mannering & Bhat, 2014), but give little insights into the effect of ownership on crashes.

Building on the evidence discussed above, we hypothesize that journeys undertaken by younger male drivers are more likely to result in crashes, potentially due to riskier behaviours, such as thrill-seeking or misbehaviour on the road. We further hypothesize that the probability of crashes increases during nighttime, with younger drivers showing a particularly elevated risk, potentially related to reckless behaviours like racing or driving under the influence of alcohol. Moreover, consistent with the findings of Tay and Choi (2016, 2017), we expect that drivers with fewer previous trips on the platform, that we contend is a proxy for psychological ownerwship, are more likely to be involved in crashes. Similarly, fewer prior trips could signal a lack of experience with electric cars or familiarity with the vehicle, increasing the probability of an accident.

These hypotheses are examined using a two-year dataset of users provided by a carsharing operator in Madrid, offering an extension to the existing body of research on carsharing crashes, which has predominantly focused on contexts like Australia and the United States. By exploring these variables, including potential misbehaviour-related influences, this study contributes to a better understanding of the factors that affect safety in shared mobility services, ultimately supporting strategies to mitigate crashes and foster sustainable mobility.

Understanding the factors that explicate crashes in carsharing is relevant for policymakers and urban planners, given the growing adoption of this mobility model in cities. The insights gleaned from this study have the potential to guide the formulation of targeted strategies and policies aimed at bolstering driving safety within the carsharing paradigm. Such interventions could encompass a spectrum of measures, ranging from modifications in police report templates to capture additional details pertinent to carsharing-related crashes, to the imposition of speed constraints, or the mandatory installation of devices such as dashcams to both elucidate accident dynamics and deter risky driving behaviours. Additionally, a substantive reduction in accident occurrences could significantly enhance the sustainability of the carsharing business model. This is particularly relevant considering the direct impact of

crash rates on insurance premiums, which represent a substantial portion of the operational costs in this sector (Consultancy Asia, 2017).

2.2 Method

2.2.1 Data Source

This investigation leveraged a comprehensive dataset provided by Carsharing Mobility Services SL ("CSMS" or "Zity"), a prominent player in the free-floating carsharing sector. Established in October 2017, Zity is a Spanish free-floating carsharing provider, operating in Madrid with a fleet of electric vehicles. During the time in which data were collected, the company had in operation over 600 vehicles, all of them Renault ZOEs which are fully electric powered. The dataset, meticulously prepared and anonymized by Zity in adherence to both internal and European Union data protection standards, encompassed comprehensive details of all journeys undertaken on the platform from January 1, 2018, to December 31, 2019. Over this period, a total of 2,177,496 trips were recorded. This dataset included an array of variables, such as the time and day of each journey, trip length, key driver demographics, and pertinent details regarding vehicular crashes and driver culpability.

The quantitative analysis was complemented by interviews with company management and service users. This mixed-method approach aligns with the work of Vergel-Tovar et al. (2020), who utilized interviews to interpret the results of their analytical model examining the relationship between road safety outcomes and the built environment. A total of eight interviews were conducted: four with Zity managers, including a member of the top management team, and four with Zity customers. These interviews, carried out independently in Spanish between April and May 2024, ensured participant confidentiality. The study adhered to the Declaration of Helsinki and was approved by the relevant Ethical Committees of Universidad Comillas, Madrid.

2.2.2 Variables

The study explains two binary dependent variables. The first variable pertains to whether a trip culminated in a crash. Within this context, a crash is delineated by the company as an incident necessitating the vehicle's repair at an external workshop. Minor blemishes or

negligible incidents are neither detected nor recorded in this framework. The second dependent variable centres on the assignment of driver culpability. The company attributes fault to the user only under conditions where the user either self-reports, acknowledges responsibility through a 'friendly report'—a formal post-collision declaration signed by the drivers and subsequently forwarded to insurance firms—or concedes culpability when presented with evidence by the company. The table below provides an overview of the variables used in the model.

Table 4. Description of variables included in quantitative model

Variable	Description	Type of variable	Values
Crash	An incident by which the car has to be taken to the garage for repair	Binary	Crash =1 No crash =0
At-Fault	The driver is found culpable of the accident and responsible for paying the repairs	Binary	At-Fault=1 Not-at-fault=0
Previous Trips	Number of trips driven by a specific user before the observed trip	Categorical	Q1 (0 to 5) Q2 (6 to 16) Q3 (17 to 44) Q4 (+44)
Gender	Male or female-only options, according to company records	Binary	Female Male
Age	Age of driver as of 1st of January 2018	Binary	Under 26 yrs old 26 or over
Time of Trip	Time at which the trip starts	Categorical	Early morning (7:00am to 10:59) Morning (11:00 to 14:59) Afternoon (15:00 to 20:59) Evening (21:00 to 23:59) Night (0:00 to 6:59am)
Day of Week	Day on which the trip starts	Categorical	Monday; Tuesday; Wednesday; Thursday; Friday; Saturday; Sunday
Trip length	Length of the trip in Km	Continuous	Logarithm of Km Logarithm of Km (squared)
Traffic	# of vehicles per hour on M30 Madrid road	Continuous	See descriptive statistics
Weather	Litres of rain in each day	Continuous	See descriptive statistics

The analytical model incorporates a set of independent covariates supplied by the company, namely Gender, Age, Previous Trips, Day of the Week and Time of Trip, and Trip Length. Gender information is bifurcated into two categories: female and male. Age is quantified in years, calculated by juxtaposing the trip date with the driver's birth date. The age range of Zity

users spans from 18 years to 90 years old. To discern the variances between younger drivers and other user demographics more effectively, Age was transformed into a categorical variable with two groups: 25 years old and below and 26 years and above. This dichotomy was established based on data analysis, which indicated a heightened crash frequency among drivers aged 18 to 25 compared to those above 25, and corroborated by a review of relevant literature (McCartt et al., 2009; Shaheen et al., 2016; Zeyin et al., 2022). The 'Previous Trips' variable was constructed using available data to represent the cumulative number of trips a driver had undertaken with a Zity vehicle before. Owing to the broad range of values, this variable was categorized into quartiles (Caulfield, 2021), each representing a distinct usage level of Zity services. The quartiles ranged from 0-5 trips in the first quartile, 6-16 in the second, 17-44 in the third, and over 45 trips in the fourth. Additionally, the model includes the Day of the Week and Time of Trip. The Time of Trip variable was segmented into five categories to reflect varying traffic conditions in Madrid: Early Morning (7:00 am to 10:59 am), Morning (11:00 am to 2:59 pm), Afternoon (3:00 pm to 8:59 pm), Evening (9:00 pm to 11:59 pm), and Night (12:00 am to 6:59 am). Lastly, the Trip Length variable, measuring the distance traveled per trip in kilometers, was incorporated to account for risk exposure. Given its highly skewed distribution, it was logarithmically transformed and modeled in a quadratic form to accurately represent the observed U-shaped pattern in the data analysis. Daily rainfall, used as a proxy for weather conditions, and the number of passing vehicles per hour on the M30 (Madrid's inner ring road), serving as a proxy for traffic intensity in the city, were also incorporated into the models.

Other factors that could influence crash rates, such as the type of vehicle or traffic regulations, did not change during the analysis period and are considered constant in the model. To ensure the robustness of the model against multicollinearity, the Variance Inflation Factor (VIF) was employed as a diagnostic tool. The VIF values for all variables were found to be lower than 2, a threshold generally accepted as indicative of minimal multicollinearity. To ensure the robustness of the model against multicollinearity, the Variance Inflation Factor (VIF) was employed as a diagnostic tool. The VIF values for all variables were found to be lower than 2, a threshold generally accepted as indicative of minimal multicollinearity.

2.2.3 Analytical model

The choice of which methodology should be employed to explain car crashes is influenced by the nature of the dependent variable, the availability of data, and advances in statistics. The dependent variable is usually a measure of either the frequency of crashes or the severity of the crash, commonly injury severity. Lord and Mannering (2010, p2) describe frequency of crashes as "the number of crashes occurring on a roadway entity over some time period". The term "crash" is more frequently used than accident because it incorporates better the human aspects as well as the unpredictability that any accident has (Elander, West & French, 1993). The word "accident" also suggests that there is some sort of fate behind the crashes instead of factors that explain them (Evans, 1991). Crash severity refers to the degree and nature of the damages done to the human body (for example death, incapacitant or non-incapacitant injury) and/or to property (Savolainen et al. 2011). Historically availability of data has been a constraint in the understanding of the phenomenon. Consequently, a major focus has been put in developing models that make better use of this data (Mannering & Bhat, 2014). This can be seen in the increasing number of statistical methodologies that are developed to explain crash frequency (Lord and Mannering, 2010) and crash severity (Savolainen, Mannering, Lord, & Quddus, 2011). Their increasing complexity has enabled researchers to extract more insights from existing data sources. However, there is not a method that can be considered more appropriate. In fact, empirical evidence from many studies suggests that the superiority of one methodological approach over another can be very data-dependent (Mannering & Bhat, 2014).

The models that attempt to analyse crash frequency are commonly based on Poisson regressions and its variants, whether crash severity and injury use discrete outcome models where the dependent variable is nominal (Mannering & Bhat, 2014). When studying frequency of crashes the dependent variable usually measures the number of crashes during a certain period and a limited space, for example a road section. Crash-frequency data are non-negative integers (0,1,2, etc.) and therefore the application of standard ordinary least-squares regression (which assumes a continuous dependent variable) is not appropriate (Lord & Mannering, 2010). Consequently, the Poisson regression approach has been the basis of the initial models. Variants of the Poisson model were developed to overcome methodological problems and increase fit such as gamma, lognormal, zero-inflated models, and more sophisticated ones like neural networks. In crash severity and injury severity the dependent

variable is a nominal variable that can adopt several values. For example, death/no death or body harm/no-harm. Savolainen et al (2011) perform a similar work review to that of Lord and Mannering (2010) and list a number of methodologies that have been used in the past. In this case, discrete outcome models such as logit/probit models dominate the list. There are many variations beyond the basic binary outcome model such as ordered discrete models and multinomial logit models. However, discrete outcome models have also been widely used for other purposes such as analysing the differences in crash likelihood between normal days and public holidays, or between car hire drivers vs. owners (Anowar, Yasmin & Tay, 2013; Chen, Suren & Xiaoxiang, 2018; Dingus et al., 2016; Haworth, Schramm & Twisk, 2021; Qiu & Nixon, 2008; Tay & Choi, 2016).

In this study, the primary unit of analysis is the individual trip. The two dependent variables are binary: the first quantifies the probability of a crash occurring during a trip, while the second determines whether the driver was at fault in the event of a crash. Initially, we developed a Heckprobit model to address a potential issue of selection bias, given that trips resulting in crashes might be more likely to be at fault. However, we ran a rho contrast test and found that the two equations are independent, making the Heckprobit model unnecessary. For that reason, we decided to use a binomial logit regression model as it is more widely used and familiar to readers.

Two models, incorporating all previously discussed covariates, were developed: one to assess their impact on the likelihood of a crash and another to determine driver´s culpability. Additionally, two interaction models were built to explore the potential interaction effects between the covariates Age and Time of Trip (Night). All analyses were conducted using the statistical software Stata (2023). Figure 4 provides a summary of the models.

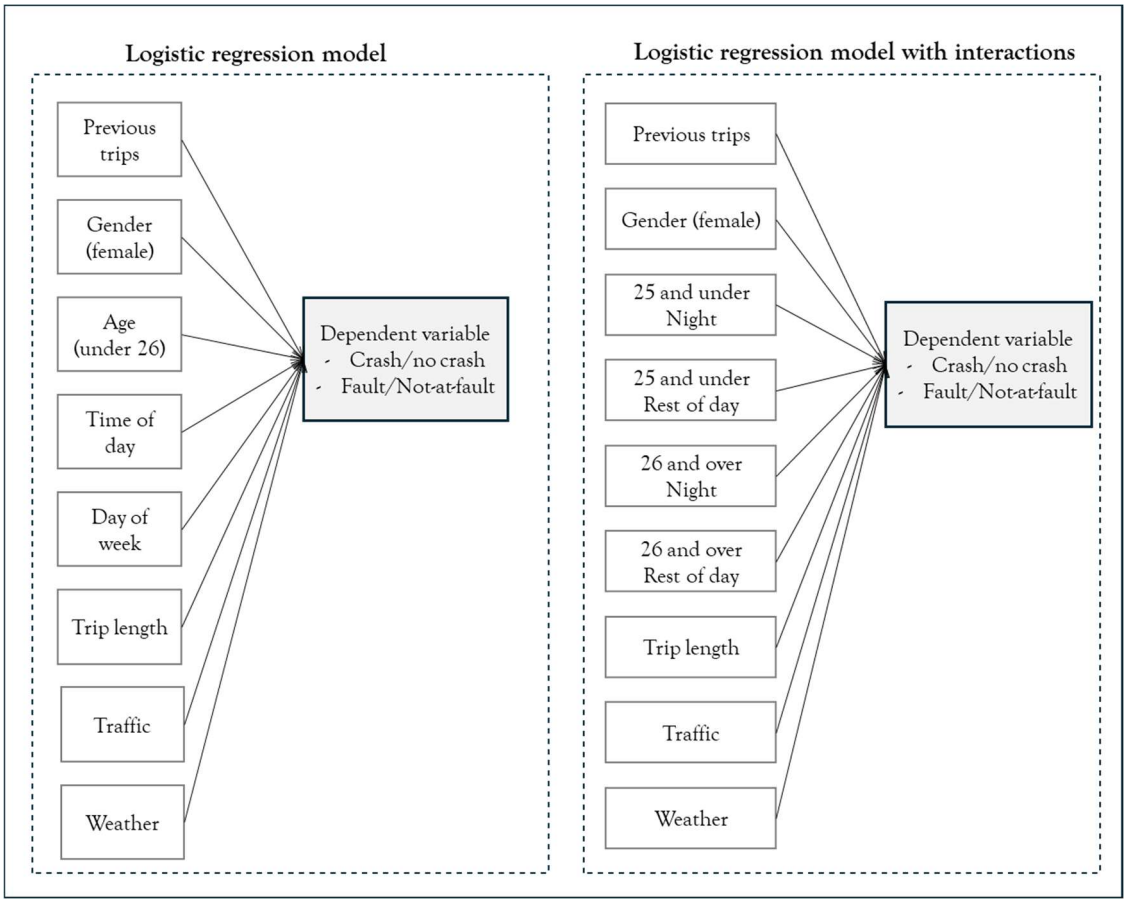


Figure 4. Pictorial description of logit models employed

2.3 Results

The main descriptive statistics for the variables incorporated in the models are shown in Table 5. A comparative statistical analysis between trips culminating in crashes and those that did not was conducted. For binary variables, a Chi-Squared test was utilised to identify statistical differences between the two groups. For the continuous variable Trip Length, a Mann-Whitney-Wilcoxon test was employed. Over the study period, a total of 2,177,496 trips were recorded, of which only 691 (0.032% of all trips) resulted in a crash. The dataset encompassed 135,572 unique users, with no instances of a user being involved in more than one crash. Tables 6 and 7 contain additional descriptive statistics for the variables incorporated in the models.

The analysis of the variable Previous Trips revealed that trips in the first quartile (0 to 5 trips) constituted to 34.0% of all crashes, higher than the 26.7% of trips that did not result in a crash. Men were the predominant users, accounting for 71.0% of non-crash trips. However,

the proportion of crashes involving women was 34%, higher than their overall participation rate. The average age of Zity users was 35.37 years, significantly younger than the average age of Spanish drivers, which stands over 47 years (DGT, 2021). Drivers 25 years old and below were involved in 40.6% of crashes, a figure that is twice the percentage of total trips taken by this age group. Considering the time of day, 22.7% of crashes occurred between midnight and 7:00 am, compared to only 17.6% of non-crash trips taking place during these hours. The days with the highest crash incidences were Thursdays, Fridays, and Saturdays, accounting for 15.6%, 18.5%, and 16.3% of all crashes, respectively, correlating with the highest trip frequencies. The average distance of crash-ending trips was found to be 11.09 km, which is notably higher than the 9.02 km average for non-crash trips. In the subset of trips where a crash occurred, drivers were deemed at fault in 78.9% of cases. This figure is slightly higher than the 60% reported by Dixit and Rashidi (2014) in their study of Get member crash data in Sydney, Australia. Higher incidences of at-fault crashes were observed in trips undertaken by users 25 and below and those occurring at night. Notably, the first quartile of Previous Trips accounted for 32.7% of at-fault journeys as opposed to 39.0% in the not-at-fault category.

Table 5. Summary of descriptive statistics

Categorical variables	Crash		No crash		p-value	Fault		Not-at-fault		p-value
	# Obs	%	# Obs	%		# Obs	%	# Obs	%	
Crash	691	0.032	2,176,807	99.97		545	78.9	146	21.1	
Previous trips										
Q1 (0 to 5)	235	34.0	580,851	26.7	.000	178	32.7	57	39.0	.148
Q2 (6 to 16)	167	24.2	521,431	24.0	.895	135	24.8	32	21.9	.475
Q3 (17 to 44)	134	19.4	533,318	24.5	.002	112	20.6	22	15.1	-137
Q4 (over 45)	155	22.4	541,207	24.9	.139	120	22.0	35	24.0	.615
Gender										
Male	456	66.0	1,544,521	71.0		359	65.9	97	66.4	.898
Female	235	34.0	632,286	29.0	.004	186	34.1	49	33.6	.898
Age cohort										
25 and under	280	40.6	443,879	20.4	.000	250	45.9	30	20.5	.000
26 and over	411	59.4	1,732,928	79.6		295	54.1	116	79.5	.000
Time of Trip										
Early morning	87	12.7	268,091	12.3	.826	63	11.6	24	16.4	.115
Morning	145	21.0	522,834	24.0	.062	113	20.7	32	21.9	.755
Afternoon	242	35.0	803,405	36.9	.304	179	32.8	63	43.2	.020
Evening	60	8.7	199,219	9.2	.669	47	8.6	13	8.9	.915
Night	157	22.7	383,258	17.6	.000	143	26.2	14	9.6	.000
Day of Week										
Monday	87	12.6	290,296	13.3	.564	66	12.1	21	14.4	.462
Tuesday	83	12.0	301,262	13.8	.164	64	11.7	19	13.0	.675
Wednesday	90	13.0	314,258	14.4	.291	69	12.7	21	14.4	.583
Thursday	108	15.6	331,361	15.2	.766	80	14.7	28	19.2	.184
Friday	127	18.4	392,050	18.0	.800	101	18.5	26	17.8	.841
Saturday	113	16.4	327,093	15.0	.329	90	16.5	23	15.8	.825
Sunday	83	12.0	220,487	10.1	.101	75	13.8	8	5.5	.006

Numeric variables	Crash		No crash		p-value	Fault		Not-at-fault		p-value
	Mean	Std.	Mean	Std.		Mean	Std.	Mean	Std.	
Trip length (km)	11.09	14.24	9.02	8.64	.315	11.31	14.80	10.34	11.95	.857
Traffic (# veh/h)	2,163	1,197	2,240	1,130	.202	2,097	1,236	2,407	1,003	.004
Weather (l/m2)	1.27	4.17	1.14	3.78	.820	1.22	4.05	1.45	4.59	.753

Table 6. Descriptive statistics: Previous trips and Gender

No crash trips				% in columns		% in rows	
	Male	Female	Subtotal	Male	Female	Male	Female
Q1 (0 to 5)	178,263	402,823	581,086	28.2%	26.1%	30.7%	69.3%
Q2 (6 to 16)	152,852	368,746	521,598	24.2%	23.9%	29.3%	70.7%
Q3 (17 to 44)	155,209	378,243	533,452	24.5%	24.5%	29.1%	70.9%
Q4 (over 45)	146,197	395,165	541,362	23.1%	25.6%	27.0%	73.0%
Subtotal	632,521	1,544,977	2,177,498	100.0%	100.0%	29.0%	71.0%

Crash trips							
	Male	Female	Subtotal	Male	Female	Male	Female
Q1 (0 to 5)	94	141	235	40.0%	30.9%	40.0%	60.0%
Q2 (6 to 16)	57	110	167	24.3%	24.1%	34.1%	65.9%
Q3 (17 to 44)	39	95	134	16.6%	20.8%	29.1%	70.9%
Q4 (over 45)	45	110	155	19.1%	24.1%	29.0%	71.0%
Subtotal	235	456	691	100.0%	100.0%	34.0%	66.0%

Table 7. Descriptive statistics: Previous trips and Age

No crash trips				% in columns		% in rows	
	25 and below	26 +	Subtotal	25 and below	26 +	25 and below	26 +
Q1 (0 to 5)	123,025	458,061	581,086	27.7%	26.4%	21.2%	78.8%
Q2 (6 to 16)	111,212	410,386	521,598	25.0%	23.7%	21.3%	78.7%
Q3 (17 to 44)	112,438	421,014	533,452	25.3%	24.3%	21.1%	78.9%
Q4 (over 45)	97,484	443,878	541,362	21.9%	25.6%	18.0%	82.0%
Subtotal	444,159	1,733,339	2,177,498	100.0%	100.0%	20.4%	79.6%

Crash trips							
	25 and below	26 +	Subtotal	25 and below	26 +	25 and below	26 +
Q1 (0 to 5)	108	127	235	38.6%	30.9%	46.0%	54.0%
Q2 (6 to 16)	66	101	167	23.6%	24.6%	39.5%	60.5%
Q3 (17 to 44)	62	72	134	22.1%	17.5%	46.3%	53.7%
Q4 (over 45)	44	111	155	15.7%	27.0%	28.4%	71.6%
	280	411	691	100.0%	100.0%	40.5%	59.5%

The outcomes of the logit models are detailed in Tables 8 and 9. In the model where the occurrence of a crash was the dependent variable, both Age and Gender emerged as significant predictors. The positive coefficients for these variables indicate a heightened likelihood of crashes for trips involving drivers 25 years old and below (.968, $p<.01$) and female drivers (.201), albeit at $p>.05$. The first quartile of the 'Previous Trips' variable (.336, $p<.01$) also shows a significant positive correlation, suggesting an increased crash probability for drivers with five or fewer prior trips on the platform. Trips occurring at night were found to have a higher crash likelihood (.351, $p<.01$). However, the Day of Week did not produce statistical significances. The variables denoting kilometers driven were significant at $p<.01$, indicating a U-shaped relationship between the distance driven and crash probability. In the model that analyses the culpability of the crash, only 25 and under (1.314, $p<.01$) and Night (1.274, $p<.01$) were statistically significant, both exhibiting larger positive coefficients than in the first model.

In the models with interactions, the combination of Time of Trip (Night) and 25 and under were statistically significant in both the crash/no-crash model (1.784, $p<.01$) and the at-fault/not-at-fault models (2.686, $p<.01$), with higher coefficients than the separate effects of

these covariates in the models without interactions. The covariate Previous Trips retained its significance only in the crash/no-crash model (.306, $p<.01$).

Table 8. Logistic regressions

# of obs	= 2,177,498	Prob > chi2	0.00			# of obs	= 691	Prob > chi2	=0.00		
	Crash/No crash						**At-fault / Not-at-fault**				
	Coefficient	**Std. err.**	**z**	**p>|z|**		**Coefficient**	**Std. err.**	**z**	**p>|z|**		
Previous trips											
Q1 (0 to 5)	.336	.105	3.21	.001	***	-.416	.270	-1.54	-123		
Q2 (6 to 16)	.119	.112	1.06	.288		.015	.296	0.05	.960		
Q3 (17 to 44)	-.124	.118	-1.04	.296		.186	.326	0.57	.568		
Q4 (over 45)	0	(omitted)				0	(omitted)				
Gender - Female	.201	.081	2.49	.013	**	.169	.212	0.79	.427		
Age – 25 and under	.968	.079	12.30	.000	***	1.314	.242	5.42	.000		***
Time of Trip											
Early morning	.099	.126	0.79	.428		-.120	.303	0.40	.693		
Morning	-.044	.105	-0.42	.673		.336	.263	1.28	.202		
Afternoon	0	(omitted)				0	(omitted)				
Evening	-.184	.147	-1.25	.210		-.177	-380	-0.46	.642		
Night (000am-0659am)	.351	.106	3.31	.001	***	1.274	.337	3.78	.000		***
Day of the week											
Monday	-.060	.140	-0.43	.665		-.227	.352	-0.65	.519		
Tuesday	-.142	.142	-1.00	.316		-.247	.360	-0.69	.493		
Wednesday	-.105	.138	-0.76	.449		-.207	.356	-0.58	.562		
Thursday	.019	.131	0.14	.886		.004	.0363	0.11	.916		
Friday	0	(omitted)				0	(omitted)				
Saturday	-012	.131	0.09	.925		-.196	.347	-0.56	.573		
Sunday	.059	.144	0.41	.685		.910	.460	1.97	.050		**
Trip length (Log km)	.077	.029	2.60	.009	***	.085	.085	1.00	.320		
Trip length ([Log km]^2)	.164	.010	15.96	.000	***	.062	.034	1.83	.067		
Traffic (# veh/h)	-.000	.000	-0.24	.813		-.000	.000	-0.43	.666		
Weather (l/m2)	.008	.009	0.85	.396		-.010	.022	-0.44	.662		
Constant	-8.760	.162	-53.91	.000		.756	.435	1.74	.082		

*** p<.01, ** p<.05

Table 9. Logistic regressions with interactions

# of obs	= 2,177,498	Prob > chi2	.000			# of obs	= 691	Prob > chi2	.000	
	Crash/No crash					**At-fault / Not-at-fault**				
	Coefficient	**Std. err.**	*z*	**p>|z|**		**Coefficient**	**Std. err.**	*z*	**p>|z|**	
Previous trips										
Q1 (0 to 5)	.306	.119	2.56	.010	***	-.427	.269	-1.59	.112	
Q2 (6 to 16)	.156	.126	1.24	.216		.021	.295	0.07	.943	
Q3 (17 to 44)	-.050	.132	-0.38	.703		.170	.321	0.53	.597	
Q4 (over 45)	0	(omitted)				0	(omitted)			
Gender - Female	.205	.091	2.26	.024	**	.179	.212	0.85	.398	
Interactions										
25 and under - Night	1.784	.143	12.43	.000	***	2.686	.747	3.60	.000	***
25 and under -Rest of Day	1.114	.100	11.07	.000	***	1.207	.244	4.95	.000	***
26 and over - Night	.468	.137	3.42	.001	***	1.107	.346	3.20	.001	***
26 and over - Rest of Day	0	(omitted)				0	(omitted)			
Day of the week										
Monday	-.095	.158	-0.60	.548		-.196	.350	-0.56	.576	
Tuesday	-.160	.160	-1.00	.317		-.221	.359	-0.62	.537	
Wednesday	-.127	.156	-0.81	.417		-.198	.353	-0.56	.575	
Thursday	-.040	.149	-0.27	.790		-.345	.326	-1.06	.289	
Friday	0	(omitted)				0	(omitted)			
Saturday	-.001	.147	-0.00	.997		-.230	.345	-0.67	.504	
Sunday	.170	.155	1.10	.273		.939	.459	2.05	.041	
Trip length (Log km)	.086	.032	2.64	.008	***	.084	.083	1.01	.311	
Trip length ([Log km]^2)	.171	.011	15.37	.000	***	.060	.034	1.78	.075	
Traffic (# veh/h)	-.000	.000	-0.26	.796		-.000	.000	-0.41	.678	
Weather (l/m2)	.005	.011	0.46	.646		-.012	.022	-0.55	.583	
Constant	-9.14	.174	-52.5	.000		.875	.415	2.11	.035	

*** p<.01, ** p<.05

The interviews provided qualitative insights that enriched the interpretation of the quantitative results obtained from the models. Zity managers expressed little surprise at the findings, unanimously highlighting a correlation between collision rates and the age of drivers, noting that younger users often engaged in inappropriate vehicle use, such as illegal racing or aggressive driving manoeuvres. Managers also confirmed that nighttime was strongly associated with higher incident rates, often linked to alcohol use. Additionally, managers noted the increased crash likelihood among drivers in the first quartile of the 'Previous Trips' variable, suggesting that unfamiliarity with automatic electric vehicles during Zity's early years may have contributed to these incidents. The top management team member added that customers generally treated Zity cars with less care than their personal vehicles, as they did not own them. However, heavy users appeared to develop a sense of responsibility toward the vehicles, treating them more carefully as they anticipated reusing them in the near future. Customers corroborated the idea that misbehaviour might explain the higher crash probability among younger drivers, particularly at night. Some interviewees pointed to the prevalence of social media videos showcasing illegal racing and reckless driving with Zity vehicles, and others reported observing groups of young people using Zity cars as makeshift bars on Friday evenings, consuming alcohol inside the vehicles. Frequent users also mentioned that their usage frequency influenced their driving behavior, as they treated the cars more carefully, knowing they would likely use the service again.

2.4 Discussion

With the growing adoption of carsharing in urban areas, understanding the factors that influence crash likelihood is increasingly important, not only to address safety concerns but also to support the long-term sustainability of shared mobility services. This study examines how specific variables, such as driver demographics (age and gender), trip timing, and the number of previous trips on the platform, influence the probability of a crash, while also considering the potential contribution of customer misbehaviour to these factors. The number of previous trips is explored as a potential proxy for psychological ownership, a concept reflecting the user's sense of attachment and responsibility towards the vehicle (Pierce, Kostova & Dirks, 2001). By identifying these factors and their links to potential misbehaviour, the research aims to inform strategies for reducing crashes, improving user behaviour, and

ultimately supporting the sustainable growth of carsharing services within the broader context of sustainable urban mobility.

The results partially corroborate our initial hypotheses. The first hypothesis posited a higher crash likelihood for trips undertaken by younger and male drivers. The data supports the increased risk for younger drivers (aged 25 and under) but not for male drivers. The result obtained for young drivers is consistent with past literature and specifically with the findings of Shaheen et al. (2016) for carsharing. Evidence from the interviews suggests that previously explored factors such as risk-taking behaviour (illegal racing or aggressive maneuvers) and lack of driving experience may contribute to the increased collision rates (Rolison et al., 2018).

Contrarily, our analysis indicates a marginally higher crash likelihood for female drivers, diverging from previous research. A potential explanation may lie in the type of crashes that occur in urban settings. According to Bingham and Ehsani (2012), there is empirical evidence that female drivers have a higher likelihood of left and right-side crashes compared to men. If a large number of the crashes recorded by Zity are of this type, this could explain why female drivers appear to have a higher likelihood of crashing. Regarding culpability, gender does not exhibit a correlation with being at fault or not. When consulted, the management of the company confirmed that they did not analyse incidents by gender but believed that the rates were similar for males and females.

The study also finds a higher crash probability during nighttime (midnight to 7 a.m.). Previous research has shown that nighttime crashes are often associated with alcohol consumption (Keall et al., 2015) and/or driver fatigue (Horne & Reyner, 1999), both of which increase impaired driving at night. In the case of Zity, alcohol appears to play a significant role. The top management team member mentioned instances where drivers abandon their cars after a crash on Friday and Saturday nights because they prefer to be penalized by the company than going through an alcohol test when the police arrive. One customer noted that he has seen groups of young people using Zity cars as improvised bars on weekend evenings. Sleep deprivation was not mentioned during the interviews. Moreover, it is likely that multiple passengers sharing the car at night could engender peer pressure for aggressive driving (Zeyin et al., 2022), resulting in increased distraction and elevated crash rates (Doherty et al., 1998). Vandalism and illicit activities further compound the risk at night, with documented instances of Zity cars being utilised for unauthorized racing in Madrid, occasionally culminating in

collisions (Lopez, 2019; Pareja, 2020). The interaction between Time of Trip and Age underscores a significant increase in both crash likelihood and at-fault probability during nighttime for younger drivers, possibly due to amplified risk-taking behaviours, as indicated by Zity management.

Regarding the influence of Previous Trips on crash likelihood, the study reveals that drivers with fewer prior trips (first quartile) are more likely to be involved in a crash. Several factors could explain this finding. Evidence from both management and customers suggests that a lack of psychological ownership might be a key reason: Zity cars are treated worse than personal vehicles, primarily because users do not own them. Drivers with very limited use of the service may not yet have developed a sense of ownership toward the vehicle or the service, potentially leading to less careful usage patterns (Shu & Peck, 2018). However, this may change with the number of trips, as the interviews with users suggested. Although the development of psychological ownership falls outside the scope of this study, it is plausible that drivers who use the service more frequently begin to perceive greater benefits (Bardhi & Eckhardt, 2012) and, as a result, adopt more cautious driving behaviour. Another factor associated with the number of previous trips could be the initial unfamiliarity with the vehicle, which may increase the likelihood of crashes (Perel, 1983; Tefft et al., 2019). For Zity, the exclusive use of automatic, fully electric vehicles may have presented additional challenges for first-time users due to their unique driving characteristics (Mechante et al., 2022). This issue was particularly evident during Zity's early years, as highlighted by the company's customer experience manager. Whether due to a lack of attachment, diminished perceived benefits, or unfamiliarity with the vehicle, fewer prior uses of the carsharing service are associated with a higher likelihood of crashes. However, this variable does not significantly affect the attribution of fault in crashes. This indicates that the factors influencing the likelihood of a crash related to prior usage (Previous Trips) do not contribute to determining culpability in such incidents.

The model includes adjustments for Trip Length, using kilometers driven as a proxy for risk exposure. The coefficients for kilometers driven display a U-shaped pattern, aligning partially with previous research suggesting that crash probability increases with greater exposure to risk (Massie et al., 1995; Regev et al., 2018; Segui-Gomez et al., 2010). Our findings also indicate that shorter trips are associated with a higher crash risk, which may be explained by the "low-mileage bias." This concept suggests that low-mileage drivers tend to drive more frequently on

local and arterial roads, which have higher traffic volumes and numerous conflict points (e.g., intersections), in contrast to high-mileage drivers, who typically travel on safer freeways and motorways with separated lanes and fewer conflict points (Hakamies-Blomqvist, Raitanen & O'Neill, 2002; Langford, Methorst & Hakamies-Blomqvist, 2006). In the case of Zity, which operates exclusively within the Madrid urban area, the high crash rates for shorter trips are likely influenced by drivers' unfamiliarity with electric, automatic models, vehicles that were uncommon in Madrid at the time of the study. As highlighted by the interviewed managers, there have even been instances of crashes occurring only a few hundred meters after the trip began.

In this thesis, the conclusions, practical applications, limitations, and suggestions for future research related to this study will be discussed alongside the insights from Study 2 in the Conclusion section. This integrated approach provides a more comprehensive understanding of how the findings from both studies collectively contribute to the broader objectives of this research.

Chapter 3. Review of frameworks to understand how misbehaviour affects SBMs

The previous study examined factors contributing to crashes in carsharing, suggesting that customer misbehaviour—such as aggressive driving or illegal racing—may play a role. It also proposed that psychological ownership and greater driving experience could reduce accident risk. The financial implications of this form of misbehaviour are evident for operators, who face higher repair and maintenance costs as well as increased insurance premiums. Unfortunately for shared mobility service providers, reckless driving represents only one of numerous negative behaviours exhibited by both customers and non-customers, with repercussions that extend beyond direct costs.

This chapter introduces three widely recognized conceptual frameworks that provide a structured approach to analysing the consequences of misbehaviour in shared mobility at both the micro and macro levels (see Figure 5). By leveraging these established frameworks, the research ensures that the findings are not only academically rigorous but also practically relevant. The frameworks employed, namely, the Business Model Framework, the Triple Bottom Line Approach of Sustainable Business Models, and the Multi-Level Perspective on socio-technical transitions, offer comprehensive perspectives for analysing and interpreting the multifaceted impacts of customer misbehaviour on both business models and sustainability transitions. These conceptual tools facilitate a systematic examination of how shared mobility operators adapt their business models in response to negative behaviours, allowing for a detailed exploration of the trade-offs between economic, social, and environmental objectives. At the macro level, the Multi-Level Perspective (MLP) is particularly effective in understanding how these business model changes, driven by misbehaviour, can influence the development of the shared mobility industry and its capacity to contribute to broader transformations within the urban transportation system.

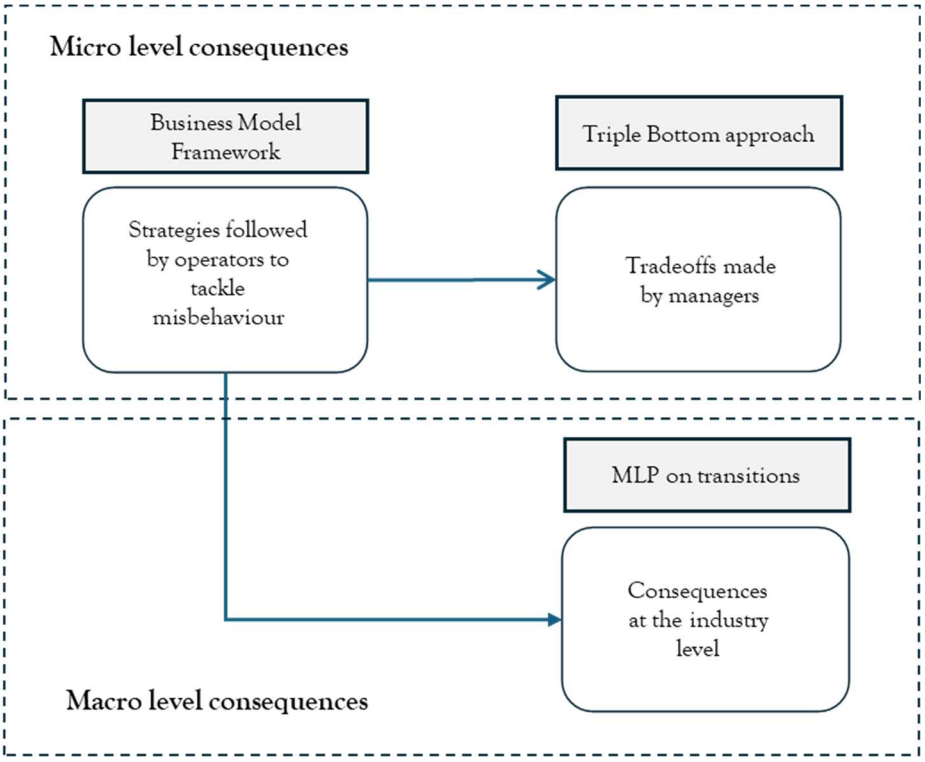


Figure 5. Basic frameworks to analyse the micro and macro consequences of misbehaviour

3.1 Shared mobility as a Sustainable Business Model

There are numerous definitions of Sustainable Business Models (SBMs) (Lozano, 2018; Geissdoerfer, 2019) with new approaches emerging continuously (Comin, Aguiar, Sehnem, Yusliza, Cazella, & Julkovski, 20). A common characteristic across these definitions is the integration of economic, environmental, and social dimensions, alongside the active consideration and involvement of multiple stakeholders and the adherence to a long term perspective. Table 10 contains an overview of the considered definitions.

Table 10. Definitions of Sustainable Business Models (in chronological order)

Source	Definition
Bocken, Short, Rana & Evans (2013)	"Sustainable business models seek to go beyond delivering economic value and include a consideration of other forms of value for a broader range of stakeholders. (p. 484)
Boons and Lüdeke-Freund (2013)	"A sustainable business model is different from a conventional one through four propositions. 1. The value proposition provides measurable ecological and/or social value in concert with economic value [...]. 2. The supply chain involves suppliers who take responsibility towards their own as well as the focal company's stakeholders [...]. 3. The customer interface motivates customers to take responsibility for their consumption as well as for the focal company's stakeholders [...]. 4. The financial model reflects an appropriate distribution of economic costs and benefits among actors involved in the business model and accounts for the company's ecological and social impacts." (p. 13)
Schaltegger, Hansen and Lüdeke-Freund, (2016)	"A business model for sustainability helps describing, analyzing, managing, and communicating (i) a company's sustainable value proposition to its customers, and all other stakeholders, (ii) how it creates and delivers this value, (iii) and how it captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organizational boundaries." (p.6)
Evans et al. (2017)	Sustainable business models are described with five propositions. "1. Sustainable value incorporates economic, social and environmental benefits conceptualised as value forms. 2. Sustainable business models require a system of sustainable value flows among multiple stakeholders including the natural environment and society as stakeholders. 3. Sustainable business models require a value network with a new purpose, design and governance. 4. Sustainable business models require a systemic consideration of stakeholder interests and responsibilities for mutual value creation. 5. Internalizing externalities through product-service systems enables innovation towards sustainable business models." (p. 601)
Geissdoerfer, Vladimirova and Evans (2018)	"We define sustainable business models as business models that incorporate pro-active multi-stakeholder management, the creation of monetary and non-monetary value for a broad range of stakeholders, and hold a long-term perspective." (p.403)

The Triple Bottom Line (TBL) has been widely used in the past to analyse sustainable business models (Slaper & Hall, 2011). The construct was coined by business consultant John Elkington (1997) to describe the economic, environmental, and social value of investment that may accrue outside a firm's financial bottom line (Hammer & Pivo, 2016). The economic

dimension focuses on value creation (Alhaddi, 2015) and on generating profit and maintaining a competitive edge by integrating sustainable practices (Gopalakrishnan, Yusuf, Musa, Abubakar, & Ambursa, 2012). The social dimension encompasses health and safety concerns, community welfare, job creation, charitable activities, cultural considerations, and organisational behaviour (Gopalakrishnan et al., 2012). Finally, the environmental dimension addresses issues such as resource efficiency, responsible use of resources and no harmful environmental impacts (Laukkanen & Tura, 2020).

Access-Based Services (ABS) and shared mobility have been increasingly studied as examples of sustainable business models due to their potential to generate positive social, environmental, and economic outcomes. Bocken et al. (2014) identify ABS, such as carsharing and bicycle-sharing services, as a key sustainable business model archetype, highlighting their ability to "deliver functionality rather than ownership." This shift away from traditional ownership models can lead to more efficient resource utilization and reduced environmental impact. Laukkanen and Tura (2020) further support this view by examining sharing economy business models, including shared mobility, for their capacity to create sustainable value. They emphasize that ABS can optimize the use of underutilized assets, minimize overconsumption, and facilitate collaborative consumption, which can ultimately reduce the overall environmental footprint.

When viewed through the lens of the Triple Bottom Line approach, shared mobility services have the potential to deliver social sustainability by enhancing accessibility and mobility for a wider range of the population who live in areas with poor public transport, as well as giving access to vehicles to lower-income groups who may not be able to afford personal vehicles (Fleming, 2018; Martinez, Pritchard & Crist, 2024). These services can also promote a sense of community and shared responsibility (Midgley, 2009). From an environmental perspective, shared mobility supports sustainability by reducing the number of privately owned vehicles, which helps lower greenhouse gas emissions and air pollution—particularly when the fleet is electric, and mitigates traffic congestion (Fishman, Washington & Haworth, 2014; Shaheen & Cohen, 2013). Also, these services enhance road usage efficiency by allowing multiple users to share the same vehicle at different times. As Martínez, Pritchard, and Crist (2024) highlight, this shift reduces the overall number of vehicles on the road and alleviates urban congestion, contributing to more sustainable urban mobility. Economically, shared mobility models offer

cost-effective transportation alternatives, alleviating the financial burden of car ownership for individuals while creating opportunities for innovative revenue streams and job creation within the green economy (Cervero & Tsai, 2004). Shared mobility can create new opportunities for employment and generate revenue from underused resources.

However, the sustainability potential of shared mobility businesses is not automatic (Arbeláez Vélez, 2024); it depends heavily on factors such as the size of the fleets and how they are designed and implemented, and their impact on transport consumption behaviour (Laukkanen & Tura, 2020; Arbeláez Vélez, 2023; Zhu, Xie, Cai, Tang, & Chen, 2023). For example, while carsharing may reduce the need for private vehicle ownership, its positive environmental impact could be offset if it replaces more sustainable modes of transportation, such as walking or cycling. From a social perspective, shared mobility users are typically younger and have higher incomes, whereas older adults and individuals from lower-income backgrounds tend to use these services less frequently (Martinez, Pritchard & Crist, 2024).

Allegedly, sustainable business models strive to balance economic, environmental, and social objectives. However, in practice, these goals often conflict, forcing companies to make trade-offs between them (Halpern et al., 2013; Svensson, Ferro, Høgevold, Padin, Varela & Sarstedt, 2018). In fact, these trade-offs may be more prevalent than achieving a harmonious integration of all three objectives (Hahn, Figge, Pinkse & Preuss, 2010). In my thesis, I apply the Triple Bottom Line (TBL) framework to analyse shared mobility and examine the trade-offs companies have made, either intentionally or unintentionally, in these objectives when addressing customer misbehaviour and vandalism.

3.2 Business Model Framework

Understanding what a business model is and how it evolves is essential for analyzing how firms adapt to external challenges, such as customer misbehaviour and vandalism. This section provides an overview of the business model concept, followed by an exploration of how business models adapt and evolve over time. This discussion establishes the foundation for applying Richardson's (2009) framework to the shared mobility context.

The concept of Business Model

There is no single, universally accepted definition of a business model (Casadesus-Masanell, 2007; Massa, Tucci & Afuah, 2017). A business model, in its simplest form, outlines the logic or architecture of how a company creates, delivers, and captures value by meeting customer needs, generating revenue, and ensuring profitability (Teece, 2010). Importantly, a business model is not just about how a firm makes money, but how it creates value for customers and partners, linking the various activities of the firm into a coherent system (Zott & Amit, 2010). It can be understood as a narrative that answers key questions such as: who is the customer, what does the customer value, how do we make money, and what is the underlying economic logic that explains how to deliver value (Magretta, 2002; Morris, Schindehutte & Allen, 2005).

To navigate the complexity of business models, several tools and frameworks have been developed to facilitate their analysis. Among the most popular tools is the Business Model Canvas (Osterwalder & Pigneur, 2010), which breaks down business models into nine distinct building blocks: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. This tool provides a visual representation of a company's business model and has been widely adopted by both practitioners and academics for its comprehensiveness. Another tool, the St. Gallen Business Model Navigator (Gassmann, Frankenberger, & Csik, 2014), categorizes business models based on 55 patterns, offering an approach that helps identify innovative business model configurations. While these tools are highly effective in providing a detailed view, they can sometimes be overwhelming or too granular for analysing specific contexts, such as the adaptation of business models in response to customer misbehaviour in shared mobility.

For this dissertation, I have chosen to use the framework proposed by Richardson (2009). This framework better aligns with the aim of this research by reducing unnecessary complexity, maintaining focus on key elements, and offering clearer insights for practitioners and managers. Building on previous literature, Richardson proposes a framework centreed on three main components: value proposition, value creation and delivery, and value capture. The core idea is that a company's business model outlines how it provides its products and services and how it generates profits. Each is explained in turn. Table 11 follows with a comparative of each component in shared mobility.

- Value Proposition. This component identifies the specific value that a company offers to its customers. It includes the unique features of products or services that satisfy customer needs and distinguish the company from its competitors. In the context of shared mobility, the value proposition may include factors such as affordability, convenience, environmental benefits, and access to vehicles without the burden of ownership.
- Value Creation and Delivery. This element examines the resources, capabilities, and activities necessary to create and deliver the promised value. It encompasses the company's internal operations, supply chain, technology infrastructure, and partnerships. For shared mobility services, this might involve maintaining a fleet of vehicles, developing a digital platform for reservations, and establishing partnerships with municipalities.
- Value Capture. This refers to the mechanisms through which the company generates revenue and maintains financial sustainability. It includes pricing strategies, cost structures, and revenue models. Shared mobility companies, for example, might employ a variety of revenue models such as subscription-based services, pay-per-use pricing, or fees for advertising in their vehicles to generate income.

Table 11. The Business Model Framework

Value lever	Description	Elements	Shared mobility – Main components
Proposition	What the firm will deliver to its customers, why they will be willing to pay for it, and the firm's basic approach to competitive advantage.	- The offering - The target customer - The basic strategy to win customers and gain competitive advantage.	- **Access to vehicles** (cars, bikes, scooters) - **Convenience** (availability through mobile apps, 24/7 access) - **Environmental benefits** (reduced emissions, lower carbon footprint)
Value creation and delivery	How the firm will create and deliver that value to its customers and the source of its competitive advantage.	- Resources and capabilities - Organisation: the value chain, activity system, and business processes - Position in the value network: links to suppliers, partners, and customers.	- **Fleet of vehicles** (well-maintained electric and hybrid vehicles) - **Operations** (vehicle maintenance, customer service, refueling or recharging) - **IT platform** (mobile apps for reservations, GPS tracking, payment processing) - **Partnerships** (collaborations with cities, charging infrastructure providers, insurance companies)
Value capture	How the firm generates revenue and profit.	- Revenue sources - The economics of the business.	- **Revenue models** (subscription plans, pay-per-minute/hour services, corporate partnerships) - **Cost structure** (maintenance, fleet acquisition, IT platform, customer service)

Source: adapted from Richardson (2009)

Richardson's (2009) Business Model Framework has been widely utilized to analyse SBMs. For example, Yang, Evans, Vladimirova and Rana (2017) expand on Richardson's model by incorporating the concept of value uncaptured for all stakeholders. Morioka, Bolis, Evans, and Carvalho (2017) provide concrete examples of companies redefining their value propositions, innovating value creation and delivery systems, and developing new ways to capture value with a sustainability focus. In the context of shared mobility, Gao and Li (2020) illustrate how the bikesharing industry redefines the value proposition to promote sustainability. However, to my knowledge neither this framework nor the business model canvas or other frameworks have been used to analyse the impact of customer misbehaviour and vandalism in companies.

By utilizing Richardson's framework, this study provides a structured lens to explore how shared mobility operators adapt their business models in response to customer misbehaviour. In conjunction with the Triple Bottom Line framework explained in the previous section, it allows for a systematic examination of how these adaptations impact not only the firm's profitability but also its ability to balance economic, social, and environmental objectives within the broader context of sustainable business models. The next section reviews the literature of socio technical transitions to evaluate the consequence of misbehaviour at the macro level.

Business model evolution

Business models are said to evolve to adapt to external discontinuities, be them opportunities or threats for sustained profitability and growth (Cassadesus-Masanell & Ricart, 2010; Foss & Saebi, 2017; Saebi et al., 2017). The studied drivers of business model adaptation are technological or regulatory changes, changes in the competitive environment or changes in consumer preferences (Climent & Haftor, 2021; Saebi et al., 2017). Past work has treated SBM as an outcome of business model innovation in response to changing conditions in material resources, regulation or consumer preferences (e.g., Bocken & Gerardts, 2020; Kennedy et al., 2017). Yet, the evolution of SBM has been overlooked, maybe due to the assumption that once a SBM is established, it remains intact.

Moreover, this literature has discussed the internal and external facilitators of business model evolution, such as firm's strategic orientation, experimental orientation, dynamic capabilities, or the characteristics of the network of an organization (Achtenhagen et al., 2013; Filser et al.,

2021; Teece, 2018). Extending the factors that may prompt the evolution of SBM, this study examines customer misbehaviour. Given that customer misbehaviour may pose a threat for the viability of SBM, notably for access-based services (Bardhi & Eckhardt, 2012), it is necessary to understand how the components of SBMs change to prevent or minimize it and the implications that these changes have for the long-term creation of economic, social and environmental value.

3.3 Transitions to sustainability

The current urban transportation system, which relies heavily on privately owned internal combustion vehicles, is a major contributor to issues such as congestion and pollution (Köhler et al., 2009; Nykvist & Whitmarsh, 2008). This system accounts for 80% to 88% of passenger-kilometres travelled in the Western world. In this context, companies in the shared mobility sector have the potential to facilitate a transition toward a sustainable mobility system—one that is environmentally friendly, economically viable, and socially inclusive (Köhler et al., 2019; Medina-Molina & de la Sierra Rey-Tienda, 2022).

The Multi-Level Perspective (MLP) on socio-technical transitions, originally proposed by Geels (2002), is a widely influential framework for analyzing transitions. The MLP serves as a valuable tool for understanding and simplifying the complex, large-scale structural changes necessary for socio-technical transitions. It explores how shifts in socio-technical systems—such as the move from fossil fuels to renewable energy (Geels, Sovacool, Schwanen & Sorrell, 2017), sustainable agriculture (Darnhofer, 2015), and sustainable mobility (Geels, 2012; Nykvist & Whitmarsh, 2008; Van Bree, Verbong, & Kramer, 2010)—emerge through the interactions of three levels: niches, regimes, and landscapes.

Niches (Micro-Level) are spaces where radical innovations emerge and develop (Geels, 2005). They play a critical role in fostering new technologies that have the potential to challenge and eventually replace established regimes. Socio-Technical Regimes (Meso-Level) refer to the entrenched structures, practices, and rules that stabilize existing socio-technical systems, including technologies, regulatory frameworks, and user behaviours (Geels, 2013). Finally, Socio-Technical Landscapes (Macro-Level) encompass broader exogenous factors—such as

technological, cultural, economic, and political conditions—that shape and influence both regimes and niches (Geels, 2002).

The multi-level perspective argues that transitions come about through interactions between processes at these three levels: (a) niche-innovations buildup internal momentum, through learning processes, price/performance improvements, and support from powerful groups; (b) changes at the landscape level create pressure on the regime; and (c) destabilisation of the regime creates windows of opportunity for niche innovations (Geels & Schot, 2007; Stolper, Bergsma & Pruyn, 2022). Yet, according to Geels and Schot (2007), transitions can follow different pathways depending on the nature of the interactions between changes in the landscape and the regimes, which can either reinforce it or put pressure on it, and niche innovations that can compete with the regime or cooperate with it. The authors propose four different pathways: (1) Transformation Pathway. Moderate landscape pressures lead to gradual adjustments in the regime, incorporating niche innovations incrementally; (2) Reconfiguration Pathway. Niche innovations are adopted within the regime, leading to significant changes in system architecture without completely overthrowing the old regime; (3) Technological Substitution Pathway. Strong landscape pressures and internal regime problems drive the complete replacement of the old regime by radical innovations from niches; and (4) De-alignment and Re-alignment Pathway. Severe landscape pressures cause the regime to break down, leading to a period of experimentation until a new stable regime emerges.

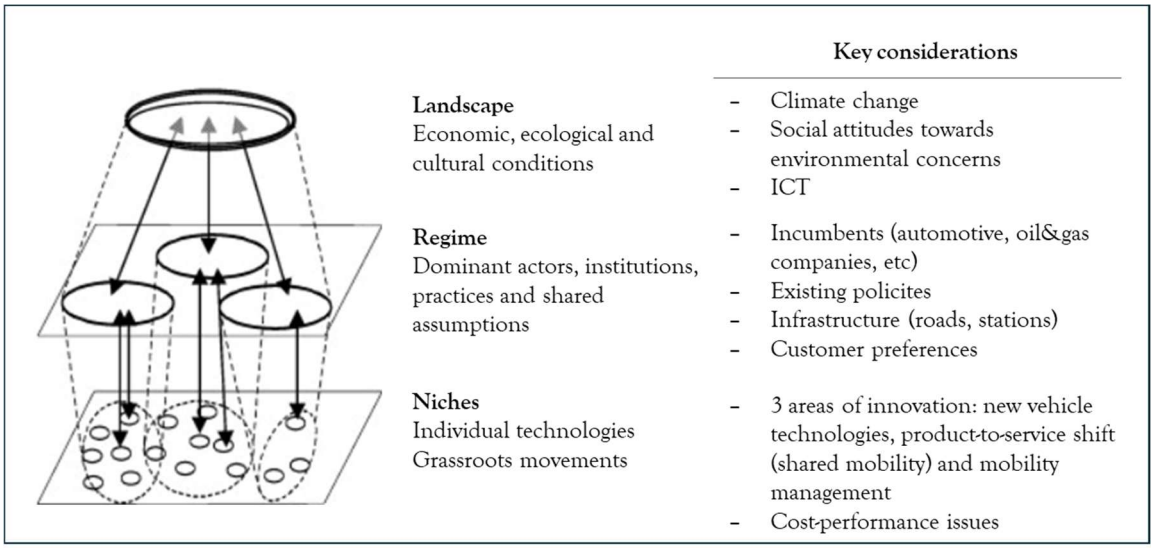
Barriers to socio-technical transitions often emerge from the interplay of multiple factors across different system levels, hindering the adoption of new technologies or practices (Stolper et al., 2022). Existing regimes frequently exhibit lock-in mechanisms and infrastructures that favour incumbent technologies, making it challenging for new innovations to scale (Geels, 2005). These barriers include regulatory and institutional obstacles that are aligned with established technologies and practices (Smith & Stirling, 2010). While niche development is a critical element of transitions (Raven, Van den Bosch & Weterings, 2010), many niche innovations face difficulties in scaling or achieving long-term survival due to internal challenges such as cost-performance limitations, restricted market reach, and misalignment with regulations, infrastructures, or user practices (Geels, 2004). Expanding on this, the role of consumers as a barrier has been examined, particularly in terms of their willingness to experiment with and adopt new technologies, practices, and business models that challenge

existing regimes (Lucas-Healey et al., 2022). Consumer engagement is vital for enabling learning processes, shaping expectations, and building networks within niches (Schot & Geels, 2007), all of which influence the potential for innovations to scale (Elzoumor & Strachinis, 2020).

The concept of Strategic Niche Management (SNM) has been developed to foster niches effectively. In a seminal paper, Kemp, Schot, and Hoogma (1998) introduced SNM as a framework for promoting sustainable innovation by protecting emerging technologies within niche environments. SNM focuses on internal niche processes, such as learning, networking, and vision development, as well as external processes that connect niches to broader societal developments (Schot & Geels, 2013). Initially applied as a tool for retrospective analysis, SNM has evolved into a proactive strategy for sustainable development. Scholars such as Caniëls & Romijn (2008) and Mourik & Raven (2006) have further refined its application as a forward-looking policy tool. SNM has been successfully implemented across various sectors, including transportation, energy, and agriculture (Hoogma et al., 2002; Jenkins & Sovacool, 2018).

The transition towards a sustainable urban mobility

As previously mentioned, the Multi-Level Perspective (MLP) has been widely applied to analyse the transition toward a more sustainable urban mobility regime, which seeks to disrupt the prevailing car-centric regime. The following paragraphs review the existing literature on this topic and identify key gaps that this thesis addresses. A summarised representation of the MLP framework as applied to this transition is provided in Figure 6 below:



Source: Adapted from Nykvist and Whitmarsh (2008)

Figure 6. Sustainable mobility transitions. Key considerations

In the transition to sustainable mobility, three niche innovations have the potential to disrupt and transform the current car-centric regime: advancements in green vehicle technologies, the shift from product ownership to service-based models (such as the increased adoption of shared mobility and public transportation), and demand management strategies aimed at reducing overall transport volumes (Nykvist & Whitmarsh, 2008). Among these, shared mobility services are often considered foundational to a sustainable mobility system. They are linked to numerous benefits, including improved urban planning and management, enhanced energy efficiency, reductions in urban air pollution, increased adoption of renewable fuels, decreased congestion, and improved accessibility (Sarasini & Langeland, 2021).

At the landscape level, external pressures such as climate change, urban air pollution, and rising fuel costs create critical windows of opportunity for transitions in mobility systems (Georgatzi & Stamboulis, 2021). Additionally, growing public awareness of environmental concerns, combined with advancements in alternative fuel technologies, acts as a catalyst for reducing car dependency (Nykvist & Whitmarsh, 2008). However, while these landscape pressures establish the conditions necessary for change, they are insufficient on their own to drive transitions. Successful transitions require alignment with developments at the niche and regime levels to enable systemic shifts (Köhler et al., 2009).

The current car-centric socio-technical regime is deeply entrenched, sustained by a combination of technologies, institutional frameworks, user practices, and cultural norms that reinforce private car ownership as the dominant mode of transportation (Geels, 2005). Institutionally, policies such as subsidies for road construction, parking requirements, and tax incentives for automobile manufacturers prioritize private car use, creating systemic barriers to sustainable mobility innovations like carsharing and public transit (Köhler et al., 2009; Medina-Molina & de la Sierra Rey-Tienda, 2022). Economically, the regime is bolstered by a global automotive industry—including vehicle manufacturers, oil companies, and insurers—that often resists disruptive innovations to protect market positions. This resistance is demonstrated through lobbying against pro-sustainability regulations or delaying the development and deployment of green technologies (Geels, 2012). Urban planning further aligns with this regime, with substantial investments in road networks and parking facilities that make car use highly convenient. These investments simultaneously present challenges to alternative modes of transport, such as public transit and bike lanes (Köhler et al., 2009). Medina-Molina and de la Sierra Rey-Tienda (2022) emphasize the importance of supportive infrastructure and the alignment of key stakeholders—including governments, industry actors, and civil society—as critical for enabling niche innovations like carsharing and electric vehicles to scale and effectively challenge the dominant transportation regime. However, the lock-in mechanisms are not solely maintained by industry incumbents or physical infrastructure. At the customer level, cultural norms associate car ownership with freedom, status, and convenience, reinforcing its dominance and creating resistance to alternatives like shared mobility or public transport (Nykvist & Whitmarsh, 2008; Geels, 2012). Köhler et al. (2009) highlight that resistance to behavioural change among customers can also pose significant barriers to the transition toward sustainable mobility. Together, these factors create a highly resilient system, resistant to change even as it faces mounting pressure to transition toward sustainability.

To date, much of the research has focused on customer adoption of new products or services primarily from an adoption (or lack thereof) perspective (Clausen & Fitchter, 2019), but it has yet to adequately address the negative impact of customer misbehaviour and vandalism on these transitions. Additionally, while there is evidence suggesting that policy at the regime level can support niche development, no existing research has examined how regulation introduced in response to misbehaviour might hinder niche growth and progress. Furthermore,

frameworks like the Multi-Level Perspective (MLP) often overlook the dynamic adaptation of niche innovations in response to resistance or external challenges. Studies also lack a systematic analysis of the long-term impacts of business model adaptations and the trade-offs between economic, social, and environmental sustainability objectives. Moreover, there is insufficient empirical evidence linking organizational strategies, such as responses to misbehaviour, to broader transition processes. Finally, current work tends to silo analyses at either the micro (organizational) or macro (systemic) level, without connecting the two, leaving a gap in understanding the broader implications of micro-level adaptations on sustainable mobility transitions.

Study 2 aims to address this gap in the literature by proposing a conceptual framework to examine the micro- and macro-level implications of customer misbehaviour and deviance in shared mobility. By integrating the Business Model Framework, the Triple Bottom Line approach, and the Multi-Level Perspective on socio-technical transitions, this framework offers a comprehensive lens to analyse the complexities and dynamics of shared mobility services. It focuses particularly on the challenges posed by customer misbehaviour and vandalism and their broader implications for the transition toward a sustainable urban transportation system.

Chapter 4. Degradation of Sustainable Business Models – Study 2 (micro implications)

4.1 Introduction

Building on the deductive findings from Study 1, which analysed key factors contributing to crashes in carsharing as a form of customer misbehaviour, Study 2 shifts to an inductive approach. It explores how shared mobility operators adapt their business models in response to diverse forms of customer misbehaviour and vandalism. This inductive exploration examines how operators navigate these challenges, considering various qualitative insights from executives of shared mobility operators, industry experts and customers. The study employs the frameworks introduced in the previous chapter to assess both the micro-level adjustments, such as operational changes and service adaptations, and their broader consequences for economic, social, and environmental objectives. At the same time, it examines the macro-level implications, evaluating how these adaptations influence the larger transition towards a sustainable transportation regime. By contrasting the deductive analysis of specific factors in Study 1 with the inductive examination of broader business model responses in Study 2, this research provides a comprehensive view of the dynamics of shared mobility in the face of customer misbehaviour.

To enhance clarity and readability, Study 2 has been divided into three separate chapters:

- The current chapter (Chapter 4) outlines the methodology and discusses the micro-level implications of the findings.
- Chapter 5 examines the macro-level implications and their broader impact on sustainable mobility.
- Chapter 6 develops our findings into a comprehensive conceptual process model to understand how shared mobility operators adapt to customer misbehaviour and the micro and macro implications of this adaptation.

4.2 Methods

This study employs a multi-case study methodology with a historical orientation to develop a conceptual framework that seeks to explain how companies adapt to misbehaviour and the consequences of such adaptation at both the micro and macro levels. The choice of a multiple case study methodology is grounded in its ability to capture the complexity of real-world business adaptations, making it ideal for investigating how mobility operators respond to

customer misbehaviour and vandalism. The multi-case approach is particularly powerful for theory building, as it allows for cross-case comparisons, increasing the potential for more robust, parsimonious, and generalizable theories compared to single-case studies (Eisenhardt, 2021; Yin, 2018). Furthermore, Langley (1999) emphasizes the value of process data and a historical perspective in understanding how business models evolve over time. Specifically, we followed a temporal bracketing strategy (Langley et al., 2013) to unveil key phases in the evolution of the cases examined. For each phase, we aimed to determine what form of misbehaviour was prevalent, how misbehaviour affected the operator, what changes were made in business model components (proposition, delivery, capture) (Foss & Saebi, 2018) and what external and internal factors may have influenced the changes. By adopting these perspectives, this study seeks not only to capture the nuanced and context-specific adaptations that companies implement in response to misbehaviour, a topic that remains undertheorized in Access-Based Services (ABS) and shared mobility (Myers, 2013), but also to contribute to both scholarly theory and practical insights for the field of sustainable businesses.

4.2.1 Sampling units

This study employs purposive sampling which allows for the deliberate selection of cases that are especially informative for addressing the research question (Suri, 2011). The study focuses on mobility operators that offer their vehicles (carsharing, motosharing, scooters, and bikesharing) for sharing in Spain, specifically for-profit, Business-2-Consumer operators (Castellanos, Grant-Muller & Wright, 2022). To capture a wide range of business adaptations, the study includes at least two operators per mode of transport, totalling ten cases (see Table 12). Notably, all selected operators have a strong presence in Spain, and some also operate in other European countries.

These cases were also selected to cover companies with varied ownership structures, including large corporations, start-ups backed by financial sponsors, and publicly owned operators. The inclusion of these diverse ownership models is relevant because ownership structures can significantly influence how companies approach misbehaviour. Large corporations, for example, may have greater financial resources and more formalized processes for dealing with vandalism but might also face greater pressure from shareholders to prioritize profitability. Start-ups, particularly those backed by financial sponsors, may be more agile and willing to

experiment with innovative strategies but could be more vulnerable to the financial impacts of misbehaviour. Publicly owned operators, such as those in bikesharing, often have different stakeholder expectations, as they may prioritize social and environmental objectives over profit. The inclusion of two public operators in bikesharing, given their prevalence in markets where private businesses also operate, provides a contrasting perspective on how ownership models influence business adaptations. The sample of ten operators is considered representative of the broader landscape. According to Arias-Molinares and Garcia-Palomares (2020), there were 29 shared mobility operators in Madrid in 2020, a city that is considered a laboratory of shared mobility. Additionally, expert input from the mobility sector and customers were incorporated to offer external insights on strategic and operational challenges and customer experience.

Despite differences in vehicle types and ownership structures, the four types of shared mobility operators have several key characteristics that make their business models comparable and the study's findings broadly applicable across the sector (Calderon & Miller, 2019). All these services offer users the ability to rent vehicles—whether cars, bikes, scooters, or motorcycles—on a pay-per-minute or short-term basis, catering to similar customer needs for flexible and accessible transportation. Their target customers are typically urban residents, tourists, and individuals without personal vehicles who seek cost-effective, convenient travel options within densely populated areas (Shaheen et al., 2015). Moreover, the operational challenges they face, such as asset management, customer misbehaviour, and the need to balance economic, social, and environmental goals, are similar across modes of transport. These commonalities make the insights derived from this study relevant not just for individual operators, but for shared mobility industry, offering broader lessons on how the sector can adapt and evolve in response to emerging challenges

Table 12: Description of operators included in the study

Operator (year of incorporation)	Year of incorporation	Brief description	Shareholder	Geographical presence
Carsharing				
CARSHARING_1	2017	Operator of an electric free-floating fleet of cars +1.000 vehicles. It can be used on a per minute basis or more recently as a monthly subscription. Only two car models	Multinational in the mobility sector	Madrid and Milan Previously present as well in Paris and Lyon
CARSHARING_2	2018	Operator of a hybrid free-floating fleet of cars c.650 vehicles. It can be used on a per minute basis or by days. Only two car models	Multinational in the energy sector	Madrid only
CARSHARING_3	2023	Full electric, flee floating model with a fleet of c.650 vehicles of a single type. Tariffs per minute and up to one full day	National insurance company	Madrid only
Motosharing				
MOTOSHARING_1	2018	More than 5.000 electric motorcycles for sharing. It can be used on a per minute basis with different tariffs depending on the driving mode (standard, sport, etc.)	Multinational in the energy sector	Several cities in Spain and Italy
MOTOSHARING_2	2016	Operator of motosharing and bikesharing with c.10.000 vehicles. It offers per-minute, daily and monthly rentals. It also offers fleet renting services to corporates	International financial sponsors	Several cities in Spain, Italy and France

Table 12 (cont.)

Operator (year of incorporation)	Year of incorporation	Brief description	Shareholder	Geographical presence
Scooters				
SCOOTER_1	2017	Large corporation that offers electric scooters and bikes, with a total fleet estimated at +35.000 vehicles	Listed company	More than 280 cities across more than 30 countries, including Spain, where it is present in several cities
SCOOTER_2	2018	Operator of scooters and electric and conventional bikes	European financial sponsors	Several Western European countries including Spain, with presence in +100 towns and cities
SCOOTER_3	2018	Operator of electric scooters, motorcycles and bicycles. The company went bankrupt at the end of 2023. It had more than 4.000 vehicles at its peak	Spanish financial sponsors	Several cities in Spain and Italy
Bikesharing				
BIKESHARING_1	2007	Operator of electric and conventional bicycles under concessional agreements with cities. +10.000 vehicles	Spanish services company	Several cities in Spain
BIKESHARING_2	2014	Operator of electric and conventional bicycles under a direct mandate from the municipality after taking over the service from a private operator. +7.000 vehicles	Local authority-owned company	One city in Spain

4.2.2 Data Collection

A combination of in-depth interviews and archival data was used. Informants within each company were selected through purposive sampling to gain a thorough understanding of the challenges related to misbehaviour and vandalism. Several criteria guided this selection. First, general managers and CEOs were interviewed for their broad, strategic perspectives on company operations. To complement these insights, managers with expertise in technology, customer experience, and fleet management were included to provide detailed views on operational areas directly impacted by customer misbehaviour. Following the tenets of theoretical sampling (Strauss & Corbin, 1998), as the study progressed, additional experts were engaged in fields that became increasingly relevant, such as insurance, mobility strategy, and business model innovation. Efforts were also made to ensure gender diversity, though this proved challenging given the predominance of male employees within the companies. Nonetheless, both male and female informants were included whenever possible. Additionally, customers were interviewed to provide a user perspective. Here, the goal was to select individuals with experience in multiple shared mobility modes and to capture a range of age groups, focusing particularly on younger users. Table 13 provides detailed information on each of the 22 informants.

Table 13: Description of informants

Operator	Title	Age	Gender	Description
Carsharing_1.1	CEO	45	Male	Responsible for launching the business and managing operations.
Carsharing_1.2	Head of Customer Experience	44	Male	In charge of managing all interactions with customers, both inbound and outbound. In the role since the company was created in 2017.
Carsharing_1.3	Fleet Manager	30	Female	Managing the maintenance and repair of the fleet as well as the relationship with the insurance provider. In the role since 2020.
Carsharing_2	CEO	38	Male	Responsible for launching the business and managing operations.
Carsharing_3	CEO Mobility	55	Male	Responsible for all mobility businesses of the parent company. In charge of the specific task of launching a carsharing service.
Motosharing_1.1	CEO	46	Male	Responsible for launching the business, putting together a team from the scratch. He also designed and implemented the expansion strategy.
Motosharing_1.2	COO	40	Male	Managing the day-to-day operations of the business, as well as the interactions with the supplier of motorcycles.
Motosharing_1.3	Head of Technology	55	Male	Definition of the in-vehicle software and hardware required to operate a sharing business, and the evolution of the app.
Motosharing_2	Head of Product free floating	39	Male	Director of the free-floating business of the company, in charge of defining all the characteristics of the product (prices, service areas, vehicle, etc).
Scooter_1	Country manager/Director of expansion	35	Male	Former director of expansion in Southern Europe. His last role in the company was country manager in Italy.
Scooter_2	Senior Public Policy Mnr. (Spain)	58	Male	Managing public tenders in Spain and the relationship with municipalities, including regulatory affairs.

Table 13 (cont.)

Operator	Title	Age	Gender	Description
Scooter_3	Country manager	29	Female	Responsible for the implementation of the business in Italy and certain cities in Spain.
Bikesharing_1	CEO	53	Male	Management of all the aspects of the service and the relationship with the client (municipality).
Bikesharing_2	CEO	41	Male	Take over of former private operator and creation of a new public. Responsible for the expansion of the service into the whole city.
Consultant_1	Partner Mobility at Big four	54	Male	Managing Director of the Transportation vertical, with experience supporting several shared operators in their strategy formulation and implementation worldwide.
Journalist_2	Mobility expert Digital Media	46	Male	Industry expert with deep knowledge of the shared mobility sector in Spain.
Insurance_3	Head of insurance Iberia	51	Male	Responsible for launching the business line of insurance brokerage for shared mobility operators in Iberia.
Expert_4	CEO Mobility advisory firm	49	Male	Past experience in a large automaker. Set up his own advisory firm to help clients launch their new ventures in shared mobility. He has advised operators in various topics.
Customer_1	Lawyer	38	Male	Frequent user of carsharing and bikes (occasionally).
Customer_2	Energy Expert	35	Female	Frequent user of carsharing and scooters (occasionally).
Customer_3	Software Developer	39	Male	Frequent user of motosharing, and carsharing (occasionally).
Customer_4	Student	23	Male	Frequent user of all modes of sharing.

The interviews were arranged in advance through email or telephone communications. Carried out in Spanish, except for the interview with Scooter_1, which was conducted in English, each interview lasted between 45 and 75 minutes and took place between March 2024 and June 2024. I conducted all interviews independently, with no one else present other than the informant. This approach was crucial to preserve confidentiality, as many of the informants are direct competitors and represent private operators who are often reluctant to disclose sensitive business information. Ensuring a private, one-on-one setting encouraged openness and allowed the participants to speak freely without concerns about external observers. While most interviews were conducted via videoconference, in-person interviews were arranged with Carsharing_3, Motosharing_1, and Scooter_2. Each interview was recorded and transcribed using standard transcription software. To ensure accuracy, I reviewed each interview at least twice, making necessary corrections to the transcripts to eliminate errors introduced by the software. To maintain the anonymity of the participants, references to the companies and informants in the transcriptions were replaced with the code name of the operator (e.g., Carsharing_1). All relevant quotes were translated into English. The ethical design of the study was approved by the Academic Committee of the PhD prior to its execution.

To set up the interviews, I provided the informants with a high-level overview of the study's objective via email. An initial interview guide was created (Appendix). Operators and experts were asked first about their professional experience in the sector and a brief overview of the business; then the interview focused on phenomenon of customer misbehaviour in the industry; next, we explored the impact of misbehaviour in the companies; fourth, the interviewed moved to the management of the phenomenon and the consequences of the measures taken; finally, we discussed lessons learned and future outlook. Consumers were probed about their experiences as victims of misbehaviour and about their knowledge of possible misbehaviour. The interviews were semi-structured, allowing room for additional questions beyond the guide. The questions were not sent in advance. Not all questions were asked to all participants, but certain questions were repeated to several informants to confirm specific views or facts. For instance, the adaptation of the service area and a more selective approach to customer acquisition were consistently highlighted. The interview guide was adapted based on evidence from previous interviews (Charmaz, 2015). As the number of

interviews increased, some questions were dropped, and others were added to incorporate new insights or topics.

In addition to interviews, we used archival materials such as media reports, company websites (both current and historical), and industry reports. Scholars such as Yin (2009) advocate for the use of archival materials to complement primary data, as they provide valuable context and support triangulation, which strengthens the validity of findings by cross-verifying information from different sources. Factiva was the primary database used to identify relevant articles, employing two types of queries. The first type was based on the names of the operators. For operators with a large volume of results, where thousands of articles were returned, I refined the queries by adding specific conditions to filter the results more effectively. The second type of query used broader terms like 'Movilidad Compartida' or 'shared mobility', to which I added specific topics that became relevant as the research progressed, such as accidents, alcohol, problems, or closures. Articles selected through these queries were read in full, and the extracted content was used to enrich and complement the interview analysis. By integrating these archival materials, the study gained additional depth, helping to enhance the credibility of the findings and provide a broader public context to the private perspectives shared in interviews. Table 14 summarises the queries and the number of articles reviewed.

Table 14. Factiva: articles reviewed

Query in Factiva	Number of articles from query	Number of included articles
CARSHARING_1 AND carsharing	577	20
CARSHARING_2 AND carsharing	388	15
CARSHARING_3 AND carsharing	63	0
SCOOTER_1 AND (patinetes OR scooters)	578	67
SCOOTER_2 AND (patinetes OR scooters)	599	38
SCOOTER_3 AND (patinetes OR scooters)	388	33
MOTOSHARING_1 AND motos	1.552	27
MOTOSHARING_2	1.381	13
BIKESHARING_1 AND (Bicicleta OR bicycles OR vandalism OR vandalism)	149	7
BIKESHARING_2 AND (Bicicleta OR bicycles OR vandalism OR vandalism)	82	29
(Movilidad compartida OR shared mobility) AND (vandalism OR vandalism)	17	13
(Movilidad compartida OR shared mobility) AND (accidentes OR accidents)	200	14
(Movilidad compartida OR shared mobility) AND alcohol	19	4
(Movilidad compartida OR shared mobility) AND (problemas OR problems)	479	15
(Movilidad compartida OR shared mobility) AND (abandono OR cierre OR close)	152	7
Total articles reviewed	**6.624**	**302**

4.2.3 Data analysis

The data analysis follows Eisenhardt's (2021) approach for building theories from case study research, involving both within-case analysis and cross-case pattern matching. This method enables the development of broader insights while maintaining a deep contextual understanding. It also helps identify unique strategies employed by different firms, as well as

common patterns across mobility operators. A thematic analysis was applied to systematically identify, organize, and offer insights into recurring themes across the qualitative dataset collected from interviews and archival data. This approach was chosen for its flexibility and ability to draw both explicit and implicit meanings from the data (Braun & Clarke, 2006). We combined this approach with temporal bracketing by identifying the key phases in the evolution of the business model together with the reasons and outcomes for these phases (Langley et al., 2013). The methodological steps followed were based on those proposed by Braun and Clarke: familiarization with the data, coding, theme generation, and producing the report.

Step 1 – Familiarization with the data

We started the analysis with the interviews and used the archival data for triangulation (Eisenhardt, 2021). Interview transcripts were reviewed multiple times to ensure accuracy and gain a deep understanding of the content. This involved listening to the audio recordings repeatedly and manually correcting the transcripts. In addition, I also explored the current websites of all operators to gather additional contextual information and reviewed relevant articles from Factiva. This step was key in identifying emerging patterns and aligning them with the topics discussed during the interviews. These sources were particularly useful for understanding how local authorities reacted to certain types of misbehaviour, such as illegal parking or driving on pavements, issues that operators generally did not mention. By integrating insights from these external sources, I was able to enhance the credibility and depth of the findings. This interactive approach—iterating between interviews, coding, and the inclusion of archival materials—ensured a thorough and nuanced analysis.

Step 2 – Formal coding

After reading the interviews and archival data, several times, formal coding was applied. Both inductive and deductive coding were employed to systematically organize the data (Fereday & Muir-Cochrane, 2006). By using both approaches, the study benefited from a structured framework based on prior knowledge while remaining adaptive to new and unforeseen insights, ensuring a more comprehensive and nuanced analysis of shared mobility.

Deductive codes were derived from the author's professional experience in the field of shared mobility, particularly as a Board Member of a carsharing operator in Madrid (Zity), as well as

from the literature review. These predefined codes included terms such as "illegal racing," "insurance costs," "strategies," and "types of misbehaviour." Simultaneously, inductive coding was applied to capture new insights and themes that emerged during interviews and the data review. This approach allowed for greater flexibility in identifying unexpected patterns, such as "helmet thefts" in motosharing, or "occupation of public space" and "Neighbourhood resistance," which surfaced from Factiva articles. Once the initial coding was completed, they were grouped in more general codes. For example, codes such as "racing" or "speeding" were categorized under the general code "Thrill-Seeking." On the economic side, codes referring to “replace assets” or “repair assets” were included under the “Economic loses - direct” code.

Step 3 – Building themes and subthemes

Once coding was completed, subthemes were identified in each category by grouping codes. For example, “Thrill-seeking”, “Economic”, “Revenge”, “Neglect” and “Vandalism” were grouped under the subtheme "Customer triggers for misbehaviour”. Figure 7 summarises the process followed.

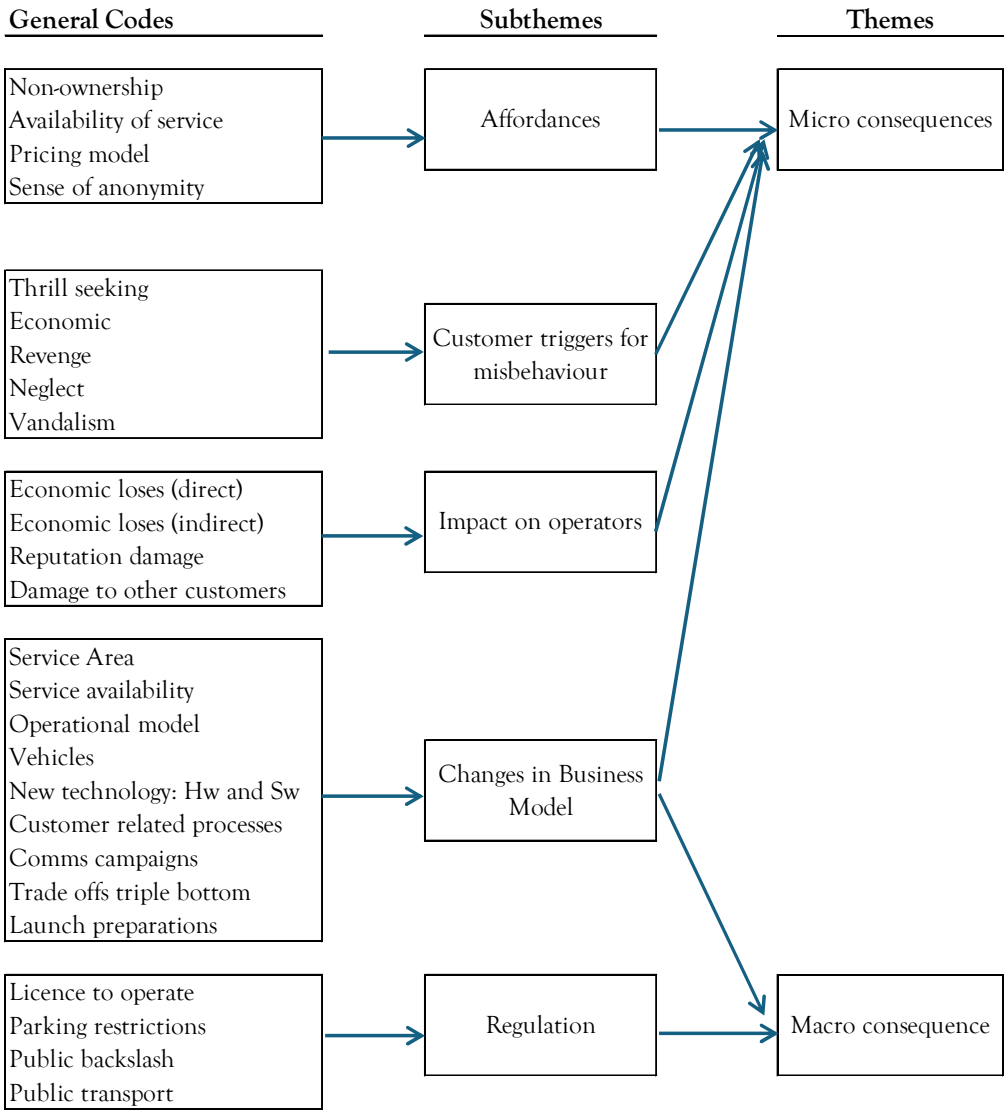


Figure 7. Codes used and identification of subthemes and themes

I then engaged in cross-case pattern matching by comparing the subthemes across six different categories: carsharing, motosharing, scooters, bikesharing, experts, and customers. This step helped identify subthemes common to all categories (customer payment issues for example), as well as the unique approaches different operators adopted to handle issues such as misbehaviour and vandalism. For example, technologies to monitor that vehicles were parked correctly were relevant for motosharing and scooters but not for cars. Afterward, subthemes were grouped into broader themes, forming the structure of the Findings section. For example, the theme "Impact on Operators" encompassed “direct economic impact” as well as indirect costs and non-economic consequences such as reputation or poor customer experience.

Another significant theme that emerged was "Changes to the Business Model," which included measures taken by companies categorized according to the Business Model Framework: measures affecting value proposition, value creation and delivery, and value capture. Individual tables were created to display key evidence from the interviews, organized by themes and subthemes.

Step 4 – Processual analysis of changes in business models

In the second stage, we coded the changes reported by operators in their business model and order them temporarily, using their own accounts of events. For example, informants would refer to "we did this before launching the service" or "the first thing we did was to exclude certain areas". We also coded the reasons invoked to justify these changes and how they affected the form of misbehaviour targeted. Thus, at the end of this stage, we had a clear understanding of the sequence misbehaviour-outcomes-changes and the reasons for the change. Finally, we did a temporal line for each operator with the aforementioned sequence; then using cross-case pattern matching (Langley, 1999), we identified common processes across operators and unique approaches adopted to handle misbehaviour and vandalism. For example, technologies to monitor that vehicles were parked correctly were relevant for motosharing and scooters but not for cars. Using these timelines, we identified three stages in the evolution of the SBM: Market reach, Profitability and Downsize-Diversification-Decline.

4.3 Findings

This section provides a detailed analysis of the impact of customer misbehaviour and vandalism on shared mobility services, as well as the adaptations companies implement in response. The focus is on identifying common themes across different transport modes while highlighting mode-specific elements when relevant. Building on the framework presented in Chapter 3, the analysis first summarises the antecedents and triggers identified through interviews and grey literature, highlighting specific behaviours that negatively impact shared mobility operators, particularly focusing on economic consequences. It then explores the strategies companies employ to mitigate these behaviours, analysing how these strategies modify various components within the Business Model Framework. These business model adjustments prioritize economic goals over social and environmental ones, shifting the sustainability focus of shared mobility services. To illustrate the key themes, we use concise

quotes compiled from interviews, Factiva, company websites, and industry reports, with additional illustrative data presented in tables.

4.3.1 Antecedents and behaviours

In the literature review, we discussed how customer misbehaviour is triggered by individual factors (Fombelle et al., 2020) that are mediated by the nature of the product or service (Schaefers et al., 2016) and the characteristics of the service exchange (Reynolds & Harris, 2009) which can either amplify or mitigate these individual triggers for misbehaviour.

The data suggests that this is indeed the case for shared mobility, where its unique characteristics (affordances) favour the occurrence of different types of misbehaviour. This pattern is consistent across the four types of operators analysed: carsharing, motosharing, scooters, and bikesharing. The analysis also reveals that traditional customer-driven triggers, such as economic incentives, thrill-seeking, neglect, revenge and vandalism, are prevalent across these operators. These findings are summarised in Figure 8 below and discussed in detail in the following section

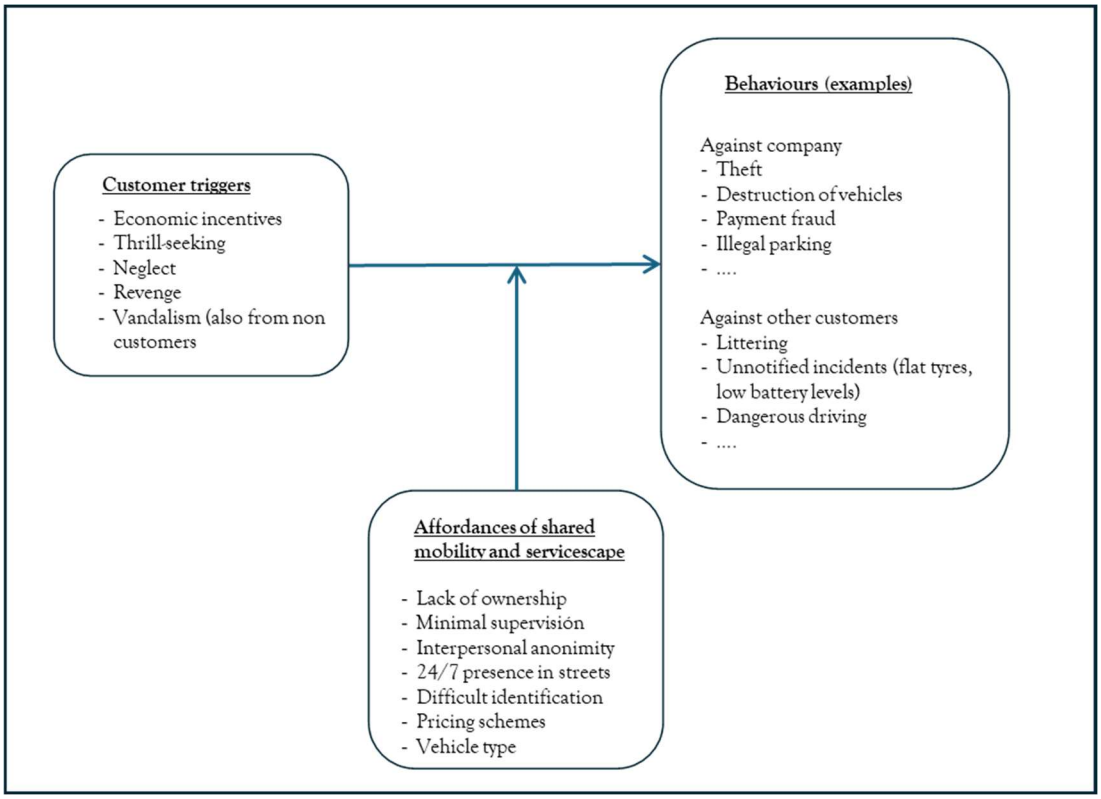


Figure 8. Proposed antecedents of misbehaviour in shared mobility

Affordances of shared mobility and servicescape

Our findings indicate that several characteristics of Access-Based Services create affordances that make them particularly susceptible to customer misbehaviour and vandalism. Hazée, Delcourt, and Van Vaerenbergh (2017) previously identified three key characteristics of that contribute to this problem: lack of ownership, minimal supervision, and interpersonal anonymity with other customers and company employees. In addition to these factors, our research highlights four further affordances that favour misbehaviour in the particular case of shared mobility contexts: the 24/7 availability of vehicles on the streets, the difficulty of identifying perpetrators, the specific pricing schemes and the type of vehicle.

Lack of ownership is frequently highlighted by managers across all operators, who note that users do not feel responsible for the vehicles since they do not own them. Comments such as "users don't care what happens to the car because it is not theirs" (Carsharing_1.1) and "in the context of sharing, there is not a sense of ownership" (Motosharing_1.2) reflect this perspective. Customers expressed similar views, admitting to treating shared vehicles worse than their own. For instance, one customer remarked, "I go over the bumps faster with the carsharing car. With my own car, I always slow down" (Customer_1). This lack of perceived ownership fosters a general disregard for vehicle condition. In Study 1, we argued that this lack of ownership might contribute to the higher accident rate among occasional users compared to more frequent customers.

Additionally, respondents highlighted that the very nature of shared mobility services, with vehicles continuously present on public streets, exacerbates their vulnerability to vandalism. The difficulty of supervision and the near impossibility of protection make these vehicles easy targets. One operator stated: "We are vulnerable because our cars are on the streets 24/7, 365 days a year, accessible to anyone. We cannot protect them." Another informant echoed this sentiment, noting, "Being constantly in the streets brings problems." These observations underscore the challenges operators face in safeguarding their assets.

Anonymity emerged as another significant factor encouraging misbehaviour in shared mobility. However, in this context, anonymity refers to the difficulty companies face in identifying those responsible for damage, rather than interpersonal anonymity with employees or other customers, as discussed by Hazée, Delcourt, and Van Vaerenbergh (2017) and

Schaefers et al. (2016). Technological limitations and data protection regulations, which prevent companies from recording users' faces, further complicate efforts to hold users accountable. As one carsharing operator explained: “Eventually, we learned that it is impossible to chase everybody because, in many cases, we are unable to determine responsibility.” This practical difficulty was echoed by Customer_3, who noted that when encountering a damaged car, she prefers to find another vehicle rather than report or use it, fearing potential errors in blame assignment by the company. Instances of incorrect blame assignment have even resulted in negative media coverage (Consumidor Global, 2023).

A recurring theme from the interviews is the impact of pricing schemes on customer behavior. On one hand, the pay-per-minute model incentivizes users to drive faster or park without adhering to regulations to minimize costs. As Carsharing_1.1 explained, “We charge by the minute, which causes users to go faster and end the service quickly, parking anywhere.” On the other hand, lower service prices, or even free services, tend to attract undesired demand and increase instances of misbehaviour. Scooter_1 observed, “The lower the cost, the higher the likelihood of vehicle vandalism due to increased public attention.” Bikesharing_1 and Bikesharing_2, both operating under public schemes, shared similar insights, stating, “When the service is free, people tend to misuse it without regard.”

Finally, the type of vehicle also appears to influence the level of misbehaviour it experiences, affecting each type of operator differently. Smaller, lighter vehicles such as bicycles and scooters are more susceptible to vandalism, whereas motorcycles and cars tend to be less affected. Additionally, customers tend to drive less cautiously when using bicycles, scooters, and cars but exercise greater care when riding motorcycles. This behavior may be attributed to the significantly higher risk that accidents pose to motorcycle riders compared to other shared mobility modes. Additional evidence from interviews is presented in Table 15.

Table 15. Distinct features of shared mobility that favour vandalism: illustrative evidence

Feature	Illustrative Evidence
Non-ownership of vehicle	- Carsharing_3. "Users think that the car is free, that it didn't cost anything, and therefore, they don't take any responsibility" - Carsharing_1.3. "Users don't take care of private property that do not belong to them" - Bikesharing_1. "We are seeing vandalism and misuse because users think that the bikes do not belong to them" - Customer_3:" If the bicycles are free, then they do not belong to anyone. This increased vandalism" - Motosharing_2. "Users treat the vehicle as if it was of public ownership. They do things with them that they wouldn't do with their own vehicles"
Minimal supervision and 24/7 availability	- Carsharing_1.1. "The car is in the street and can be vandalised by multiple agents" - Motosharing_1.1. "By nature, the service is exposed to vandalism" - Entrepreneur_1. "Companies favour the interaction with the product to encourage usage"
Anonymity (difficult identification of perpetrator)	- Scooter_3. "The thing is that we do not know if the user who damaged the vehicle was the first one, the second or the third" - Bikesharing_2. "When the bike is withdrawn illegally from the base, there is no way to know who took it" - Entrepreneur_1. "Systems to report damages before the trip occurs are less and less used because it wasn't easy to identify the responsible for the damage" - Carsharing_2. "You have to be careful with data protection regulation" - Carsharing_1.2. "It is one of the biggest problems that we have, and GDPR regulation does not help"

Customer triggers

Based on the data collected, we have identified five primary motives for misbehaviour that are widely discussed in the literature: economic incentives, thrill-seeking, vandalism, neglect and revenge. They are all influenced to a certain extent by the affordances that were mentioned previously. These motives are first analysed at the individual level, followed by an exploration

of common themes identified in the data, such as the amplifying effect of social media, the relationship between the type of vehicle and misbehaviour, the influence of crime rates in cities, and the evolution of misbehaviour over time.

Economic reasons are a significant driver of misbehaviour across all types of shared mobility services. These mainly include saving costs for customers or generating income for them. For example, speeding and illegal parking occur in carsharing as customers seek to minimize the cost of the trip since they are charged by the minute, a very distinctive characteristic of shared mobility operators. Additionally, some customers attempt to use the service for free by using fraudulent accounts (motosharing), hacking the system (scooters), or forcibly removing bikes from their docks. On the income generation side, stealing entire vehicles, batteries, helmets, and other components for resale has been reported in motosharing, scooters, and bicycles but not in carsharing. This has been a major issue for operators. One motosharing operator reported more than 190 batteries stolen per week, equivalent to one fifth of the fleet, at a cost of 1,800 euros per battery (El Mundo, 2022).

Table 16. Economic reasons as motives for misbehaviour: illustrative evidence

Transport mode	Quotes	Examples of misbehaviour identified
Carsharing	Carsharing_1.1. "We charge by the minute which causes the user to go faster and end the service quickly, parking anywhere"	Carsharing_1: payments fraud; stealing parts of the car (cables) Carsharing_2: steal parts of the car (car headrest for example) Carsharing_3: payments fraud Press (ABC July 1). Steal identities
Motosharing	Motosharing_1.1. "Users try to use the service for free" Motosharing_1.2. "The battery crisis huge. They were stolen to be re-used somewhere else. We have seen our batteries in Tuk Tuks, a three wheeled vehicle used in Madrid to give rides to tourists" Motosharing_1.2. "Stolen helmets were found in shops in el Rastro (a popular flea market in Madrid)" Motosharing_2. "Users are driving against the clock" Motosharing_2. "Google passwords have been stolen and used to ride our motorbikes for free" Motosharing_2. "Some users have pretended to be involved in an accident with a third party to make the insurance company pay for the damages"	Motosharing_1.1: riding for free; false insurance claims; stealing helmets Motosharing_2: theft of helmets; false insurance claims; no identification in case of accident

Table 16 (cont.)

Transport mode	Quotes	Examples of misbehaviour identified
Scooter	Scooter_1. "Parts of the vehicle and batteries are stolen to be sold or recycled" Scooter_1. "Teenegers always try to figure out how to keep riding for free or start a free rental" Scooter_3. "Many users owed money to the company and still used the service using promo codes"	Scooter_1: riding for free Scooter_2: theft of batteries Scooter_3: theft of scooters; theft of batteries Scooter_1: stealing parts of the vehicle. Press (El Confidencial 23 jan, 2020): strip parts
Bikesharing	Bikesharing_2. "Somehow people learnt how to use the system for free by tearing the bikes off the station" Bikesharing_2. "We saw parts of our bikes being sold in Wallapop, an only buying and selling platform of second-hand articles "	Bikesharing_1: false insurance claims; private use of bike Bikesharing_2: driving for free Bikesharing_2: theft of batteries; stealing parts of the bikes Bikesharing_1: tearing bikes off their dock
Other	Journalist_1. "Operators should offer other fares beyond the pay-per-minute, which induces speeding to pay less. The whole sharing system incentivises speeding"	

Also, customers may use the vehicles to experience excitement and thrill. This includes behaviours such as speeding, performing dangerous manoeuvres, and engaging in illegal racing, sometimes under a false identity. There are instances of "ghost" customers who have stolen the identity of real customers to organize illegal races with shared cars in the streets of Madrid (ABC, 2020). This behaviour was observed in carsharing but not in other modes. When asked about this, a motosharing operator mentioned that drivers do not want to put their lives at risk driving motorcucyles, but that this was different with cars because the occupants are more protected, pointing again to an affordance of the vehicles that modulate the type of misbehaviour. Carsharing_1_3 mentioned that this type of behaviour is more concentrated in "a certain age range and times of the day, where crashes are more common" referring to younger customers who speed, drive the vehicles at night, sometimes under the influence of alcohol (Insurance_1). In fact, the use of alcohol is somewhat accepted by users of shared mobility, particularly in smaller vehicles that are not perceived as dangerous (Customer_4). Findings from Study 1 confirmed that being young and driving at night increases the probability of having an accident in carsharing, possibly influenced by alcohol consumption.

Vandalism, defined as the "willful damage to or destruction of property owned by others" (van Vliet, 1992, p. 32), appears to be a form of misbehaviour that affects all shared mobility operators. When informants were asked why people would vandalize an asset that provides a useful service to the community, they offered various explanations, including disbelief, novelty, antisocial behaviour linked to specific Neighbourhoods, and cultural triggers. For example, Scooter_1 observed users tampering with QR codes on scooters, rendering them inoperable without any apparent purpose. In her view, these acts were a way for vandals to "send a message" to the operator. Fortunately, this problem eventually diminished. Other acts of vandalism seem unrelated to the specific operator, suggesting they are part of a broader pattern of antisocial behaviour. Consultant_1 highlights a correlation between general vandalism trends in certain areas and vandalism targeting shared mobility assets, indicating that such behaviours are linked to larger social issues. Operators often address this indirectly by discussing the distinct characteristics of certain cities and neighbourhoods. Carsharing_1.1 notes significant differences in vandalism rates between countries and cities, while Scooter_1 points out that crime rates within cities are an important indicator of the likelihood of vandalism against their scooters. Consultant_1 echoes this sentiment, emphasizing that

vandalism varies significantly across neighbourhoods within cities. Taking a broader perspective, Customer_2 suggests, "I may be wrong, but I think vandalism is linked to culture. It changes from country to country."

As previously mentioned, smaller, lighter, and less expensive vehicles tend to be more frequently misused and vandalized. The significance of vehicle size was highlighted by Journalist, who noted, "There seems to be more vandalism with small vehicles such as scooters and bicycles." This observation was corroborated by Scooter_3, who emphasized that the light weight and portability of scooters make them easy targets for vandalism. Motosharing_1.1 also pointed out that, compared to scooters, it is rare to see motorcycles fully vandalized or stolen.

Table 17. Vandalism as motive for misbehaviour: illustrative evidence

Transport mode	Quotes	Examples of misbehaviour identified
Carsharing	Carsharing_1.3. "I just don't understand why people would vandalise a car for no reason. It doesn't make sense for me"	Carsharing_1: burn cars; cracking car seats; break navigator screen; hitting the car Carsharing_3: graffitis;
Motosharing	Motosharing_1.1. "It was not uncommon to see our motorbikes on the floor. Clearly someone had pushed them for no reason"	Motosharing_1.1: breaking parts; knocking over the vehicle Motosharing_2: Forcing the hauls;
Scooter	Scooter_1. "People would paint on the QR code, which leaves the vehicle non operational"	Scooter_1: burning of vehicles; painting QR codes Entrepreneur_1: throwing scooters to rivers and other places
Bikesharing	Bikesharing_1. "People try to tear off the bikes from the stations. When they see they cannot do it they just leave the bikes alone"	Bikesharing_1: throwing bikes anywhere Bikesharing_2: destroying bikes

Neglect of basic vehicle care has emerged as a significant form of misbehaviour in shared mobility. This behaviour is facilitated by the affordances of the service, where the absence of direct supervision and the difficulty in holding users accountable create opportunities for neglect without immediate consequences. The fact that users do not own the asset further exacerbates this issue.

Customers may neglect to care for the vehicles either due to a lack of knowledge about proper usage (unintended neglect) or for reasons of convenience (intended neglect). Examples of unintended neglect include users leaving windows open or doors unlocked, making the vehicle vulnerable to vandalism (Carsharing_1.3), or draining the vehicle's battery without recharging it (Carsharing_2). In bikesharing, the problem of users failing to lock bicycles properly at the end of their trip has been a long-standing issue, although recent improvements seem to have resolved it (Lavozdigital.com, 2023). However, the most frequently cited form of neglect is illegal parking. In an effort to end trips quickly and avoid additional charges (since pricing is typically per minute), users often park vehicles in inappropriate places, prioritizing convenience over regulations (Scooter_3). Sidewalks have become a common choice for illegal parking (El Confidencial, 2024; El Pais, 2023; Heraldo de Aragon, 2022), as users seek to park near their destination without regard for the impact on public spaces.

Table 18. Neglect as motive for misbehaviour: illustrative evidence

Transport mode	Quotes	Examples of misbehaviour identified
Carsharing	Carsharing_2. "In 2016 our customers were not used to electric vehicles. They would use up all the battery using the air conditioning" Carsharing_1.3. "Because it is not their cars, some customers forget to close the windows or leave the door open, which leaves the car exposed to vandalism" Carsharing_1.3. "There are some customers that used up all the battery on purpose, even if they have been advised not to do so. That generates additional operational costs" Carsharing_1.2. "Some customers just don´t know how to use the app properly"	Carsharing_1: littering; smoking Carsharing_2: exhaust battery range; illegal parking
Motosharing	Motosharing_1.2. "Drivers hit the wheels against curbs or potholes. They don't really care" Motosharing_2. "There are customers that don't bother to fill the accident report, which compromises the position of the company in a potential claim"	Motosharing_1.2: careless driving Motosharing_2: not filling insurance reports
Scooter		Entrepreneur_1: driving on pavements Bikesharing_2: abandoning bikes in the streets
Bikesharing		Press (El periodico, 4 May 2024): high wear on brake pads due to inappropriate use; leave bikes outside designated stations; violating traffic rules

Revenge against company assets is another common motive for misbehaviour, often driven by frustration or perceived injustice not only from customers but also from citizens and even competitors in the mobility space. Unhappy customers may resort to actions such as kicking cars, breaking windows, or jumping on hoods, usually in response to perceived injustices like overcharges due to system errors or being blocked from using the service. However, the most

extreme reactions come from citizens, particularly toward smaller vehicles like scooters, motorcycles, and bicycles, as many view the occupation of public space by private operators negatively. In one Spanish city, 85% of respondents in a local newspaper poll expressed a desire to ban shared scooters (El Confidencial, 2023). Operators acknowledge that their vehicles can displace private owners from public parking spaces (in the case of motosharing) and create obstacles for pedestrians (El Mercantil Valenciano, 2019), which can lead to acts of vandalism by frustrated neighbours. Examples include burning vehicles, throwing them into bins, or covering them with faeces (El Confidencial, 2021). Additionally, revenge has come from other modes of transport, particularly in the early days of shared mobility, when allegedly taxi drivers vandalized shared cars, motorcycles, scooters, and bicycles as they viewed these new mobility options as a direct threat to their business and argued that they were unfair competitors due to a lack of regulation. Although there is no direct evidence of this acts in the archival data, comments from several informants suggested that this may be the case. For example, Insurance_1 commented that "Carsharing was a target of taxi drivers because they were seen as a threat to their business". Similar comments were expresed by managers of carsharing and motosharing (see Table 19 below).

Table 19. Revenge as motive for misbehaviour: illustrative evidence

Transport mode	Quotes	Examples of misbehaviour identified
Carsharing	Carsharing_2: "In the early days the cars, ours and our competitors´, were vandalised by taxi drivers who were against the service" Carsharing_1.3. "Sometimes, if a user had a bad experience with the service, they would kick the cars, jump on top of them, or break the windows"	Carsharing_2: Hitting cars, breaking windows
Motosharing	Motosharing_1.1. "There were so many motorbikes parked that for the private owner it was very frustrating. They would just pull out your motorbike of the parking and place theirs instead" Motosharing_1.2. "We have caught by surprise taxi drivers doing things to our motorbikes. However, revenge from clients, for example because they have been fined, is worse" Motosharing_2. "It is sufficient that you see a shared motorbike park in the wrong place, in front of your house for example, to get angry and kick the motorbike or something else"	Motosharing_1.1: displacing vehicles; breaking parts; knocking over the vehicle
Scooter	Scooter_1. "In certain neighbourhoods, citizens get fed up and they go against the company or the scooters, sometimes completely destroying them, burning them, or throwing them into the water" Scooter_2. "A lot of the vandalism is produced by the neighbours that see how they cannot get out of their homes because there is a scooter in the front door"	Entrepreneur_1: throwing scooters to rivers and other places
Bikesharing	Not mentioned	Not mentioned

A common trend in the evolution of vandalism and customer misbehaviour over time was also observed. This will also be discussed later in the document when we analyse the adaptation process of companies. These issues tend to peak during the initial phase of operations and then gradually decrease. Informants mentioned that there is usually a spike in

vandalism when the service is first launched (Scooter_1, Scooter_3, Bikesharing_1), particularly if shared mobility is new to the city. Scooter_1 noted that “if you are a first comer to a city, in the beginning you seem to be a key target." This idea is echoed by Entrepreneur_1 who said that “the fact is that being a new service with very easy access, brings vandalism and bad customer misbehaviour”. Over time, as the public becomes more familiar with the presence of these vehicles on the streets, instances of vandalism tend to decrease (Scooter_3). Eventually “the novelty effect fades away” (Entrepreneur_1). Revenge-driven behaviours also subside as vehicles are parked more appropriately and other modes of transportation realize that their businesses are not being threatened. Customer misbehaviour similarly improves over time. Initially, users “play around with the vehicles to see how they work” (Scooter_1) and many users take advantage of promotional codes to try the service for free, but they are often not the most careful or responsible customers. As Carsharing_1.1 explained:

> *The customer base evolves. When you launch, people use promotions and access the service for free, but they are not good customers. Over time, these customers disappear, and default payment issues decrease naturally.*

Finally, the evidence shows that social networks may play a role in amplifying these behaviours if they encourage imitiation. Platforms such as X (formerly Twitter) or Instagram often showcase acts of vandalism, which can encourage further destructive behaviour. Carsharing_3 recounted an incident where a car was crashed, and the event was widely shared on Instagram, garnering over two million views: "They crashed it, and it was published on social media, on Instagram. It’s a video with around 2,000,000 views." Scooter_1 mentioned the common practice of spreading such acts online, which can fuel a cycle of imitation and notoriety. There are also instances of pictures circulating on X and other social media platforms showing bicycles hung in trees (Metropoli Abierta, 2022) or completely covered in graffiti (ABC, 2024). This is confirmed by customers, who report seeing cases of vandalism on well-known social platforms: “we all have seen videos of illegal racing on social media.” (Customer_4).

4.3.2 Impact on operators

There is limited public information depicting the quantification of the impacts of misbehaviour on operators. As Journalist_1 noted, companies are reluctant to share this information due to concerns about their image and reputation. However, external evidence

presented in the literature review suggests that misbehaviour significantly affects all types of shared mobility operators, sometimes to the extent that they cease operations in certain cities. Examples include Autolib in France, BMW in the United States, and several bikeshare operators in the UK and China.

In this section, we use the Business Model Framework (BMF) to analyse the evidence from our data on how misbehaviour impacts operators. While most informants initially focused on value capture, such as the additional costs caused by misbehaviour, the data also revealed effects on how misbehaviour operations are run (value creation and delivery) and how it also impacts the value proposition by reducing vehicle availability and diminishing the overall customer experience. The table below summarises the main impacts according to the BMF.

Table 20. Summary of impact of misbehaviour and vandalism on shared mobility operators

Value Lever	Impact
Value Proposition	- Reducing number of vehicles available on the streets - Damaged and dirty vehicles - Reputational damage
Value delivery and Creation	- Distraction for management teams - Increased operational complexity
Value Capture	Increase in direct costs: - Repairs and maintenance - Theft of vehicles and components - Fines for illegal parking - Increase in insurance premiums Increase in indirect costs: - Surveillance technology - Larger operational teams for fleet management Loss of revenue: - Reduced fleet availability - Defaulted customer payments

Increased costs, an element of the Value Capture component, are widely reported. These costs can be direct (those resulting from the damage itself) or indirect (expenses to mitigate misbehaviour).

Among the direct costs, informants reported increased repair and maintenance costs due to the additional wear and tear caused by misuse. This includes minor damages such as small dents, flat tires in carsharing, broken side stands and mirrors in motosharing, and damaged braking systems in scooters and bikes. However, operators were unable to quantify these costs.

In contrast, the economic impact of vehicle theft, particularly the theft of valuable components like batteries, was easier to quantify and more significant. Scooters and motosharing were especially vulnerable to theft. For example, Bikesharing_2 reported losing 130 bicycles per day at one point, forcing the company to triple the size of its team responsible for recovering bikes from the streets (ABC, 2024). Battery theft has also been a major issue. Motosharing_1.2 mentioned losing 30 to 40 batteries in a single day, amounting to €100,000 in losses. The respondent described the situation as "crazy" and noted that at one point, they considered shutting down operations. Scooter_2 highlighted that a single battery could cost up to €400, with the total cost per vehicle reaching €700. Illegal parking has also been a significant cost, particularly for scooters and motosharing. Local authorities have issued fines for improperly parked vehicles. In Madrid alone, the police imposed 87,469 fines in one year, with 63% of those fines going to scooters, 20% to motorcycles, and 17% to bicycles (El Periodico de España, 2022). Fines range from €30 to €200, depending on the city (20 Minutos, 2020). Another direct cost is the insurance premium, which according to Insurance_1, "can be around a third of the total costs, and that excludes repairs." Insurance premiums are a direct reflection of the extent of misbehaviour, potentially escalating to levels that threaten the viability of the business (Motosharing_1). Beyond the cost, insurance can become a critical issue, as it can even "force you to close operations if you cannot secure coverage" (Carsharing_1.1). This underscores the importance of effectively managing relationships with insurance providers (Carsharing_3). As one insurance expert noted, some companies are reluctant to offer coverage due to the high risks involved and the lack of historical data, with insurers frequently entering and exiting the market and only offering annual policies instead of multi-year contracts. This issue is particularly severe in motosharing and scooter services, which are more vulnerable to misbehaviour than heavier vehicles (El Confidencial, 2024). As Motosharing_1.2 explained: "Some insurance companies didn't even bother to bid for coverage of our motorcycles. It was too risky for them."

Indirect costs are incurred to minimize misbehaviour, particularly through investments in technology such as cameras and IoT devices to monitor how customers use vehicles, increasing operational expenses. Bikesharing_2 reported spending over €50 million to upgrade its fleet and docking infrastructure with equipment designed to prevent theft and vandalism (El Periodico de España, 2024). Operators also expanded their teams to recover stolen vehicles and reposition them to safer areas to avoid further damage, a topic discussed in more detail in the next section on business model adaptations.

Loss of revenue is another significant impact on value capture, mainly due to reduced fleet availability and defaulted customer payments. Acts of vandalism, such as painting over QR codes, render scooters or bikes unusable (Scooter_1). Similarly, bikes removed from their docking stations are often used for free, damaging both the bicycles and the docking infrastructure (Bikesharing_2). Customer payment defaults can reach as high as 20%, according to Carsharing_1, who also mentioned the difficulty in recovering these debts. This issue is particularly challenging for scooters, where the average ticket per ride is low. As Scooter_1 explained

> *You know you are never going to recover that amount of money because you know that even if you go to a debt collection firm… which firm is going to make a call to recover €5? It doesn't. It isn't worth the time.*

The operational challenges posed by misbehaviour significantly affect how companies are managed, particularly in terms of Value Delivery and Creation. It diverts operational teams, who are often forced to address issues such as battery depletion, a task that falls outside their primary responsibilities. For example, Carsharing_2 reported towing more than 500 cars per month solely due to battery depletion. At the top management level, these challenges shift the focus away from service improvement and toward resolving issues related to vandalism. As Motosharing_1.2 explained: "The management team, we spent 80% of our time solving issues related to the motorbikes and only 20% on the needs of our clients."

Finally, misbehaviour negatively impacts the Value Proposition of companies by reducing fleet availability and worsening the overall customer experience. Damaged or dirty vehicles frustrate customers and harm the company's reputation. In some cases, this even leads to the decision to cease operations: "Ultimately, the decision to close operations in the city was primarily due to poor image and reputation" (Carsharing_1.2).

4.3.3 Strategies to tackle misbehaviour: How to become an "Un-sustainable" Business Model

In this section, we apply the Business Model Framework to systematically analyse the impact the strategies shared mobility operators employ to address misbehaviour. Based on the evidence, we argue that these strategies lead to significant changes at the three levers of the business model, and that these changes occur following a temporal pattern which is in turn affected by internal and external forces. These variations of the business model ultimately compromise the sustainability of the business by prioritizing economic objectives over social and environmental ones, transforming their businesses from a model of "Shared mobility for all" to "Premium niche mobility solutions".

Figure 9 presents the framework that integrates the findings.

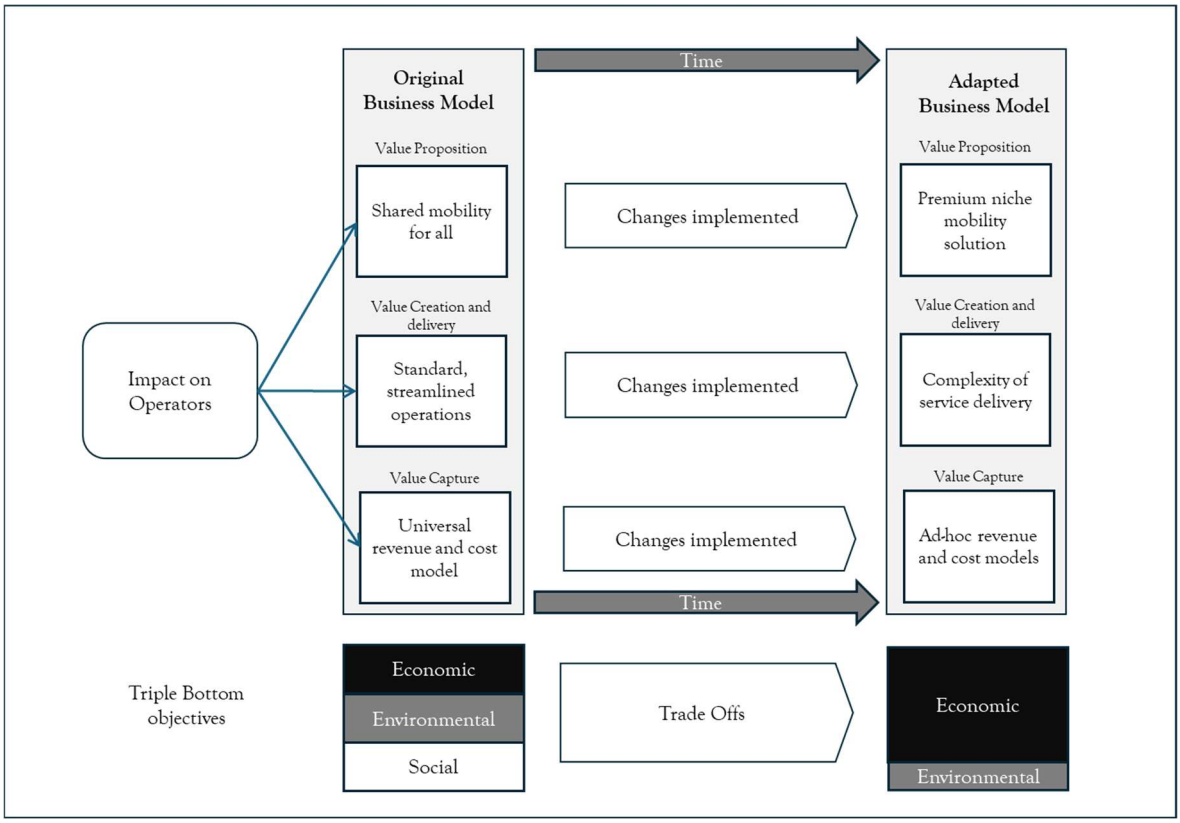


Figure 9. Adapted vs. original business model

Changes in Business Model

In this subsection, we explore the adjustments operators have made to their business models in response to misbehaviour, focusing on the three key elements of the Business Model Framework (BMF): Value Proposition, Value Creation and Delivery, and Value Capture. Table 21 below summarises the key findings. This analysis is further enriched by examining how these changes evolve over time as a result of intertwined changes in management capabilities and objectives, shareholder preferences, and the evolving dynamics of consumer behaviour, competition, regulation and technological advancements

Table 21. Changes made by operators to their business models

Value component	Changes made to business model
Value Proposition	Reduced area of coverage Selective switch off the service Limit age
Value Creation and Delivery	Vehicles more adapted to sharing: - Fleet replacement for fit for purpose models - Changes to the vehicle Introduction of new technologies: - To monitor the vehicle and the trips - To communicate with customers New customer handling processes: - Cumbersome onboarding - Blocking customers Operations: - Asking customers to participate in open and close procedures - Internalise operations team - Increase presence of operational teams on the streets Ad-hoc marketing campaigns
Value Capture	Manage demand through pricing: - Dynamic pricing to disincentivise certain trips - General increase in pricing

Value Proposition

The value proposition refers to what the firm offers its customers and why they are willing to pay for it. The data show that all shared mobility companies have made significant adjustments to their value propositions, primarily by modifying the service area to reduce misbehaviour. This has been a widespread practice across operators, as confirmed by Consultant_1, who explained: "not staying in certain areas is the best strategy to tackle certain behaviours." Scooter_1 added: "The first, and most important measure, and it is not a fair measure, was to exclude certain areas." Coverage area is a key element of the service offering because, as Carsharing_1.2 noted, "the most important criteria for a user is that the vehicle is closer" or that the area aligns with where they live. Companies monitor locations where vehicles are frequently vandalized or misused, using heat maps to guide their deployment strategy. Even bikesharing services employ this tactic, though with some restrictions set by the municipality: "We have to cover the whole city for political reasons. Having said that, vandalism has influenced the detailed footprint of the service in each Neighbourhood" (Bikesharing_2). Carsharing_2 emphasized that "Defining the area coverage is key to managing accidentability. It affects where the customer is from and the origin-destination of the trips." In doing so, the company indirectly filters its customer base, ensuring the service is available in areas where customers show better behaviour. There is ample media coverage of this issue, with several articles describing how companies have avoided or withdrawn from lower-income neighbourhoods to reduce misbehaviour, focusing instead on higher-income areas or tourist spots (El Pais, 2023). In Madrid, for example, preferred neighbourhoods for shared operators are within the M30 ring road and in northern districts (Mercad2, 2021). In Seville, the area covered by a motosharing operator almost perfectly matches neighbourhoods with the highest per capita income, largely due to concerns about vandalism (El Diario.es, 2020). Another approach is the temporary discontinuation of service during specific periods. For instance, Motosharing_1.2 and Carsharing_3 suspend operations during high-risk times, such as New Year's Eve. Even public bikeshare operators have adopted this strategy by closing certain stations during school holidays.

Specifically for carsharing, the three operators implemented minimum age and driving experience requirements to access their services, setting limits at 21 years for Carsharing_1

and Carsharing_2, and 25 years for Carsharing_3. These restrictions are based on the perception, corroborated by Study 1, that younger, less experienced drivers are more likely to engage in high-risk behaviours, such as speeding, reckless driving, and using vehicles for purposes that may increase the likelihood of crashes or damage. As respondents noted, the additional experience and maturity required by these age limits aim to foster more responsible use of shared vehicles and minimize incidents. Further evidence supporting these measures is provided in Table 22.

Table 22. Changes to business model - Value proposition: illustrative evidence

Value component	Comments
Offering	Reducing service area - Carsharing_3. "We excluded certain areas to avoid problems" - Carsharing_1.2. "In [city], we reduced very aggressively our area coverage in which we were suffering a lot of problems" - Motosharing_1.2. "We spent a lot of time redefining the area coverage to maximise the potential value of the use of our motorbikes which included among others, the cost of misuse and vandalism" - Bikesharing_1. "We covered the whole city. It was mandatory by the contract with the municipality" Switching off the service - Motosharing_1.1. "Sometimes, we would switch off the service at night" - Motosharing_2. "We close the business on New Year's Eve because the probability of having extra costs due to damages is quite high. It is not worth it"
Customer	The customer - Carsharing_1.1. "We set a minimum age to drive our cars" - Carsharing_2. "We set a limit of 21 years old or 2 years of driving experience to access the service"

Value Creation and Delivery

Changes in value creation and delivery processes encompass the resources, capabilities, and activities that a company uses to produce and deliver its offerings to customers (Richardson,

2009). Based on the evidence, these changes are divided into two main categories: Assets and operations. Further evidence is provided in Table 23.

At the asset level, companies have replaced entire fleets with vehicles better suited for shared mobility, modified key components, and invested in onboard technology. Vehicle selection has been a key element for shared mobility operators, evolving from the use of commercial, non-specialized vehicles to custom designs that are generally heavier and more robust to withstand the wear and tear of shared mobility. This shift has been especially important for scooters, which, according to Scooter_1, "moved away from off-the-shelf vehicles that had not been designed by us" and were generally lightweight, to "heavier ones which are more difficult to vandalize" (Scooter_3). Other operators, like carsharing and motosharing, pursued a different strategy, aiming to "find good unit economics with low maintenance costs and good autonomy for the battery" (Motosharing_2) by choosing vehicles that are "easier to repair, smaller, and functional, even if that meant more vandalism because the car was perceived as less robust" (Carsharing_1.3). Both bikesharing operators also changed suppliers of bikes and station infrastructure, opting for models known for their durability and anti-vandalism features. In fact, they now use the same provider, renowned as "a top provider worldwide" (Bikesharing_1) for its emphasis on features designed to combat theft and vandalism (ABC, 2023). Additionally, operators have modified existing commercial vehicles to enhance protection and improve repairability. Motosharing_1.1 noted that "Initially, the motorbike was a standard private vehicle. We evolved it to make it more fit-for-purpose for sharing," incorporating features such as cables to secure helmets and reinforced trunks with locks that are harder to break.

Additionally, companies adopted new technology primarily aimed at monitoring vehicles and providing real-time feedback to customers. The ultimate goal is for customers to feel observed, thereby reducing the likelihood of misbehaviour or vandalism. For scooters, geofencing technology was essential in reducing illegal parking and the associated penalties. For some operators, it even influenced vehicle selection: "Vandalism was key to decide which monitoring technology to use" (Bikesharing_2). This technology can also alert users in real time if their driving is dangerous or if they are doing something wrong, such as parking outside permitted areas. These systems are used to "obtain information in real-time and send alerts to users" (Carsharing_1.1), for instance, notifying users of poor driving (Carsharing_2).

Carsharing_1.3 explained that this real-time monitoring technology has proven effective, with one carsharing operator reporting a 36% reduction in accidents after implementing these new devices in part of its fleet (El Confidencial, 2022). This technology can be embedded in both hardware, such as geofencing for managing scooter parking, and software solutions (Scooter_3).

At the operational level, companies have implemented several process changes that affect both customers and internal operations. For instance, making the onboarding process more rigorous, rather than user-friendly, helps better screen potential drivers and reduce fraudulent accounts. Companies also block existing customers to prevent fraud and encourage rule adherence, such as properly securing bikes (Bikesharing_2) or refraining from infractions (Motosharing_1.1). To address payment issues, a credit card pre-authorization has been added as a precaution (Carsharing_1 and Carsharing_3). Operators have also introduced procedures for customers to report existing or new damages (for cars and motorcycles) and to provide evidence of correct parking (for motorcycles and scooters) to minimize fines. In certain cities, these processes are mandated by municipal regulations (La Vanguardia, 2021). Additionally, some customers proactively document vehicle damage, even when not required, to ensure protection in case of disputes (Customer_4).

From a service delivery perspective, the evidence suggests that companies managing their operations internally, rather than outsourcing them, are more effective in addressing misbehaviour and vandalism. Carsharing_1.3 shared that in a city where they initially experienced high levels of misbehaviour, they used external suppliers to manage the fleet. However, after switching to an internal operations team, “things improved a lot.” According to Scooter_2, the issue with subcontractors is that they “only act if they make money,” which can compromise service quality. Improving on-street logistics and direct interventions has also proven effective. For example, operators worked to better distribute vehicles across streets, as “too much concentration would frustrate the citizens and increase vandalism by revenge,” and ensure proper parking through visual inspections (Scooter_2).

Finally, while mass marketing and communication campaigns have been used in the past to educate users and build a sense of community around company brands, their effectiveness remains questionable. For instance, Carsharing_2 launched a campaign to explain how the mechanical characteristics of electric cars could potentially lead to more accidents. However,

the impact of these campaigns is doubted by both operators and customers. Carsharing_1.3 observed limited success, while Customer_1 noted that they "do not read any notification from the company unless it is a price reduction or a promotion," and Customer_4 admitted, "frankly speaking, I do not remember any specific campaign." Operators have also tried to foster a sense of belonging among users, but this has proven difficult, as customers often subscribe to multiple services simultaneously (Carsharing_1.1; Consultant_1), driven primarily by convenience. One exception is Carsharing_3, which benefits from a large, established customer base built by its parent company, a well-known brand in the city, thus inheriting a stronger sense of community among users.

Table 23. Changes to business model – Value creation and delivery: illustrative evidence

Value component	Comments
Vehicles	Changes to the vehicle model, from off-the shelf to fit-for purpose vehicles - Carsharing_1.1. "The car now has additional elements of protection to protect it from small impacts such as stickers or plastic parts" - Scooter_1. "Scooters are now very repairable and easy to change parts like the fork or the wheel. Eventually, we moved to swappable batteries" - Carsharing_3. "At the beginning we had two type of cars. Now we only have one, more urban, which invites to a more tranquile type of driving." - Motosharing_1.2. In 2018, there were not specific motosharing vehicles in the market. Same for scooters" Changes made by the operators to the vehicle to make it more fit-for purpose vehicles for sharing: better protection, more repairable - Carsharing_1.2. "Initially, the cars were not designed for carsharing. They were just regular cars. We introduced changes little by little" - Motosharing_1.1. "We added cables to secure the helmets and reinforced the trunks. Initially they did not exist" - Motosharing_1.2. "We added a mechanical block to the battery to aScooter_2d theft" - Motosharing_2. "We diminished the power of the motorbikes. It did work"
Technology	Introduction of new technology to increase monitoring - Motosharing_1.1. "From the beginning, our motorbikes had a lot of IoT. We could detect almost anything" - Scooter_1. "Several companies have added alarms if the vehicle is moved illegally. I am not sure it is that effective." - Scooter_1. "The application of geofencing is a strategy against vandalism" - Scooter_1. "Companies use machine learning to map the city" Communication with customers in real time - Carsharing_2. "If you can identify that a customer is driving poorly and you notify him/her in real time, that in itself reduces accidents significantly" - Motosharing_1.1. "From the beginning we had a tool to receive feedback from customers about the service. We evolved it to adapt to the issues that appeared in the service"

Table 23 (cont.)

Value component	Comments
Operations	Onboarding of new clients - Carsharing_3. "We deliberately slowed down the sign up process on Friday evenings to aScooter_2d customers who want to use the car then, when accidents are more common" - Carsharing_1.2 "We have improved the system to validate new registrations" - Motosharing_1.1. "Our on-boarding process was quite good. We could check automatically all the documentation to avoid fraud" Blocking bad customers - Motosharing_2. "We would block users temporarily if they owed money to the company" - Motosharing_1.1. We had a black list where we blocked customers who had committed an infraction" - Scooter_3. "We would trim our database from time to time" - Scooter_1. "It was not worth it to try to recover unpaid amount from customers. It was much easier just to block them" Customer report processes - Carsharing_3. "We introduced a pre-authorization for the first trip." - Carsharing_1.1. "We want to improve our damage reporting system. For two reasons: one to identify the driver in the case of an incident and two, to make our customer feel observed" - Motosharing_1.1. "We introduced the need to send a picture after parking the vehicle to aScooter_2d illegal parking" - Motosharing_2. "In 2019, we introduced the obligation to take a picture after the trip was finished" - Bikesharing_2. "Now, if a user does not secure the bike properly in the station, we block him/her. That measure has reduced vandalism a lot" - Motosharing_2. "Taking a picture after the trip is finished has become a standard not just for motorbikes, but for bicycles and scooters as well"

Table 23 (cont.)

Value component	Comments
Operations	Internalisation of operations - Carsharing_1.3. "Having your own team is a key factor that benefits our service. Our drivers care about the car, they are part of the image of our company" - Carsharing_1.3. "In city we started with an internal operations team and things improved a lot" - Scooter_2. "The operations were internal. Subcontractors only act if they make money. It is important to keep the quality" - Bikesharing_1. "Operations are all internal" Improve on-street activities - Motosharing_1.2. "We were very proactive in collecting and distributing the motorbikes. Too much concentration would frustrate the citizen and increase vandalism by revenge" - Scooter_2. "We routinely inspected the vehicles to check whether they were well parked" - Scooter_1. "We deployed operations crews in the streets to explain to users how to use the service"
Marketing campaigns	- Carsharing_2. "We launched a campaign to inform about the power characteristics of electric cars and how it could lead to more accidents" - Carsharing_1.3. "Users do not care about comms campaigns because the car is not theirs" - Customer_1. "I do not read any notification from the company unless it is a price reduction or a promotion"

Value Capture

Adjustments to value capture mechanisms have been implemented across various shared mobility operators, addressing both revenue generation and cost management. A common theme on the revenue side is price increases and the implementation of dynamic pricing strategies to manage demand in specific areas or times of day. An examination of current and historical fare comparisons on operators' websites reveals an overall trend of increasing prices. For example, Carsharing_1 has almost doubled its tariffs from 0,26 €/min in 2020 to 0,41 €/min in 2024 while Motosharing_1 increased them by 26% in 2024. Scooter_3 for example, increased its average prices by 40% in 2021. In the case of the bikesharing operators, prices have shown only a moderate increase, probably due to the fact that they are owned by the local authorities and partially subsidised. In relation to dynamic pricing Carsharing_2 noted that "Prices were significantly higher on Friday and Saturday nights," indicating a strategy to align pricing with perceived risk levels. Similarly, Motosharing_1.2 highlighted instances of increasing prices in areas prone to vandalism during certain times, aiming to incentivize users to relocate vehicles to safer areas. Regarding costs, we were unable to obtain specific estimates from operators on the expenses associated with implementing the various measures discussed earlier (referred to as indirect costs). However, anecdotal evidence suggests that the direct costs of misbehaviour are substantial, as noted in our earlier discussion on its impact on operators. Table 24 provides additional insights gathered from the interviews.

Table 24. Changes to business model – Value capture: illustrative evidence

Value component	Comments
Revenues	Dynamic pricing/Increase pricing - Carsharing_1.1. "We increase prices to reduce the usage in certain timeframes in which accidentability is very high. This also partially covers extra costs" - Carsharing_2. "Pricing is a key element in managing what type of usage you want from your cars" - Carsharing_2. "Prices were much higher on Fridays and Saturdays nights" - Carsharing_3. "We now increase the price at night and in some occasions even switch off the service" - Motosharing_1.2. ""Some areas showed high vandalism at certain moments of the day. We would reduce pricing there to encourage users to use them so they could move to other areas"

In summary, the evidence suggests that operators have employed a wide range of strategies to tackle customer misbehaviour, which affects the services they offer, the delivery mechanisms, and their ability to capture value. These strategies primarily aim to mitigate the financial costs incurred due to misbehaviour, which range from direct damages such as theft or vehicle burnings to increased operational costs and targeted investments to manage these issues. Moreover, these strategies were sequentially deployed. This processual view of the strategies is explained next.

The degradation process

The strategies adopted by shared mobility operators and their impact in their business models have followed a similar trajectory over time, shaped by management capabilities and objectives, shareholder preferences, and the evolving dynamics of consumer behaviour, competition, regulation and technological advancements. Based on the data, we identify three distinct phases across all shared mobility options: *Market reach, Profitability and Downsize-Diversification-Decline.* Figure 10 illustrates the process. In each of the two initial phases we describe the prevalent forms of misbehaviour, the impacts of misbehaviour on the operator, the changes implemented in the business model to address them, and the internal and external factors that influence these changes. The final phase, which I refer to as *Downsize-Diversification-Decline* describes the different strategies followed by the operators at the end of the process.

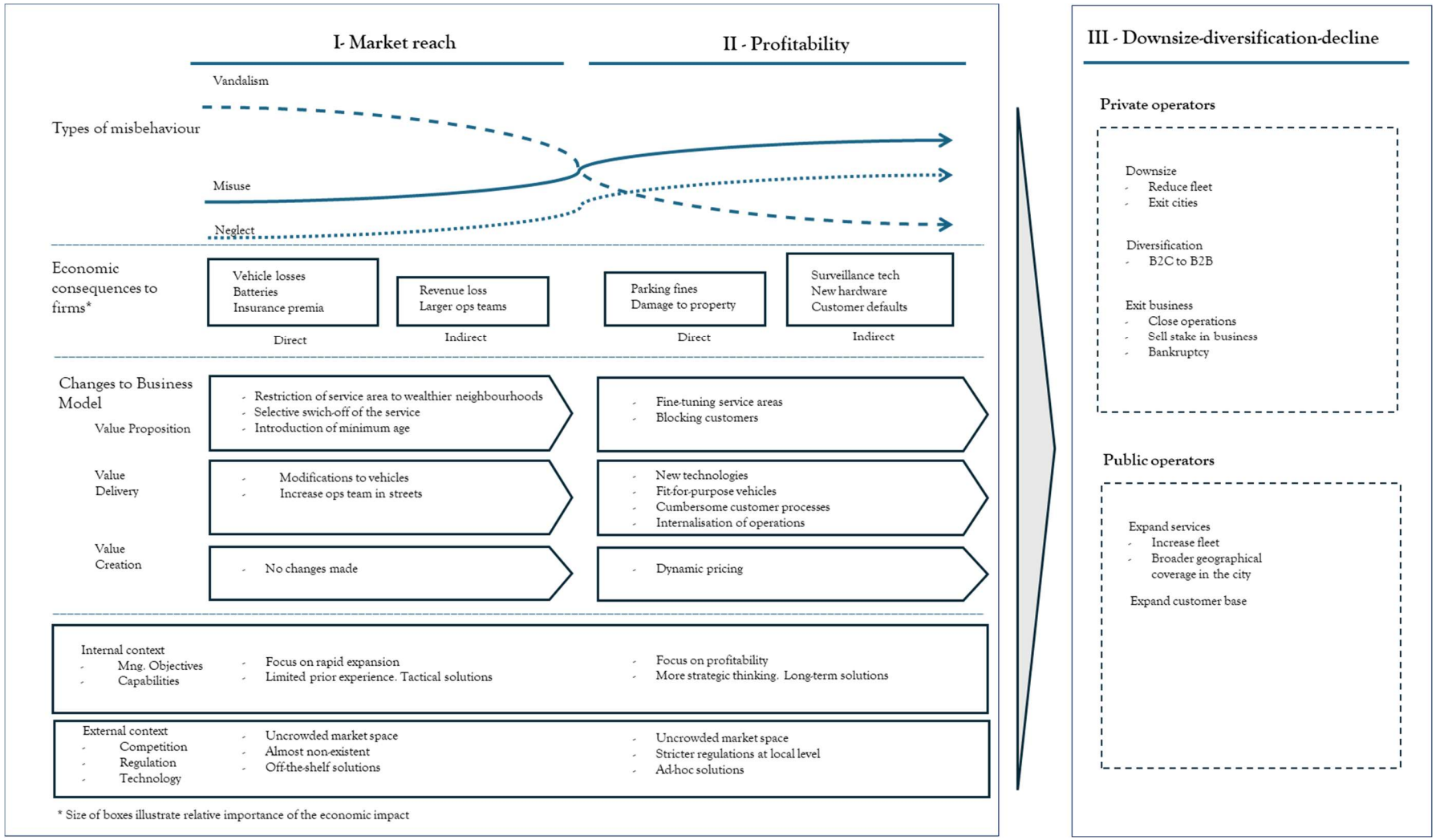


Figure 10. Visual depiction of SBM evolution of shared mobility operators

First phase: Market reach

Three forms of misbehaviour were particularly relevant in this phase: vandalism, neglect, and misuse, often intertwined in their effects. Vandalism was the most prevalent, though it stemmed from different motives: pure destruction, driven by a deliberate intent to damage corporate assets; revenge, carried out by dissatisfied customers, frustrated citizens dealing with improperly parked vehicles, or even competitors; and economic gain, where individuals stole helmets, batteries, or even entire vehicles for resale or personal use. Neglect was also common, particularly in the form of illegally parked vehicles left on the streets. Finally, misuse was widely reported, with instances of reckless driving and the use of vehicles for illicit activities.

Shared mobility operators experienced the economic consequences of misbehaviour. Three economic impacts were particularly relevant at this stage. First, the direct costs to repair or replace damaged or stolen vehicles (or parts) significantly increased. Second, direct costs associated with insurance premium also increased, particularly in motosharing and scooter services, which are more vulnerable to misbehaviour than heavier vehicles (El Confidencial, 15 November 2021). Finally, operators also acknowledged the loss of revenue due to reduced fleet availability. The three combined severely affected the economic targets of operators at this initial stage.

To address misbehaviour and its negative consequences, operators changed two components of their business model. First, they modified the value proposition by restricting the service areas and raising the minimum age (El Diario.es, 12 October 2020; 5 October Mercad2, 2021). The only exception is found in bikesharing operators governed by the municipality. Additionally, carsharing operators limited the customer base by setting minimum age limits for service access. Because younger users were more likely to engage in neglect and misuse of vehicles, increasing the age limit was a strategy to circumvent these customers. As Carsharing_3 explained:

> *Our first lesson was just 9 days after launching the service. In Christmas eve a car is crashed and posted in social media, in a video with over 2 million views (...) In that moment we decide to increase the minimum age to 25*

These changes reconfigured their value proposition. Formerly, it was based on the availability of vehicles and the possibility of being used citywide by all citizens. It was also promoted as a

climate-friendly mobility solution for all. Yet, the changes applied reduced the customer base that could access this solution and increased the environmental footprint of operators. Second, they adjusted the value delivery by making simple vehicle modifications. For instance, Carsharing_1 reduced vehicle torque forcing customers to use the Eco-mode to mitigate misuse from excessive acceleration, while motosharing and scooter operators addressed battery theft by securing batteries to vehicles.

The modifications described above to address misbehaviour resulted from a combination of internal and external factors. Two internal factors explained the evolution: the organizational objectives and their capabilities at anticipating and handling misbehaviour at the time. In this stage, operators wanted a rapid expansion and had very limited prior experience in the industry. This lack of expertise left many operators ill-prepared to fully anticipate or effectively address the challenges posed by customer misbehaviour and vandalism. Operators underestimated the severity of misbehaviour, given the intense market pressure to launch operations swiftly. As Scooter_1 explained: "Even if the outlook was bleak, the company would go ahead and launch no matter what." Consultant_1 corroborated this, stating: "We included in our clients' models a certain amount of loss for vandalism, based on historical data and the type of city and Neighbourhoods in which our client operated. However, reality was much worse." The goal of rapid expansion together with the limited capabilities explained that operators relied on tactical, fast to implement, and low-cost solutions aimed at tackling the most pressing forms of misbehaviour (i.e., vandalism) rather than developing long-term strategies.

Among the external factors, the competitive landscape, relatively uncrowded at this stage, allowed operators to prioritize customer acquisition and market share over profitability. With limited competition, companies focused on rapid growth to attract investor funding and meet shareholder targets. This explains why they chose customer-friendly policies, ruling out penalties or fines for misbehaviour, not to compromise this goal. At most, customers received post-trip notifications requesting better behaviour. (Carsharing_1). Another external factor explaining the evolution of the SBM is the lack of regulation at the time, that allowed companies to expand rapidly without significant legal constraints (El Mundo, 19 December 2019). However, the absence of regulation also contributed to vandalism, especially to revenge-motivated vandalism. This motivated the imposition of fines to operators for illegal parking

which eventually led operators to introduce new changes to tackle illegal parking. A final external factor was technology availability. There were missing tailored technological solutions for addressing misbehaviour. This forced operators to adapt off-the-shelf technologies not designed for their unique needs. Companies launched using commercial vehicles that were unfit for purpose and generic software platforms with limited customization. As Carsharing_1.3 mentioned: "When we launched the cars they only had the open and close remote technology." Consequently, vehicle modifications during this phase were minimal and reactive, mostly oriented to avoid economic-motivated vandalism.

Second phase: Profitability

In this phase, while vandalism progressively declined, misuse and intentional neglect were maintained or, even, increased (El Periódico, 4 May 2024). Forms of intentional neglect included illegal parking (El Mundo, 28 March 2023), smoking in the vehicle, littering, careless driving and reluctance to fill accident reports - which severely impacted operators as they could not claim the costs from insurance companies (Motorsharing_1.2 and 2)-. As the customer base increased, payment fraud also increased and so did misuse especially over speeding (Journalist_1, Scooter_1) and illegal racing. Impact of misbehaviour. Whereas in the first stage misbehaviour reflected in increased direct costs, in this stage also indirect costs rose. In addition to the rising insurance premiums and repair/replace of vehicles and pieces, parking fines were a significant direct costs. Operators -notably scooters and motorbikes-increased costs of covering fines for illegal parking. In Madrid alone, the police imposed 87,469 fines in one year, with 63% of those fines going to scooters, 20% to motorcycles, and 17% to bicycles (El Periódico de España, 2022). Fines ranged from €30 to €200, depending on the city (20 Minutos, 2020).

Indirect costs increased because to handle the new types of misbehaviour operators invested in surveillance technologies, harder to break vehicles and expanded their operational teams to recover and reposition their fleet. Bikesharing_2 reported spending over €50 million to upgrade its fleet and docking infrastructure with equipment designed to prevent theft and vandalism (El Periodico de España, 23 January 2024). As the customer base increased payment defaults negatively impacted operators. Customer payment defaults could have reached as high as 20%, according to Carsharing_1, who also mentioned the difficulty in recovering these

debts. This issue was particularly challenging for scooters, where the average ticket per ride was low (Scooter_1).

During this phase, operators further modified business models components. First, regarding the value proposition, in addition to the service area restrictions introduced in the previous phase, operators suspended services on specific dates—such as New Year's Eve and the start of school holidays—to prevent vehicle misuse. This measure was applied across private transport modes (Carsharing_1; Carsharing_2; Motosharing_1) as well as public bikesharing schemes. As Bikesharing_2 explained:

> *We now close certain stations during school holidays to minimize the impact of vandalism from young customers.*

At the value delivery level, operators invested in purpose-built vehicles (Carsharing_1; Motosharing_1; Motosharing_2; Scooter_1, 2, and 3) and upgraded supporting infrastructure, in some cases requiring substantial financial resources (Bikesharing_2). Regarding the new vehicles, Scooter_1 noted: "The company moved away from off-the-shelf light vehicles that had not been designed by us to heavier ones that are more difficult to vandalize." Operators also integrated new onboard technologies to monitor vehicle usage, aiming to create a sense of surveillance among customers. These technologies included driving monitoring devices in carsharing, alarm systems to detect unauthorized trips (Scooter_1), and geofencing mechanisms to ensure regulatory compliance and reduce fines (Motosharing_1; Scooter_1; Scooter_2). These solutions proved effective; for example, Carsharing_1 reported a 36% reduction in accidents after implementing the new technology in part of its fleet.

Additionally, customer processes became more burdensome to better screen out deviant drivers and encourage proper usage, making the service less user-friendly. Operators introduced credit card pre-authorizations (Carsharing_3) and upgraded systems to validate new registrations and prevent fraud (Carsharing_1; Motosharing_1). Ending a trip also became more complex, requiring users to upload photos of parked vehicles to confirm proper placement, which was validated with the new geofencing technology. Non-compliance led to penalties. For instance, scooter operators imposed a €10 fine for improper parking, which significantly reduced illegal parking incidents from 80% to just 3.2% within a few months (Cinco Días, 21 July 2022). Another significant change in value delivery was the expansion of operational teams working in city streets to mitigate issues related to illegal parking (Scooter_2;

Motosharing_1) and theft (Bikesharing_2), in some cases replacing subcontractors. This trend was observed across all shared mobility operators.

Regarding value capture, some operators adopted dynamic pricing strategies, adjusting rates based on location and time to either discourage use or incentivize vehicle relocation. For example, Carsharing_2 increased prices on Friday and Saturday nights to discourage usage that may lead to accidents whereas Motosharing_1 used pricing to influence user behaviour:

> *Some areas experienced high vandalism at certain times of the day. We reduced pricing there to encourage users to move vehicles to other locations.*

In this stage, operators were more oriented towards profitability than market reach. As Insurance_1 observed: "Operators focused first on attracting clients. They are now cleaning their customer base, trying to retain only the good ones". This explains why they began implementing penalties and sanctions to misbehaving users. Their focus was not customer growth, but revenue growth, which required retaining the non-misbehaving customers. Operators also gained expertise in the reasons for customer misbehaviour and obtained more financial support from large investors to invest in new vehicles and on-board technology. All these internal factors explain why they adopted a more strategic approach, investing in more expensive, longer-to-implement solutions that could prevent the types of misbehaviour observed.

The changes were nonetheless enabled also by external factors. Partly, these solutions were enabled by technological developments of suppliers and service providers, with whom operators established strategic alliances. As misbehaviour was growingly recognized as a problem in the industry, suppliers also sharpened their capabilities to develop technologies that could address the threat, e.g., monitoring systems, geolocation tools or data analytics platforms. These technologies enabled operators to manage fleets more efficiently and gain deeper insights into user behaviour. Carsharing_1.3 for example mentioned that "With the new technology on-board of the vehicles, we can detect pretty much all the accidents. Before, it was impossible." Also, they worked with vehicle manufacturers to replace existing vehicles with more robust options that had advanced monitoring technologies embedded, or to modify features such as motorcycle trunks, scooter weights, and bicycle station designs to improve durability and functionality.

Simultaneously, the public backlash against shared mobility, particularly the perceived invasion of public spaces by scooters, prompted local authorities to introduce stricter regulations, such as designated parking zones (El Periodico, 24 February 2023; El Economista, 10 May 2023). Because these fines jeopardized profitability targets, operators opted for ad hoc procedures at the expense of creating a worse experience for users.

Throughout both phases, operators adopted an experimental mindset, understanding that refining their business models would require ongoing adaptation and iterative improvements. Motosharing_1.1 described this approach as "learn as you go. We did not really change our business model on purpose. It was more a trial-and-error fine-tuning," highlighting the continuous, rather than drastic, nature of these adjustments. Operators constantly tested new approaches to enhance operations, experimenting with technologies and responding to "crooks who are always smarter than you" (Motosharing_1.2). Carsharing_3 noted: "We tried new things every day," while Scooter_1 emphasized the need to test new technologies to stay ahead. This trial-and-error approach allowed companies to learn from failures and quickly adapt their strategies. Operators acknowledged that setbacks, including losing vehicles to misbehaviour, were part of the learning curve necessary for improvement. Scooter_1 remarked that these challenges were essential to refining the business by saying "losing a lot of vehicles is part of learning how to operate in the market", underscoring the resilience and flexibility required to navigate the evolving shared mobility landscape.

Third Phase: Downsize-diversification-decline

Despite the changes introduced, some forms of misbehaviour remained, augmenting costs, creating operational inefficiencies and increasing the pressure to ensure viability. Operators then made further changes to their business model, as explained next. In one instance (Scooter_3), the company eventually filed for bankruptcy.

Some companies downsized their geographical footprint, focusing on the safest and most profitable urban areas. For example, Carsharing_1 withdrew from two cities, with one of its shareholders exiting the business entirely by selling its stake. Despite their initial intention to do so, Carsharing_2 and Carsharing_3 never expanded beyond their initial cities, maintaining a reduced fleet and service area. Similarly, Motosharing_1 significantly scaled back, reducing both its geographical presence and fleet size and keeping their operations in certain neighbourhoods. In other cases, companies faced regulatory setbacks, such as Scooter_1,

which was banned from operating in a major city due to persistent issues with illegal parking and unsafe riding practices. Meanwhile, Scooter_2, which initially had an extensive footprint in Spain, ultimately consolidated its operations to just two highly touristic cities, operating in the city centres. Other operators diversified their business models aiming to reach financial targets. Motosharing_2, for instance, expanded into the B2B segment, introduced petrol-powered vehicles, and shifted toward long-term rentals, moving away from an exclusively short-term, pay-per-minute model.

In contrast, public bikesharing schemes followed a different trajectory. Benefiting from public subsidies, Bikesharing_1 and Bikesharing_2 not only survived but expanded their service areas, customer base, and total number of rides. This suggests that public financial support played a crucial role in sustaining shared mobility services, particularly in ensuring accessibility and affordability that privately operated services could no longer maintain.

Trade-offs among triple bottom objectives

These findings show that the SBM evolved from "shared mobility for all" to a "premium niche mobility solution". This evolution implied a degradation of the original SBM underpinned by two intertwined processes: a progressive focus on financial viability and a growing prioritization of a smaller and wealthier segment of customers. As a result, the previously sought balance between economic, environmental and social value was compromised and the business model became less sustainable.

The evidence suggests that except for the public or semi-public bikesharing schemes that are partially subsidized, the focus on the financial bottom line comes at the expense of the social objective of providing sustainable, accessible mobility for all, a claim many companies initially made, and to a lesser extent, the environmental targets. Misbehaviour exacerbates the tension between these objectives, leading companies to prioritize financial objectives over social and environmental aims. This focus results in the exclusion of low-income Neighbourhoods, increased prices, and a more selective client base.

Financial Objectives

While there is no detailed external data on the precise financial impact of misbehaviour on shared mobility operators, interviews indicate substantial effects, often to the point where

certain operators have been forced to exit the market. In light of these pressures, it is unsurprising that profitability becomes the primary concern for management teams, especially among those privately-owned operators. Although companies recognize that "the trade-off between economic and social objectives is real" (Motosharing_2), they emphasize the critical importance of financial sustainability. As Carsharing_1.1 put it: "The business needs to be profitable. Otherwise, it must close." This challenge is particularly acute for startups, which lack the financial security of established shareholders and have typically prioritized from the outset capital-raising, scaling, and attracting industry players to buy them out (El Periódico de Aragón, 2023). Scooter_3, which was backed by a financial sponsor, succinctly stated: "Our only goal was to expand into more cities and raise more capital." The company eventually went into administration. For the bikesharing operators included in the study, the financial consequences of misbehaviour is a significant increase in the capital expenditure (bicycles and stations) which they cover partially through subsidies.

Social Objectives

As a result, economic objectives were prioritized over social ones, disrupting the previously sought balance between the two. The changes in their business model to counteract misbehaviour and reduce its financial impact had significant negative implications for accessibility and affordability, particularly for users who would benefit most from cost-effective mobility options. Operators limited the service coverage to areas with lower rates of vandalism and higher usage, excluding low-income and peripheral areas, which further contributed to inequalities in access to mobility alternatives (El Diario.es, 13 October 2020). Additionally, they progressively selected and retained the most reliable users, further concentrating the service in a smaller segment of customers. They also raised prices, making shared mobility a costly, less accessible option for many.

The disrupted balance between economic and social objectives was acknowledged by informants. Although initially it was presented as a new mobility option, alongside other public services, as the industry matured operators claimed a different representation distancing from the notion of public service and growingly presenting it as a private service. As Motosharing_2 noted: "Why don't they ask Amazon for the same things they demand from us?". Entrepreneur_1 was adamant: "The only objective for shared mobility operators should be to become profitable. Cities cannot expect private operators to act like public services. If

they want that, they should launch their own services." Other informants defend that unless subsidies were provided to cover for the cost of misbehaviour, the service cannot be democratized and rendered available in certain areas, because simply “the numbers just don't add up” (Carsharing_1.1.). Regarding pricing, one operator stated they "would never introduce a reduced social tariff unless cities required it" (Carsharing_1.1), adding:

> *The social aspect is fine, but it must be subsidized. If a city wants the service to cover certain areas, they should pay for it. Otherwise, the numbers just don't add up.*

Consultant_1, who has significant experience with public tenders, echoed this perspective, asserting: "This is pure economics. If the tender imposes certain obligations, then you need to protect yourself with appropriate pricing or an obligation for the administration to cover costs related to vandalism or insurance."

The issue of service coverage is similarly viewed across other mobility types. Motosharing_1.2 remarked: "I could understand these demands if we were a public service, but we are not. We pay a license to operate a business, and we operate where our customers demand. It is complicated to be treated as a public service for some things and as a private business for others. If the public wants us to have scooters in Villaverde, they need to provide financial incentives. You cannot be both public and private at the same time." Consultant_1 added that, while broad city coverage is desirable, the financial burden is unsustainable.

In the particular case of the bikesharing operators, the trade-off is less acute because the systems are partially subsidized. For that reason, they can allow to have lower prices and maintain an increasingly wider area coverage. Bikesharing_2, a public service provider, was clear about their pricing strategy: "Frankly, if I had to set prices to cover my costs, they would be similar to commercial scooters. But public bikesharing operates on a different model.” Bikeshing_1 commented on the area coverage by saying that “We covered the whole city. It was mandatory by the contract with the municipality.”

Nevertheless, some operators believe that social and environmental objectives can contribute to a successful strategy. They argue that "the different objectives are synergetic" (Scooter_2) and can be integrated into core business models (Carsharing_3), partly because "eco-friendliness and having a positive social impact is what cities now want" (Entrepreneur_1).

Environmental Objectives

All shared mobility services generally contribute positively to environmental goals, with operators actively promoting the use of electric and shared vehicle fleets to highlight sustainability. In the case of bikesharing, the emphasis extends to human-powered transportation, further underscoring its environmental benefits. A review of operator websites shows a clear focus on environmental messaging: "Your carsharing 100% electric. Join the sustainable mobility"; "Move in a sustainable manner in City"; "New bicycles and stations for a more active and sustainable mobility"; "Ride Green"; "We contribute to healthier cities and more vibrant communities"; and "Our service allows you to move across the city conveniently in a sustainable manner." Customers also align with this vision identifying the service's electric nature as a key factor in choosing one operator over another.

Operators took direct steps to reduce their environmental footprint. For instance, Motosharing_2 emphasized a practical approach, opting to repair components rather than replace them. Scooter_2 described integrating circular economy practices with economic gains

> *Once you set up a circular economy solution, you see that it makes economic sense. We moved from paying for our waste (mainly metal and batteries) to selling it for a positive value.*

Scooter companies also highlight their use of green energy and recyclable materials, with some reporting that up to 90% of their components are recyclable (El Español, 2021).

Despite these efforts, the environmental benefits of shared mobility are undermined by the additional waste generated from vehicles and spare parts needed to replace those damaged by vandalism and theft. This not only increases operational costs but also adds to environmental degradation, weakening the sustainability credentials of shared mobility services.

In summary, findings from Chapter 4 show that in responding to misbehaviour, the SBM loses its initial sustainability focus, an evolution we refer to as the degradation of SBM. Operators prioritized financial value creation, disrupting the balance they originally sought to maintain. Their initial social mission of providing accessible and equitable mobility was abandoned, as evidenced by increased prices, selective user retention, and the exclusion of high-risk, low-income areas. The only exception was public bikesharing schemes, where subsidies help preserve social and environmental objectives. However, we acknowledge that other factors may have also played a role in this degradation. For instance, parking availability, population density, and access to public transportation, in addition to levels of misbehaviour,

are key considerations for companies when determining service footprints and vehicle positioning. Moreover, while the general increase in prices is partly a response to the rising direct and indirect costs caused by misbehaviour, it is also a commercial strategy adopted by companies that perceive their users as willing to pay more for the service. These factors, however, fall outside the scope of this study.

Chapter 5 adopts a macro perspective to analyse how misbehaviour in the shared mobility industry hinders its scalability and its potential to foster a sustainable urban transportation paradigm, shifting away from the private car-centric regime.

Chapter 5. From Niche to… nowhere? Putting brakes to new sustainable mobility – Study 2 (macro implications)

The previous chapter examined how customer misbehaviour and vandalism disrupt operations in shared mobility services, prompting adjustments across three business model dimensions: value offering, value creation and delivery, and value capture. These adaptations ultimately hinder the sector's ability to maintain the balance between economic, social, and environmental objectives. In Chapter 5, we expand the analysis to assess how these shifts limit the sector's potential to drive sustainable mobility. Additionally, while not a central focus of this study, we include insights from informants on the sector's outlook, adding practical implications to the discussion.

To analyse the macro implications of customer misbehaviour and vandalism, we use the multi-level perspective (MLP) framework for socio-technical transitions, initially proposed by Geels (2002) and widely applied in studies of transitions across domains such as energy (Geels, Sovacool, Schwanen & Sorrell, 2017), sustainable agriculture (Darnhofer, 2015), and mobility (Geels, 2012; Nykvist & Whitmarsh, 2008; Van Bree, Verbong & Kramer, 2010). The current urban transportation system, dominated by privately owned internal combustion vehicles, constitutes a socio-technical regime shaped by entrenched norms, technologies, policies, infrastructure, user behaviours, and cultural factors that foster car dependency (Köhler et al., 2009; Nykvist & Whitmarsh, 2008). Within this context, shared mobility services emerge as a niche innovation with potential to challenge the dominant regime. This niche exists alongside other innovations, including green vehicle technologies, enhanced public transportation investments, and mobility management strategies focused on reducing overall transportation demand (Nykvist & Whitmarsh, 2008).

The MLP framework (Geels, 2005) posits that socio-technical transitions are driven by interactions among three levels: niche innovations, the established socio-technical regime, and the broader socio-technical landscape. Successful transitions occur when developments across these levels align, allowing niche innovations to gain momentum and disrupt the regime under pressures from broader landscape shifts (Geels & Schot, 2007). However, as noted in the literature, barriers exist that can delay or even jeopardize transitions, affecting all three levels (Stolper, 2022).

Shared mobility benefits from favourable landscape pressures, including political support, cleaner technologies, and environmentally conscious customers and the rise of the sharing economy among other macro trends (Nykvist & Whitmarsh, 2008; Georgatzi & Stamboulis,

2021; Yeganeh, 2021). However, with the exception of public or semi-public station-based bikesharing schemes, the shared mobility industry has struggled to achieve financial sustainability (Gilbert, 2020), and consumer adoption remains limited, partly explained inadequate infrastructure, limited accessibility and a potential cultural preference for private vehicle ownership (Li, Long, Chen & Geng, 2017; Chahine, Christ, & Gkritza, 2024)

We argue that misbehaviour is another critical factor hindering the development of shared mobility as a viable niche capable of challenging the car-dependent regime. Insights from our data reveal how misbehaviour impacts the shared mobility niche's ability to gain momentum, ultimately compromising its potential to disrupt the dominant regime. At the niche level, companies' adaptations to their business models in response to misbehaviour hinder the widespread adoption of shared mobility services. Additionally, regressive trends at the regime level, exacerbated by misbehaviour, further complicate the industry's growth. These include the introduction of new regulations by local authorities to address the initial chaos created by scooters and motosharing; these regulations, as we explained in the previous chapter, also affected their business models. Furthermore, the slow response from manufacturers and technology providers in delivering fit-for-purpose, affordable mobility solutions hampers operators' efforts to scale effectively. The financial expectations of private shareholders, who demand rapid returns on investment, exacerbate these challenges. The additional costs caused by misbehaviour often force managers to adopt quick, low-cost fixes that may undermine the long-term value proposition for customers. In contrast, public bikesharing schemes appear to be less affected by these pressures, benefiting from public funding and subsidies that allow for a more inclusive and sustainable approach.

Figure 11 summarizes the impact of customer misbehaviour on the transition toward a sustainable transportation regime from the perspective of the Multi-Level Perspective (MLP). The remainder of this chapter provides a more detailed examination of the consequences of misbehaviour at the niche level and the challenges that shared mobility companies face from the existing regime. To complement this analysis, we also outline key strategies that could support the growth of shared mobility, enabling it to play a more significant role in urban transportation.

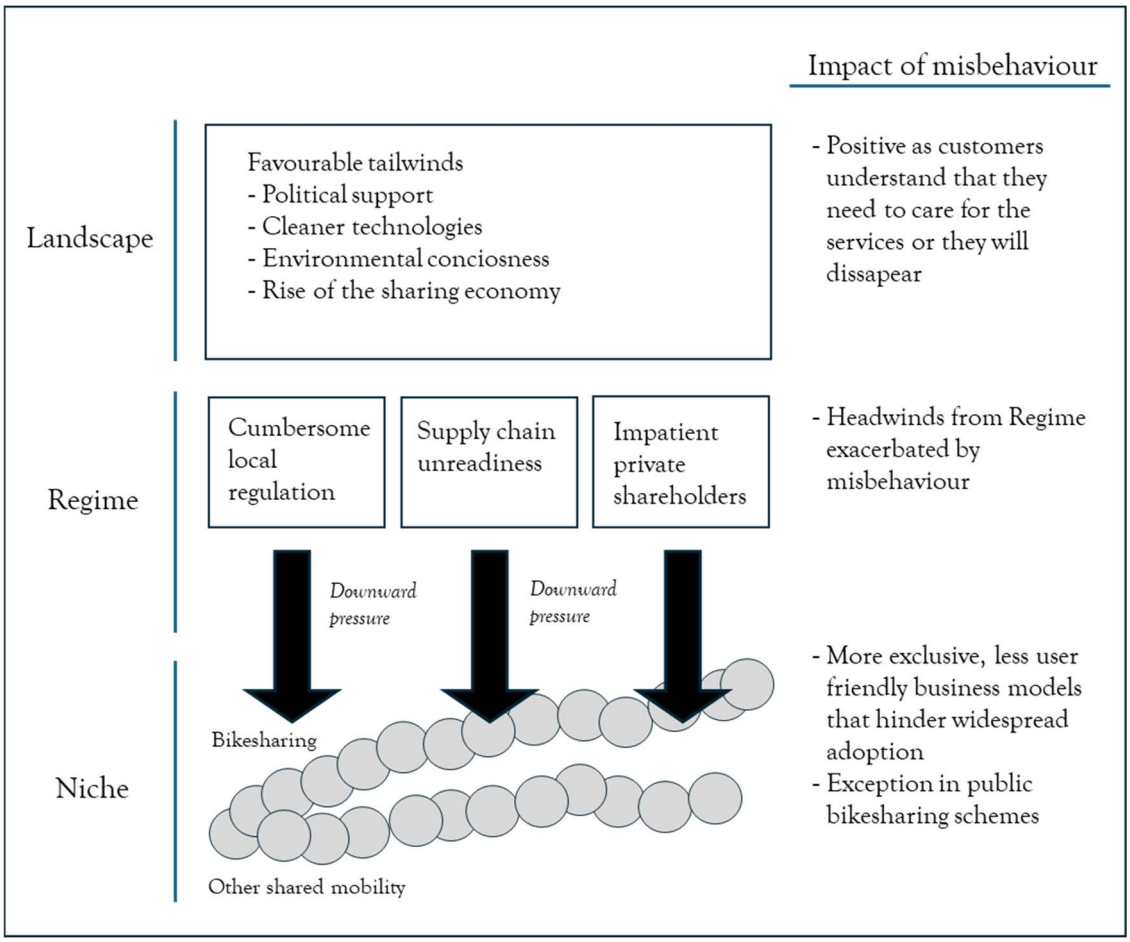


Figure 11. Impact of misbehaviour using the MLP framework

5.1 Niche level - Delayed widespread adoption

At the niche level, the evidence gathered suggests that in response to misbehaviour, companies evolved their business models in ways that hinder the wider adoption of their services. This delay in user adoption arises from two main factors. First, the service is increasingly becoming

an exclusive offering, with premium prices accessible only to a limited customer base. Second, adjustments to the business models of shared mobility operators often involve notable trade-offs that impact customer experience. Table 25 summarises the key findings which are discussed in detail in the remaining of the section.

Table 25. Impact of changes to business model that affect widespread adoption

Value component	Changes made to Business model	Making the product more exclusive	Worsening customer experience
Value Proposition	- Reduced service area - Switching off service at certain times - Minimum age	The customer sees that the use case is reduced to certain types of trips, and ceases to see the service as a real alternative to a private car	Frequent changes to the service area annoys customer base
Value Creation and Delivery	- New processes for interaction with client - Increased monitoring		The interaction with the service becomes cumbersome. Additionally, there is a negative reaction to being constantly "observed"
Value Capture	- Higher prices - Dynamic pricing	The customer base shrinks because the cost of using the service is considered too high.	The customer is confused and is not able to ascertain the cost of the service.

Companies have adapted their business models to offer a product that is less accessible and more expensive, increasingly targeting a narrower, wealthier customer base. The only exception is public bikesharing schemes. Service areas are becoming more restricted, effectively making them accessible only to higher-income customers and ultimately eroding public trust. Such a selective approach delays the broader adoption of these sustainable transportation options, as potential users turn to more reliable, though less sustainable, alternatives, such as private car ownership. Also, age limits in carsharing are aimed at avoiding young drivers who may show riskier driving behaviour, eventually increasing accident rates. However, this is a

segment that is less likely to own a car and that could benefit more from shared mobility, especially in trips to/from areas where public transportation is less frequent or convenient.

In terms of pricing, misbehaviour has driven up the cost for the customer in two primary ways. First, a general increase in prices to cover for higher direct and indirect costs. These include expenses, such as theft, battery replacements, fines for illegal parking, and rising insurance premiums, as discussed in section 4.3.2 on the impact of misbehaviour on operators. Additionally, indirect costs aimed at reducing misbehaviour, including investments in new technologies and increased operational expenses, contribute to this increase. As these services grow more costly and less convenient, they are increasingly catering to a wealthier, niche audience, which limits their potential for widespread adoption and delays the transition to sustainable transportation. Second, higher prices are used to manage demand, including dynamic pricing, making shared mobility services less accessible and appealing to a broader audience, thereby affecting affordability and inclusivity. As evidenced before, there are several examples of price increases of up to 40% in one single go.

At the value creation and delivery level, the introduction of new processes often results in a more cumbersome user experience (Carsharing_1.2). These processes include more complex onboarding procedures (Scooter_3), pre-authorizations, new security measures, and additional steps to complete a ride, such as taking photos (Motosharing_2) or installing additional locks (Bikesharing_2). Companies recognize the need to balance the benefits of these measures with their potential negative impact on customer experience. As Motosharing_2 stated: "We need to balance certain actions that educate our users, such as taking a picture when the service is finished, with the need to grow the business."The addition of monitoring technologies to track driving behaviour and ensure correct parking affects the value proposition by diminishing the sense of freedom customers expect. Carsharing_1.3 noted: "Customers don't like to think they are being observed," which can reduce the appeal of shared mobility services. This sentiment extends to other services as well, where scooter users, for instance, are required to park correctly and take a photo, which can feel intrusive.

Furthermore, at the value capture level, dynamic pricing, while intended to optimize revenue for operators, can frustrate customers. As Customer_1 shared, "It sucks that I have to pay more when I use it to come to work," indicating the potential for confusion and dissatisfaction when customers ignore the final price of their ride in advance.

These trends have been observed across all operators except for Bikesharing_1 and Bikesharing_2, which operate under public or semi-public schemes. In both cases, these companies have successfully maintained and even expanded their geographical footprint while improving vehicle quality and keeping prices low. As highlighted in the interviews, their ability to maintain the balance in tri-value creation is largely attributed to their status as subsidized services, with ownership retained by local authorities. This model allows them to operate as public services rather than profit-driven businesses, making such outcomes both feasible and acceptable within their framework.

5.2 Regime level – regressive trends that keep shared mobility under water

We have identified three trends that operate at the regime level and that are influenced by the vandalism and customer misbehaviour that shared mobility have experienced: an unsupportive regulation; impatient investors who demand almost immediate financial returns, and a supply chain that is not well developed yet.

At the regime level, misbehaviour strains the relationship between shared mobility operators and regulators, who have implemented policies aimed at addressing public concerns such as illegal parking, dangerous driving, and vandalism. Operators report that these policies are primarily reactionary and crafted at the city level, creating a fragmented regulatory landscape that complicates and often impedes the expansion of shared mobility services. Evidence from interviews and other sources reveals that in countries like Spain, the lack of a national, unifying framework for shared mobility leaves regulation to local authorities, resulting in a patchwork of divergent rules (ABC, 2024; El Mundo, 2019). This has led some operators to describe the regulatory landscape as a 'sudoku' (El Economista, 2023), complicating efforts to scale and innovate. The inconsistent regulations create an uneven playing field, with some operators adhering strictly to licensing criteria while others benefit from lenient enforcement. Scooter_2 described this as:

> *Creating unfair competition: we lost a tender a year ago because we didn't overstate the actions we could take if awarded the contract, for example in terms of community education. Others got the license but did nothing about it.*

Operators contend that these regulations are often politically motivated and lack a nuanced understanding of the industry, leading to increased operational costs and limited service areas. Carsharing_1.1 noted that cities "regulate merely for the sake of regulation," without considering broader impacts on sustainable mobility. Some operators express frustration over inconsistent treatment, arguing that regulators should "leave us alone, because they try to regulate a very dynamic environment with no success; the market self-regulates" (Motosharing_2). Motosharing_1.2 echoed this, pointing out that 'cities regulate with very little idea of how to do it,' while Scooter_2 highlighted that even when regulations exist, "the issue is that there is no enforcement from cities." Furthermore, operators feel that municipalities, which heavily subsidize public transport, act as direct competitors while simultaneously imposing restrictive regulations on private operators.

Additionally, the type of investor backing the operator seems to influence as well the strategies followed by each of them to tackle misbehaviour. All cars, motorbikes and scooters operators included in this study are funded by private investors, be financial investors or corporate investors , who required profitability in the short term. As explained earlier, the changes introduced to protect their profitability eventually reduced the attractiveness of the business to customers, delaying widespread adoption. However, in the case of public or semi-public backed schemes in bikesharing is different. The fact that these services are subsidized enables them to absorb the costs of misbehaviour while maintaining a coverage area and a pricing model that is still attracted to the wider public.

Finally, the supply chain has not evolved to provide ad-hoc vehicles at an attractive cost. Operators initially started their operations with off-the-shelf vehicles and although some adaptations were made (trunks for helmets and battery locks in Motosharing_1), the reality is that today specific shared mobility vehicles are very limited and not produced at scale. The main reason is that there is not enough volume for manufacturers to justify the investment. A notable exepction is station based bikesharing as promoted by public authorities. In this space, a large worldwide demand has enable the creation of pure players that specialised in developing strong, affordable bikes and stations that can withstand better different forms of vandalism and customer misbehaviour. Both Bikesharing_1 and Bikesharing_2 reported using the same supplier, a North American multinational.

In contrast, associated technology such us monitoring, geofencing, app development and fleet managemement seems to have evolved in a more positive way, probably given that their cost of development is lower than designing and building a new vehicle, for example app development is based on pre-existing software packages, and that the technology can be used elsewhere with little adaption. For example, fleet management software can also be used for car renting or logistics.

The challenges just described illustrate what Schot and Geels (2007) describe as a lack of alignment between niche innovations and the existing regime. Misbehaviour exacerbates this misalignment by introducing operational challenges that invite additional regulatory scrutiny. It puts additional pressure on private funders to tackle quickly misbehaviour without necessary thinking about the broader consequences for the sustainability of the businesses. Meanwhile, a key supporting industry such as vehicle manufacurers, does not develop vehicles specific for shared mobility that could help overcome some of the problems that misbehaviour causes to operators.

5.3 Future paths

The eventual transition pathways for shared mobility will depend on how the challenges discussed above, as well as others, are addressed. Geels and Schot (2007) identify several potential pathways for socio-technical transitions, including reconfiguration, technological substitution, and de-alignment and re-alignment. At present, sustainable urban mobility appears to be following a reconfiguration pathway, where niche innovations coexist with the established regime, driving incremental changes rather than fully disrupting it. Misbehaviour reinforces this pathway by limiting the potential for shared mobility to advance into a more disruptive technological substitution or de-alignment pathway, where it could replace private car ownership as the dominant regime. As a result, shared mobility remains constrained within its niche, unable to achieve its full potential as a transformative force in urban mobility. From our interviews, we identified insights related to the three regime elements previously discussed. These elements, if they were to evolve, could significantly support the development of shared mobility. Figure 12 summarises our findings.

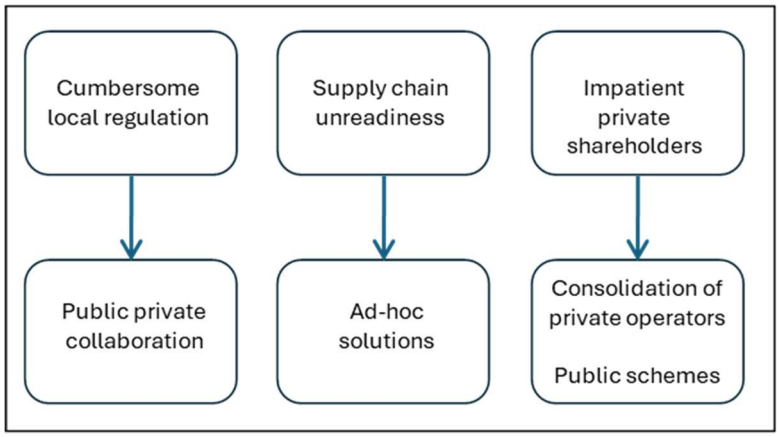


Figure 12. Changes in the regime that would favour shared mobility

Regulation plays a crucial role in shaping the future of shared mobility. On one hand, the European Directive on ambient air quality and cleaner air encourages the establishment of Low Emission Zones and parking restrictions which should favour the use in cities of electric shared mobility services over internal combustion private cars and motorcycles. In the particular case of Spain, the Climate Change and Energy Transition Act, enacted in May 2021, requires municipalities with more than 50,000 inhabitants to establish low-emission zones to combat air pollution. On the other hand, as misbehaviour decreases over time and the initial public concerns about safety and space usage subside, local authorities may need to revisit and adjust regulations. Collaborating with operators, they could develop a new framework that enables companies to achieve profitability while meeting environmental and social goals, namely ensuring vehicle availability across the entire city, not just in affluent or touristic neighbourhoods. In this context, public authorities and regulators could draw on principles from Strategic Niche Management (SNM), which emphasizes the importance of protecting niche innovations from mainstream competition and supporting them through controlled experimentation and learning processes (Schot & Geels, 2007). By working closely with operators, regulators can create favourable conditions that balance profitability with broader environmental and social objectives. A notable example of successful SNM is the development of organized carsharing in Switzerland, where niche protection allowed the service to thrive under supportive conditions and eventually expand its market presence (Kemp, Truffer & Harms, 2000). From the evidence gathered in this study, we observe elements of niche protection within public bicycle schemes, where local authorities actively invest in service improvements and encourage user adoption. However, this level of support does not currently

extend to private shared mobility operators, highlighting an area where regulatory intervention could foster a more inclusive and sustainable urban mobility ecosystem.

Technological advancements will continue to play a critical role in mitigating damages, minimizing inconvenience for citizens, and enhancing the functionality of shared vehicles to better accommodate shared use. Future vehicles "will need to be more functional, durable, and cost-effective" (Journalist_1). As Carsharing_2 noted, "Hopefully, there will be more vehicles specifically designed for sharing, at a low price, and with low accident rates." Such advancements are essential not only for improving the user experience but also for ensuring the financial sustainability of shared mobility services.

From the perspective of shareholders, consolidation within the shared mobility sector appears inevitable if operators are to achieve profitability. As Motosharing_1.2 emphasized:

> *There is no place for many operators. Maybe one or two, considering the huge size of the investment required, for example in technology. Operators need a minimum volume of activity.*

This observation highlights that only a few large players are likely to dominate the market, given the significant investments needed in technology and infrastructure. The sector's scale and market reach remain uncertain, with lingering questions about its ability to extend beyond its current niche. In Madrid, for instance, shared mobility accounted for only 1% of the total daily trips in 2021 (La Razon, 2021). As Carsharing_2 remarked, “The service is not a product for everybody.” Rising costs have made these services less accessible, and in some cases, such as scooters, they are primarily targeted at tourists with a high willingness to pay (Scooter_1). Journalist_1 noted: “I think the future is uncertain. There is not much demand, really. It is very niche, for young people.” However, the outlook appears brighter for public bikesharing schemes partially subsidized. According to Mordor Intelligence (2024), the European Bike Sharing Market is projected to double between 2024 and 2029, driven by government initiatives and investments aimed at improving cycling infrastructure and promoting sustainable transportation. As Scooter_3 observed, “If I had to bet on a particular shared mode, I would go for public bikesharing. The future is theirs.”

At the landscape level, several structural trends are creating favourable conditions for the expansion of shared mobility (McKinsey, 2023). First, there is a growing transition from individual to pooled vehicle use. Rising urban congestion and city-led policies to reduce private

car dependency, such as car-free zones, congestion charges, and reduced parking availability, are encouraging more consumers to adopt shared and flexible mobility solutions. Shared rides are becoming more cost-effective and convenient, reinforcing their appeal in dense urban environments. Second, urban mobility preferences are changing, with a shift from larger to smaller vehicles. Many consumers are increasingly favouring micromobility solutions, such as e-bikes and scooters, due to parking constraints, traffic congestion, and sustainability concerns. And third, technological advancements are facilitating a shift from driver-operated vehicles to autonomous, shared mobility services. The introduction of robo-taxis and robo-shuttles could provide more affordable and accessible point-to-point transport options, reducing the need for private car ownership and shifting value creation from traditional car-based shared mobility models to automated and pooled alternatives.

Finally, modifications at the business model level could also enhance the financial sustainability of operators, although their impact on social and environmental aspects remains unclear. For example, station-based or designated parking models help reduce operational expenses related to fleet management and minimize clutter in public spaces, but they come at the cost of reduced flexibility and area coverage. Additionally, in the specific case of carsharing, some operators are incorporating conventional internal combustion vehicles with longer ranges into their electric fleets to lower costs and expand service offerings to include daily or weekly rentals.

Chapter 6. From inclusive vision to niche reality: A conceptual model to explain shared mobility´s response to misbehaviour and its consequences

We develop our findings from Chapters 4 and 5 into a comprehensive conceptual process model to understand how shared mobility operators adapt to customer misbehaviour and the micro and macro implications of this adaptation. The model, depicted in Figure 13, extends Fombelle et al.'s (2020) customer deviance framework by illustrating how countermeasures adopted by companies to mitigate misbehaviour and vandalism lead to evolving business models. These adaptations, in turn, alter the original nature of the shared mobility model. The resulting changes influence not only the immediate economic, social, and environmental objectives (micro-level implications) but also the broader transition toward sustainable urban transport systems (macro-level implications).

The model integrates three primary conceptual frameworks discussed in Chapter 3: the Business Model Framework, the Triple Bottom Line Approach, and the Multi-Level Perspective (MLP) on socio-technical transitions. The Business Model Framework explains how misbehaviour impacts the core elements of shared mobility business models, driving adjustments in value propositions, value creation, and value capture, and providing insight into the processes companies follow in response. The Triple Bottom Line Approach assesses how these adaptations influence sustainability objectives across economic, social, and environmental dimensions. Finally, the MLP framework contextualizes these changes within the broader socio-technical landscape, illustrating how shared mobility interacts with existing regimes and transitions toward sustainable urban transport.

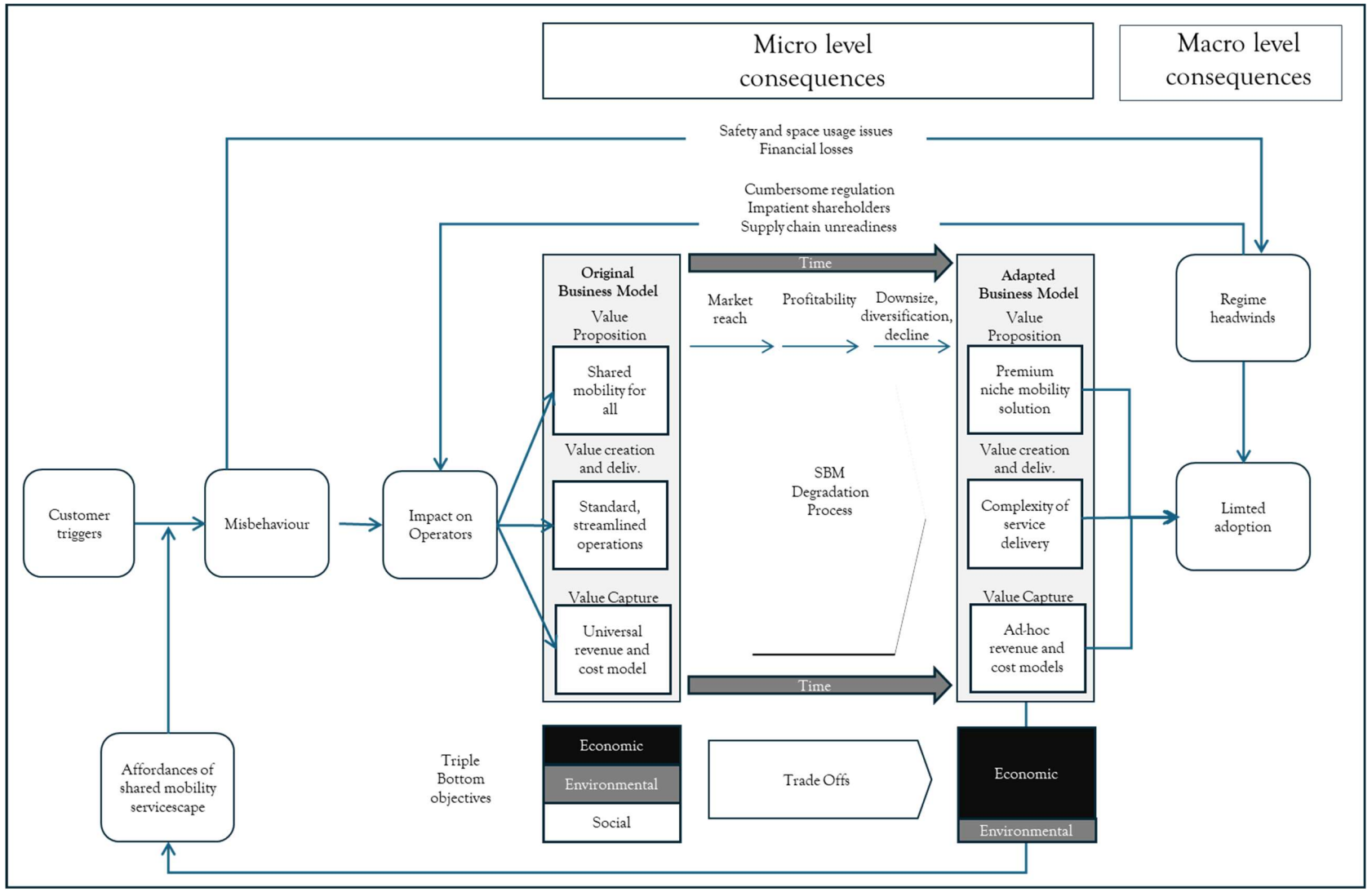


Figure 13. Conceptual model for SBM degradation and customer misbehaviour

The model identifies individual drivers of misbehaviour, such as financial incentives, thrill-seeking, neglect, and revenge, which are mediated by the servicescape and the unique affordances of shared mobility services. Key contributing factors include the lack of ownership, as vehicles are rented by the minute, and the 24/7 availability of vehicles on public streets with minimal supervision. Additionally, anonymity, both between users and with the service provider, further enables misbehaviour. This lack of traceability often prevents operators from identifying perpetrators or holding them accountable, creating an environment where users feel freer to engage in behaviors they might otherwise avoid. Moreover, the per-minute rental model incentivizes users to drive faster and park vehicles as quickly as possible to minimize costs, increasing the likelihood of reckless driving and improper parking. Finally, vehicle type also influences misbehaviour, with smaller, lighter vehicles—such as bicycles and scooters—being more susceptible to vandalism and misuse compared to larger vehicles like motorcycles or cars. Findings indicate that the economic impact on firms is significant, with substantial costs arising from repairing or replacing damaged assets and implementing countermeasures. Revenues are further reduced by payment fraud and vehicle unavailability. This cascade of issues, including fleet reductions and declining vehicle conditions, undermines the value proposition for customers, who perceive the service as less reliable and enjoyable.

Using the Business Model Framework, we analyse the strategies companies employed to manage misbehaviour. Evidence suggests these strategies transform business models across three dimensions: Value Proposition, Value Creation and Delivery, and Value Capture. To mitigate misbehaviour, operators have restricted service areas to regions with lower incidences of misbehaviour, suspended services during high-risk times (e.g., New Year's Eve), and introduced age restrictions for drivers in carsharing services. Vehicles have been adapted for shared use, incorporating technologies to monitor usage, while onboarding processes have become more rigorous and operational procedures more cumbersome. Pricing models have also been adjusted, including dynamic pricing mechanisms that impose higher fees on specific user groups (e.g., younger drivers) or use cases (e.g., nighttime trips).

The strategies adopted by shared mobility operators and their impact in their business models have followed a similar trajectory over time, shaped by management capabilities and objectives, shareholders´ priorities and the evolving dynamics of consumer behaviour, industry lifecycle, technological advancements, and regulatory changes. We call this process the degradation of

SBM. Three distinct phases have been identified: Market reach, Profitability and Downsize-Diversification-Decline. During the Market reach phase, operators typically relied on off-the-shelf technology and introduced services in cities with minimal regulation and limited competition. Initial responses to misbehaviour were often reactive and straightforward, addressing immediate challenges like battery theft or illegal parking. As the industry matured, it entered a stabilization phase characterized by custom technologies, stricter regulatory environments, and increased market saturation. Operators gained deeper insights into customer misbehaviour, prompting proactive investments in vehicles and onboard technologies, which are typically more expensive. Business processes, such as customer onboarding, were revised to enhance control, and new parking procedures were added to comply with regulations. Operators also adopted more selective customer acquisition strategies, targeting lower-risk users, and developed sophisticated pricing models to manage demand.

The business model adaptations made to mitigate misbehaviour have significant micro- and macro-level consequences. At the micro level, companies shifted away from broader social goals, prioritizing economic sustainability over inclusivity. This shift transforms their value proposition from "shared mobility for all" to a more exclusive "premium niche mobility solution," catering primarily to higher-paying customers in wealthier neighbourhoods. While companies claimed that environmental objectives remained a priority, this focus persists mainly because these goals align with economic interests.

At the macro level, misbehaviour impacts both niche and regime dynamics, hindering shared mobility's ability to challenge the car-centric system. At the niche level, business model adaptations delay widespread adoption, transforming shared mobility from an accessible urban solution to a costlier, niche service. Customer experience suffers due to added constraints and reduced service areas. At the regime level, local authorities introduce stricter regulations in response to misbehaviour, addressing issues like illegal parking, reckless driving, and vandalism. These regulations, while intended to manage public concerns, often impose costly adjustments on operators and degrade the customer experience. Also, private shareholders, concerned about the financial toll of misbehaviour, push for quick fixes that disregard long-term implications, ultimately reducing demand for services. Meanwhile, technology and vehicle providers are often unprepared for the challenges posed by

misbehaviour, delaying the development of tailored solutions for the shared mobility industry. This misalignment between niche innovations and regime-level factors, characterized by regulatory pressures, shareholder demands, and supply chain delays, significantly hampers shared mobility's potential to disrupt the current urban transportation regime, which remains heavily reliant on private car ownership.

Conclusions

Sustainable business models (SBMs) evolve over time, yet research on their post-establishment transformations remains limited. While much attention has been given to how business models innovate toward sustainability, less is known about whether they can sustain their promise of creating economic, social, and environmental value in the long run. Existing literature often assumes that SBM evolution is inherently beneficial across all three objectives. However, changes in SBMs do not always reinforce sustainability goals; instead, they can create trade-offs that compromise the balance between financial viability, social inclusivity, and environmental impact. This thesis contributes to this emerging discourse by examining an overlooked driver of business model evolution: customer misbehaviour. Shared mobility, a subset of Access-Based Services (ABS), is particularly susceptible to misbehaviour and vandalism, posing unique challenges for service providers. This study analyses the consequences of misbehaviour at two levels. At the micro level, it explores how shared mobility business models have adapted to mitigate misbehaviour. At the macro level, it examines how these adaptations impact the broader adoption of shared mobility as part of the transition toward a more sustainable urban transportation system.

This research employs a multi-method approach to provide a comprehensive understanding of the research problem. Study 1 adopts a deductive approach to examine the factors contributing to crashes in carsharing, drawing on a unique dataset of 2.2 million trips from a major carsharing operator in Madrid. The quantitative analysis reveals that crashes are more frequent among younger drivers and during nighttime hours. Insights from the literature, along with interviews with company executives and customers, suggest that misbehaviour may be linked to risk-taking tendencies among younger users and instances of illegal service use at night. Additionally, the findings indicate that occasional carsharing users are more prone to crashes compared to frequent users. Based on prior research, this could be attributed to a lack of psychological ownership, the sense of possessiveness and attachment toward a resource. While a detailed exploration of psychological ownership is beyond the scope of this thesis, the data suggests that familiarity and convenience may influence accident rates. Moreover, the electric nature of carsharing fleets may have contributed to higher crash rates due to distinct driving characteristics, such as quicker acceleration. This effect could have been more pronounced when electric vehicles were still relatively uncommon in Madrid, making drivers less familiar with their handling.

Building on these findings, Study 2 takes an inductive, multi-case approach with a longitudinal perspective, drawing from in-depth interviews with managers, experts, and archival data to explore how shared mobility operators adapt their business models to address misbehaviour and vandalism. The analysis highlights significant consequences at both micro and macro levels.

At the micro level, the adaptations made to mitigate misbehaviour significantly alter shared mobility business models, compromising their social objectives in favour of profitability and survival. We call this process, the degradation of SBM. Companies shift from offering "green shared mobility for all" to providing a "premium niche mobility solution" that caters to a smaller, wealthier customer base. The only exception is public bikesharing, which followed a different trajectory, likely due to the support of public subsidies. While environmental objectives remain a stated priority, their alignment with economic interests—such as recycling practices that reduce costs—may explain their persistence. However, these benefits were likely offset by the additional waste generated from replacing vandalized or stolen assets.

At the macro level, misbehaviour impacts shared mobility in two critical ways. First, business model adaptations at the niche level hinder the broader adoption of shared mobility services, transforming them into exclusive offerings accessible to a limited customer base. These adjustments often involve trade-offs that negatively affect customer experience. Second, misbehaviour elicits strong reactions from the existing regime, with local authorities responding to public concerns over issues like illegal parking, reckless driving, and vandalism by introducing stricter regulations. While these regulations aim to address public grievances, operators often perceive them as excessive or arbitrary, creating additional barriers to the expansion of shared mobility services. Furthermore, impatient investors seeking rapid financial returns push managers toward short-term fixes that ultimately limit the services' accessibility and inclusivity. Compounding these challenges, supply chains initially fail to provide fit-for-purpose tools and technologies to address misbehaviour and vandalism effectively.

In conclusion, this thesis demonstrates that Sustainable Business Models (SBMs) do not always evolve toward greater sustainability; instead, they can degrade when faced with persistent customer misbehaviour. This degradation alters the balance between economic, social, and environmental objectives, often favoring financial survival at the expense of accessibility and

inclusivity. Additionally, this research highlights how misbehaviour not only disrupts individual business models but also slows down the broader transition to sustainable urban mobility. By analyzing these dynamics at both micro and macro levels, the thesis provides key insights into the challenges faced by SBMs, particularly in the shared mobility sector, and underscores the need for innovative solutions that integrate financial viability with long-term sustainability goals.

Contributions

This thesis makes significant theoretical and empirical contributions to the fields of Sustainable Business Models (SBMs) and business model evolution, customer deviance, and socio-technical transitions.

The first theoretical contribution of this thesis is to the literature on SBMs and business model evolution, with a particular focus on Access-Based Services (ABS). While numerous studies have examined how business models innovate toward sustainability (Bocken & Gerardts, 2020; Mignon & Bankel, 2022; Zollo et al., 2013), they have largely overlooked the transformations that SBMs undergo once established (Cosenz et al., 2019; Moggi & Dameri, 2021). By drawing on the Business Model Framework and the Triple Bottom Line (TBL) approach, this research develops a conceptual framework that explains how shared mobility business models degrade when they fail to maintain the promise of tri-value formation in the face of customer misbehaviour, a factor largely neglected in business model evolution studies. This thesis also contributes to the reconceptualization of consumer roles in business model transformation. Existing literature has theorized consumers as accepters or rejecters of value propositions (Clausen & Fichter, 2019; Priem et al., 2018); however, this research extends this understanding by demonstrating that consumers-as-harmers can also drive business model evolution.

Furthermore, this thesis expands the understanding of antecedents that contribute to failures in balancing economic, social, and environmental objectives by identifying technological limitations and regulatory constraints as additional drivers, beyond the commonly cited pressures from shareholders. Regarding shareholder priorities, private mobility operators, under pressure to deliver rapid financial returns, are often forced into short-term decision-making that ultimately alters their original business vision. This pressure frequently leads to a shift from an inclusive shared mobility model to a niche-focused approach, catering to less

price-sensitive customers in select geographic areas. In contrast, publicly funded bikesharing services, supported by government subsidies, can maintain a long-term vision of mobility for all, without compromising inclusivity. Beyond shareholder influence, this thesis highlights the role of technology and regulation as additional antecedents shaping the strategic evolution of shared mobility business models. Technological limitations often force companies to make suboptimal operational decisions. For instance, the inability to remotely control vehicles or accurately attribute culpability for misbehaviour frequently compels operators to reduce service areas as a means of mitigating vandalism and customer misconduct. Similarly, regulatory constraints impose additional pressures. For example, geofencing requirements for designated parking zones may force companies to eliminate service areas entirely to avoid compliance burdens. While such measures are often pragmatic from an operational standpoint, they frequently come at the expense of accessibility and inclusivity, ultimately undermining the social objectives of SBMs.

The second theoretical contribution of this thesis is to the literature on customer deviance. While some studies conceptualize customer deviance as a linear process (Fombelle et al., 2020), identifying triggers, types of deviant behaviour, and corporate responses, much of the literature focuses on specific misbehaviour types and their direct consequences for firms, employees, or other customers (Echeverri, Salomonson & Åberg, 2012; Fisk et al., 2010; Sommovigo et al., 2019). However, this thesis reveals that misbehaviour management is far more dynamic and complex than previously suggested. Our findings indicate that the strategies companies adopt to address misbehaviour are not static but evolve over time, influenced by internal and external factors. This process-oriented approach provides a dynamic perspective on misbehaviour management, illustrating how existing know how and management readiness, technological advancements, regulatory shifts, and industry competition influence which measures are taken and when. For instance, shared mobility operators often rely on reactive, quick-fix, and cost-effective measures during their initial operations. These strategies, while expedient, are designed to address immediate challenges and are typically constrained by the limited financial resources available at the company's inception and the available technology. For example, technologies such as geofencing, which were not commercially available when many shared mobility businesses launched, now provide new ways to monitor and manage customer behaviour. Similarly, the reliance on commercially available vehicles not purpose-built for shared mobility constrains the measures companies can implement. As

these businesses mature, they gain access to a wider range of technology solutions and tend to adopt more sophisticated, robust, and resource-intensive measures that address the evolving complexity of their operations and broader challenges. Throughout this adaptation process, regulatory frameworks also evolve. Initially minimal or non-existent, these frameworks add burdens to customer experiences, such as mandating parking in designated areas and restricting potentially effective measures like facial recognition.

The conceptual model developed in this research also highlights how the cumulative effects of these corporate strategies lead to substantial business model changes. These changes, in turn, alter the affordances available to customers, influencing the very triggers that drive customer deviance. In the ABS context, this research identifies additional affordances that facilitate misbehaviour, beyond the commonly cited lack of ownership, minimal supervision, and interpersonal anonymity. These include: the 24/7 availability of vehicles on the streets, the difficulty of identifying perpetrators, the specific pricing schemes and the type of vehicle.

The third theoretical contribution of this thesis advances the literature on socio-technical transitions and sustainable mobility. Prior research has primarily focused on the resistance posed by elements of the existing regime, such as the automotive industry, policymakers, and infrastructure, as well as the challenges associated with customer adoption of new products or services. However, the detrimental effects of customer misbehaviour and vandalism on these transitions have been largely overlooked. This thesis addresses this gap by systematically analysing how such behaviours challenge shared mobility services, hinder their scalability, and limit their potential to disrupt the prevailing car-centric regime. At the regime level, while existing studies recognize the supportive role of policy in fostering niche development, they often fail to consider how regulations introduced in response to customer misbehaviour can unintentionally constrain niche growth. Additionally, this research highlights how shareholder pressure for rapid financial returns and an unprepared supply chain creates additional barriers to the scalability and long-term viability of shared mobility.

Furthermore, frameworks like the Multi-Level Perspective (MLP) often overlook the dynamic adaptations of niche innovations in response to external challenges. This research enriches the MLP by proposing a conceptual framework that captures these evolving processes and highlights the reciprocal relationship between customer misbehaviour and business model evolution. Moreover, the empirical evidence presented in this thesis helps bridge the gap

between micro- and macro-level analyses. By employing a multi-method approach, combining qualitative insights from industry experts with quantitative analysis of carsharing data, this research connects organizational strategies to broader socio-technical transitions. It demonstrates how micro-level changes in business models, driven by customer misbehaviour, shape macro-level outcomes within the sustainable mobility regime.

Empirically, this research provides rich qualitative evidence drawn from interviews with industry executives and experts, who shared candid insights on a topic rarely explored in depth. General managers and CEOs were interviewed to offer broad, strategic perspectives on company operations. To complement these views, managers specializing in technology, customer experience, and fleet management contributed detailed insights into operational areas directly affected by customer misbehaviour. As the study evolved, additional experts were consulted in fields that became increasingly relevant, such as insurance, mobility strategy, and business model innovation. Although limited, the study also incorporated the perspectives of customers to better understand the phenomenon. These interviews were supported by an extensive review of over 6,000 press articles, historical and current websites, and industry reports. Furthermore, the study on carsharing crashes provides unique insights derived from a proprietary database of 2.2 million trips from a carsharing operator in Madrid. This dataset extends the scope of existing research on carsharing crashes, which has predominantly focused on contexts such as Australia and the United States. Additionally, it introduces a new factor for consideration: the impact of the number of previous trips completed on the platform.

Practical Applications

The findings from this dissertation offer valuable insights for practitioners and policymakers. For SBM managers, the proposed conceptual model provides a framework to holistically understand the consequences of their business model decisions and better navigate trade-offs between economic, social, and environmental objectives. This research underscores the need to address misbehaviour beyond a profit-and-loss perspective, considering its impact across the entire business model. By integrating value proposition, value creation and delivery, and value capture, managers can develop holistic strategies that mitigate external factors such as misbehaviour while balancing the economic, social, and environmental goals of sustainable business models. For shared mobility operators, in particular, it offers guidance on

implementing changes to manage customer misbehaviour, enhance safety, and promote sustainable mobility solutions. The circular framework proposed in this thesis provides deeper insight into how countermeasures not only shape immediate outcomes but also reshape business models, ultimately influencing the triggers of customer misbehaviour.

Shared mobility providers can also apply these insights to design services that proactively reduce misbehaviour. For instance, integrating features like geofencing to ensure proper parking or telematics to encourage safer driving can significantly improve user behaviour and reduce operational disruptions. Managers might foster psychological ownership among users by introducing loyalty programs or subscription packages, encouraging occasional users to become regulars and promoting a sense of care and responsibility toward the service. Additionally, targeted safety strategies—such as adaptive pricing during high-risk periods or personalized safety communications sent before and after trips—can further reduce incidents and enhance the user experience. Optional online training for new users, focusing on safe driving practices and operational guidelines, could also play a role in mitigating risks. Community engagement presents another avenue for addressing misbehaviour. By working with local organizations or launching public campaigns, shared mobility companies can foster a sense of shared responsibility among users, reducing vandalism and promoting more respectful behaviour. Moreover, proactive incident management systems that empower users to report issues can enhance trust and enable companies to respond more effectively. Further research, through field experiments, should examine whether these strategies are effective at curbing customer misbehaviour

For policymakers, this research highlights the potential of subsidized models in promoting SBMs that balance economic, social, and environmental objectives. In shared mobility, subsidies can extend the reach of services to underserved populations, ensuring affordability and inclusivity while supporting sustainability goals, like the approach taken with public bikesharing systems. By offsetting costs associated with implementing safety features or expanding service areas, subsidies can help operators maintain their commitment to equitable access without compromising financial viability. Policymakers could further tie subsidies to performance metrics, such as accident reduction rates or inclusivity improvements, to align public and private objectives and encourage long-term societal benefits. Infrastructure development is another key area where policymakers can make a difference. Creating well-lit,

secure parking zones or expanding dedicated bike lanes can enhance user safety and reduce incidents of vandalism. Governments can also encourage industry-wide standards for safety and misbehaviour management, ensuring consistency and transparency across providers. Educational campaigns targeting users can raise awareness about the proper use of shared mobility services, emphasizing the shared benefits of these systems and the importance of responsible behaviour.

Collaboration between managers and policymakers is essential for creating the right environment for SBMs to flourish and maintain their goals. For shared mobility, public authorities and regulators could leverage principles from Strategic Niche Management (SNM), which emphasizes the importance of shielding niche innovations from mainstream competition. By working with operators within a framework of controlled experimentation and learning, policymakers can foster innovation ecosystems where companies, governments, and communities collaborate to develop solutions for shared mobility's most pressing challenges. Additionally, policymakers and companies could co-develop sustainability metrics to measure the impact of misbehaviour and mitigation strategies on the Triple Bottom Line, ensuring that shared mobility solutions remain aligned with broader societal objectives.

Ultimately, this research equips managers and policymakers with the tools to navigate the trade-offs inherent in sustainable mobility. By understanding and addressing the root causes of misbehaviour and its broader implications, both groups can ensure that shared mobility solutions contribute meaningfully to a more inclusive, safe, and sustainable transportation ecosystem.

Limitations and Future Research

This thesis, while comprehensive in its approach, acknowledges several limitations that impact both the generalizability and scope of its findings. These limitations fall into three main areas: data availability, context specificity, and the evolving technological and regulatory landscape.

A primary limitation in data availability concerns the scope and specificity of the dataset used in Study 1. The analysis was limited to crashes involving vehicles that required external repair, with only 58% of these incidents directly linked to a user. This exclusion raises potential biases, as unaccounted incidents might exhibit unique patterns or be influenced by additional factors not captured in this study. Moreover, the dataset does not include information on

drivers' prior experience with electric vehicles or other carsharing platforms, which limits a more detailed assessment of how familiarity with shared mobility services influences behaviour. In Study 2, confidentiality constraints prevented access to detailed financial data from the operators examined, which could have helped quantify the economic impact of customer misbehaviour. Also, we could not obtain evidence of the evolution of the environmental footprint of operators, limiting a more nuanced and precise analysis of how this form of value evolved. Additionally, the perspectives of individuals who feel excluded by these services were not included, limiting a fuller understanding of social inclusivity and accessibility challenges within shared mobility services.

In terms of context specificity, both studies rely on data from shared mobility operators in Spain, although some of the operators were established as well in other countries. This focus makes the findings highly context-dependent, shaped by unique cultural norms, traffic patterns, and city layouts that may not reflect the circumstances in other regions. Although the types of misbehaviour are likely the same, their prevalence may change in other countries. Additionally, the study does not explore in detail the differences between types of investors backing the companies. Variations in investor characteristics, such as financial resources, risk tolerance, and expectations for returns, may shape company responses to misbehaviour, with higher-risk tolerance investors likely supporting longer-term, preventive strategies, while those seeking quick returns might favour short-term solutions. This investor diversity could lead to differing strategic adaptations across shared mobility providers. Also, other measures may be implemented in other countries since, our study shows, the measures undertaken to tackle misbehaviour depend on the internal capabilities of operators, their relationships with suppliers and available technology. Replicating this study across diverse geographies could reveal other changes in their business models. The study also focuses on shared mobility as a form of Access-Based Services (ABS), which may limit the transferability of findings to other ABS sectors, such as tool-sharing or fashion rental, where assets and usage dynamics differ, and customer identification may be more straightforward.

The evolving technological and regulatory landscape of the shared mobility sector presents additional challenges. Rapid technological advancements, such as enhanced surveillance and predictive analytics, along with shifting regulatory frameworks could change the strategies noted for managing misbehaviour. Ongoing research is needed to monitor how new tools and

policies influence customer behaviour and shape companies' strategies for managing misbehaviour, allowing for adjustments in real time as the sector adapts.

Future research lines

This study also opens fruitful lines of inquiry. First, in relation to Study 1, future research should aim to better understand the latent factors linked to previous usage patterns and introduce additional variables to enhance our understanding of factors contributing to carsharing-related crashes. A more comprehensive exploration of the psychological elements at play, particularly regarding concepts of ownership and perceived service value, would enrich insights into the motivations behind misbehaviour. To complement the quantitative data used in this study, future research could adopt in-depth qualitative methods, such as interviews with accident-prone users, broader customer surveys, and detailed case studies. These approaches would offer a more holistic perspective on the factors contributing to crashes, potentially guiding the design of more targeted and effective mitigation strategies. Additionally, experiments could be developed to test the effectiveness of interventions aimed at fostering a sense of psychological ownership among users, evaluating their impact on reducing crash rates and improving overall safety in shared mobility services.

Second, further research could also focus on understanding the decision-making processes of managers in shared mobility companies, especially regarding strategies for addressing customer misbehaviour and vandalism. This might include investigating the types of data managers rely on, the analytical methods they use, and any adaptations to management practices or organizational structures that result from these insights. By uncovering the internal processes that inform companies' strategic responses, such studies could reveal important factors that shape how organizations respond to operational challenges arising from misbehaviour.

Third, while this study highlights customer misbehaviour as a key driver of business model degradation in shared mobility, future research could adopt a more holistic approach by examining additional factors that may contribute to this process. Elements such as parking availability, population density, and access to public transportation likely play a significant role in shaping service footprints, pricing strategies, and operational constraints. Moreover, while price increases have been linked to rising costs associated with misbehaviour, they may also reflect broader commercial strategies driven by market demand and competitive positioning.

Investigating these factors in conjunction with customer misbehaviour could provide a more comprehensive understanding of the trade-offs that operators face when adapting their business models.

Fourth, a deeper investigation into the financial and environmental implications of customer misbehaviour and the influence of investor expectations on company responses would provide further insights into the sustainability of shared mobility business models under different financial constraints. By examining the economic pressures and financial strategies adopted by companies with varying investor profiles, researchers could gain insights into the sustainability of shared mobility business models under different financial constraints. Investor backing—whether characterized by high-risk tolerance, long-term orientation, or the need for quick returns—could significantly shape the adaptive measures companies implement, providing important context for understanding shared mobility's long-term viability.

Fifth, cultural and socio-economic contexts also play a role in shaping the prevalence and nature of customer misbehaviour in shared mobility. Comparative studies across different regions and countries could extend the generalizability, while identifying region-specific challenges and effective solutions. Such research could enhance our understanding of how cultural norms and socio-economic factors influence customer behaviours and how companies might tailor their strategies to different cultural settings.

Sixth, studying the social trade-offs within shared mobility services is another promising research avenue. This line of inquiry could investigate how different measures to curb misbehaviour affect various customer demographics, potentially revealing unintended consequences that exacerbate social inequalities.

Finally, future research could broaden the scope of study to include other Access-Based Services (ABS) beyond shared mobility, such as fashion rental, tool-sharing platforms, or peer-to-peer lending. By examining customer misbehaviour in these other ABS sectors, researchers could identify both common patterns and unique challenges, enabling a more comprehensive understanding of misbehaviour across diverse contexts and asset types. Such comparative analysis would contribute valuable insights into the broader dynamics of access-based business models, customer engagement, and sustainable business models.

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Appendix

Initial interview guide

A. <u>Interviews with Experts</u>

1. Introduction

1.1. Could you briefly describe your role within the company and your experience in shared mobility operations?

1.2. Can you give an overview of the company's history?

1.3. What are the key success factors of this business?

2. Understanding of Customer Deviance

2.1. How do you define customer deviance within the context of your shared mobility services? Has this definition evolved over time?

2.2. Can you share some examples of common types of misbehaviours or deviance observed among users of your services? Have you noticed that they have changed over time?

2.3. How do these misbehaviours impact your operations and the overall customer experience?

2.4. Have you experienced incidents of vandalism by individuals who are not customers of your service?

2.5. How does vandalism by non-customers differ in impact and handling from customer deviance?

2.6. What types of vandalisms are more common?

2.7. Do you experience differences between cities?

3. Identification and Measurement of Deviance

3.1. What processes or systems do you have in place to identify and monitor customer deviance?

3.2. How do you quantify or measure the impact of these behaviours on your service and operations?

3.3. Are there any specific indicators or metrics that you find particularly useful in tracking customer deviance?

3.4. Do you categorize the impacts?

3.5. Any difference in how you identify and measure vandalism? For example What mechanisms are in place to detect and respond to vandalism incidents involving your shared mobility assets?

4. Management/changes to Business model

4.1. Can you discuss any significant changes you've made to your business model or operations in response to customer deviance/Vandalism? Please answer trying to follow a chronological order

4.2. Have there been any instances where customer misbehaviour led to a reevaluation of your service policies or features? If so, could you elaborate on these changes?

4.3. Can you provide examples of how technological advancements (e.g., GPS tracking, app-based controls) have been utilized to address customer misbehaviours?

4.4. Have you used other means, such as persuasion, appeals, etc.?

4.5. How do you collaborate with local authorities or other stakeholders in addressing and preventing vandalism?

4.6. How do you balance the need for operational adjustments with maintaining a positive customer experience?

4.7. How do you involve customers in the process of creating a more responsible and respectful user community?

4.8. What preventive measures have been implemented to protect your assets from vandalism by non-customers?

4.9. Are there any community engagement or public awareness initiatives you've undertaken to reduce the incidence of vandalism?

4.10. Do you have a common approach for all cities? If not, why?

5. Challenges and Lessons Learned

5.1. What have been the biggest challenges in dealing with customer deviance, and how have you addressed them?

5.2. What are the main consequences for the business model definition or how the business is operatated?

5.3. Based on your experience, what lessons have been learned in managing and adapting to customer misbehaviour in shared mobility?

6. Future Outlook

6.1. How do you see customer deviance evolving in the context of shared mobility, and what future strategies are you considering to address it?

6.2. Are there any emerging trends or technologies that you believe will significantly impact how you manage customer deviance?

7. Closing

7.1. Is there anything else you would like to share that we haven't covered, related to customer deviance and its impact on your business?

7.2. Do you have any advice for other shared mobility operators facing similar challenges with customer deviance?

B. <u>Interviews with Customers</u>

1. Which type of mobility operators have you used in the past?
2. What frequency?
3. Why do you use it? Cheap? Convenient?
4. Have you seen an evolution of the services provided? (customer tradeoff)

5. What type of misbehaviour do you know about?
6. Have you committed any? Do you know anyone?
7. Why do you think they do it?
8. What consequences do you think it has for you as a customer?
9. Companies mention that they have adapted to manage misbehaviour and vandalism. Have you notice any changes?
10. Are you happy with the area covered? And with the pricing? Have you seen an evolution?