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Environment and Sustainable Development Program

The Co-design of MaaS-Lite Bundles by Commuters in Bahrain: Environmental Implications of Customization Decisions and Bottom-up Mobility Planning

A Thesis Submitted in Partial Fulfilment of the Requirements for the Doctor of Philosophy Degree in Environment and Sustainable Development

Submitted by:

Naser Ayman Naser

202008060

Supervised by:

Dr. Tariq Mahmood

Associate Professor

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Thesis Discussion Committee Decision

Form Code: UDNGS013

Student Name:	Naser Ayman Mohamed Saeed
Student ID. No.	202008060
Department:	
College:	Science
Program:	Ph.D. in Environment and Sustainable Development
Student GPA:	3.81
Thesis Title:	The Co-design of MaaS-Lite Bundles by Commuters in Bahrain: Environmental Implications of Customization Decisions and Bottom-up Mobility Planning

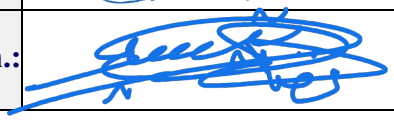
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The student is awarded the grade Pass **in the thesis course** ESD798

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■ **After making the modifications attached with this decision.**

Discussion Committee Members Approval:

1.	**Supervisor Name:**	Dr. Tariq Mahmood	**Sign.:**	
2.	**Internal Examiner:**	Dr. Ezzat Khan	**Sign.:**	
3.	**External Examiner:**	Prof. Nedal T. Ratrout	**Sign.:**	

Abstract

This study centers on the emergent mobility concept termed Mobility as a Service or (MaaS) and its sustainable implications on transportation within the Kingdom of Bahrain. Therein, a narrowed focus on a single journey type (commuting to either a workplace or Higher Education Institution) and transport options available in Bahrain is adopted.

A mixed-methods approach comprised of both thematic and statistical analyses is adopted to interpret survey data collected from passengers to better understand their attitudes and perceptions towards different transport modes and their environmental impacts. Even though key findings strongly suggest a continuing preference for car-based transport options (along with the heightened specter for modal displacement of public transport offerings), the establishment of initiatives specifically based on the introduction of alternative transport modes, wider use of emissions labelling and pricing, and awareness campaigns have empirically emerged as promising options for stimulating a transition towards sustainable mobility within the Kingdom. All of which have been determined based on the inclusion of survey questions (that generated 302 responses) that assess the mobility habits and preferences of passengers in Bahrain and when travelling abroad to foreign countries and three proxy Pro-Environmental Behavior questions focusing on environmental consciousness.

On a conceptual level, the study also demonstrates the ongoing diversity in how MaaS is constantly being defined and redefined (in the form of newer concepts) in both a homogeneous and heterogeneous manner with the former creating unnecessary duplication and overlap. Thus, the study concludes with a proposed framework that captures the different MaaS concepts based on common parameters that have emerged from an extensive review of the literature. And, also, a refined version MaaS befitting the scope of this study is also proposed: (C-MaaS) or (Commute-Mobility as a Service) which stands as a journey-specific crossover between the already established University as a Service and, the more prevalent, Corporate Mobility as a Service conceptualizations.

Lastly, the adoption of emissions modelling techniques for more detailed analysis of the sustainability and emissions impact of (MaaS), specific subgroups (blue-collar vs white-collar

employees), and socioeconomic (i.e., income levels) in Bahrain are proposed as areas for future research and consideration.

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Glossary of Terms, Abbreviations, and Acronyms

AaaS: Accessibility as a Service

AE-MaaS: Autonomous Electric Mobility as a Service

AI : Artificiel Intelligence

API: Application Programming Interface

CaaS: Cycling as a Service

CMaaS: Corporate Mobility as a Service

CSV: Comma-Separated Values

CtG: Cradle to Gate

DDM: Design, Development, Marketing

DMO: Destination Marketing Organizations

DSS: Decision Support System

E-D Logic: Environment-Dominant Logic

ECSaaS: Electric Car Sharing as a Service

EIF: Environmental Impact Functions

eMaaS: Electric Mobility as a Service

EU: European Union

EV: Electric Vehicle

FMLM: First Mile Last Mile

FTO: Freight Transport Operators

FTS: Flexible Transport Systems

G-D Logic: Goods-Dominant Logic

GCC: Gulf Cooperation Council

GDPR: General Data Protection Regulation

GSO: Gulf Standardization Organization

HEI: Higher Education Institutions

HOV: High Occupancy Vehicle

ICEV: Internal Combustion Engine Vehicle

IMF: International Monetary Fund

IMI: Intermediary MaaS Integrators

IoMS: Internet of Mobility Services

ITS: Intelligent Transportation Systems

JSON: JavaScript Object Notation

KSA: Kingdom of Saudi Arabia

LaaS: Logistics as a Service

LCA: Life Cycle Analysis

LMI: Level of MaaS Integration

LSP: Logistics Service Providers

MaaF: Mobility as a Feature

MaaS 2.0 (CaaS): Collaboration as a Service

MaaS: Mobility as a Service

MaaS4PaF: Mobility as a Service for Passengers and Freight

MaaSINI: Mobility as a Service Inclusivity Index

MB-MaaS: Mobile Blockchain Mining as a Service

MENA: Middle East and North Africa

MII: MaaS Integration Index

ML : Machine Learning

MLP : Multi-Level Perspective Theory

MMI: MaaS Maturity Index

MOD: Mobility on Demand

MTT: Ministry of Transportation and Telecommunication

O-D: Origin-Destination

PAX: Passenger

PAYG- Pay as You Go

PEB: Pro Environmental Behavior

PKT: Passenger Kilometers Travelled

PMT: Passenger Miles Travelled

POI: Point of Interest

PPM: Push-Pull Mooring

PPP: Polluter Pays Principle

PSS: Product Service System

PT: Public Transportation

PTO: Passenger Transport Operators

RH: Ride-Hailing

RmaaS: Regional Mobility as a Service

S-D Logic: Service-Dominant Logic

SOV: Single Occupancy Vehicle

TAM: Technology Acceptance Model

TaaS: Transportation as a Service

TDM: Transport Demand Management

TNC: Transport Network Company

TPB: Theory of Planned Behavior

TSM: Transport System Models

TtW: Tank to Wheel

TXT: Text file format

UaaS: University as a Service

UITP: *Union Internationale des Transports Publics*

UTAUT : Unified Theory of Acceptance and Use of Technology

UmaaS: Urban Mobility as a Service

VKT: Vehicle Kilometers Travelled

VMT: Vehicle Miles Travelled

WaaS: Walking as a Service

WTP: Willingness to Pay

WtT: Well to Tank

WTU: Willingness to Use

WtW: Wheel to Wheel

XaaS: Everything as a Service

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Chapter 1. Introduction

This study pursues a twofold objective by, firstly, exploring the burgeoning mobility concept known as Mobility-as-a-Service (MaaS) along with its theoretical and conceptual development. Secondly, the study adopts a refined sandbox variant of MaaS on the basis of available public transport options in Bahrain and focuses on a single journey type: Commuting to either the workplace or Higher Education Institutions.

The latter objective is then used to offer a lens into how MaaS might be introduced in the Kingdom along with the expected attendant grassroots/bottom-up impacts – i.e., modal displacement (shift towards less sustainable transport modes); acceptance/rejection of pull-push strategies towards less polluting, higher-capacity mobility offerings in line with UN SDG Target 11.2; and ways through which a meaningful and stable socio-technical transition towards the acculturation of sustainable mobility habits and behavior can be fostered.

Visibly, the key factors perpetuating the dominance of Single-Occupancy Vehicle, as possibly the highest form of unsustainable transport, within the Kingdom of Bahrain range from those grounded in pragmatism (perceived lack of available alternatives), ethnoreligious (privacy for women) and sociocultural (cars viewed as status symbols) values, and historical path dependence (overwhelming and disproportionate national policies towards expansive road projects to address mobility concerns)

Altogether, this lends further credence to the need for participative, bottom-up mobility planning when formulating, given the variety of aforementioned factors, a multipronged strategy comprised of Push-Pull and Hard-Soft policies to stimulate a socio-technical transition towards not only currently available transit options (i.e., Bus Services) but also options that are in the pipeline (i.e., Bahrain Metro) – through, again, the fostering and acculturation of sustainable urban mobility habits and behavior.

The first chapter '*Introduction'* focuses on providing on an introductory lens into the concept of MaaS, the key research objectives, and significance. The second chapter *'Literature Review'* extensively delves into the MaaS literature and scholarship highlighting key variants and conceptual heterogeneity, sustainability implications of MaaS, along with a broader focus on sustainable mobility developments within Bahrain and the GCC. Moving on to Chapter three

'Research Methodology', the focus shifts towards discussing the key methodologies adopted in this study along with their strengths and limitations along with additional protocols adopted in sampling, treating, and analyzing the data. In chapter 4 *'Findings and Results'*, detailed findings from both the thematic and statistical analyses are provided and analyzed. Chapter five *'Discussion and Recommendations'* concludes this study by highlighting and discussion the core theoretical and practical contributions. References and key appendices are provided thereafter.

1.1 Genesis of Mobility as a Service

Accurately chronicling the emergence of MaaS is slightly illusive considering that the integrating of disparate transport modes and correction of transportation supply and demand imbalances through the deployment of technology, as part of the *Intelligent Transportation Systems* (ITS) discourse, has long predated MaaS (Castellanos et al., 2022; Pangbourne et al., 2020).

Concepts that preceded, and helped culminate in the emergence of, MaaS also range from 'flexible travelers', 'combined mobility', 'integrated mobility solutions' (Kostiainen & Tuominen, 2019; Smith & Hensher, 2020), and 'smart sustainable mobility' (Milne et al., 2024). Initiatives such as *Samtrafiken*, which was founded in 1993, focusing on the integration of various modes of public transportation (such as ticketing for bus and tram services) have also come to be seen as precursors to MaaS due to their MaaS-like characteristics (Fenton et al., 2020).

Similarly, the emergence of MaaS under the banner of *New Mobility Services* (Hasselwander et al., 2023), *Internet of Mobility Services* (IoMS) (Groth et al., 2021), *Innovative Mobility* (Fujisaki et al., 2022), *Cooperative Intelligent Transport Systems* (C-ITS) (Alam et al., 2016), *Co-Modality* (Skoglund & Karlsson, 2012), *Smart Mobility* (Castellanos et al., 2022) as a subset of the literature on Smart Cities (Anthony Jnr et al., 2020), and *Flexible Transport Systems* (FTS) has, likewise, been preceded by an earlier concept termed *Mobility Management* which centers on the provision of coordinated and integrated transport services, through the deployment of technology, to passengers (Hensher et al., 2020a) which dates back to 1991 (Signorile et al., 2018). A UITP (*Union Internationale des Transports Publics)* Position Paper published in 2011 has articulated on the possibility of integrating separate transport services such as car-sharing, bike-sharing, demand-responsive transit, and taxi services (amongst others) to augment public transport (Esztergár-Kiss & Kerényi, 2020).

Moreover, MaaS has also come to viewed as the culmination of a crossover between inter-related bodies of literature such as the '*Diffusion of Innovation*' (Fenton et al., 2020), '*Collaborative Innovation*', and '*Sustainability Transitions*' studies (Smith & Hensher, 2020). Likewise, the interplay between MaaS and other emergent technologies such as Internet of Things (IoT) and Automation (Wong et al., 2020), Big Data Analytics (Anthony Jnr et al., 2020) such as Data Mining (Shang et al., 2022), Blockchain (Chinaei et al., 2022), Artificial Intelligence (AI), and Machine Learning (ML), and industries such as Sustainable Tourism (Signorile et al., 2018), has also paved the way for additional strands of research demonstrating the potential of the concept in facilitating a transition towards efficient vehicle usage, optimization of transport networks (Wong et al., 2020), and hence, sustainable mobility.

The term MaaS has reportedly been popularized in Finland, during the European Congress on Intelligent Transport Systems held in Helsinki (Smith & Hensher, 2020), back in 2014 even though the first MaaS trial, *UbiGo*, was conducted in Gothenburg, Sweden (Smith, Sochor, & Sarasini, 2018) as part of the broader Swedish 'Go:Smart' project alliance (Zhang & Zhang, 2021).

However, the narrative surrounding MaaS – as evidenced by the terms invoked to describe MaaS such as comprehensive, seamless, user-centric, intelligent, and sustainable – has been viewed by authors such as Pangbourne et al. (2018) and Smith & Hensher (2020) as overly optimistic and, as of yet, unproven (Wittstock & Teuteberg, 2019) and debatable (Fenton et al., 2020). As such, the risk of feedback effects and (Wong et al., 2020) unintended consequences stemming from the multiple complex interdependencies and interconnectivities – which have yet to be sufficiently explored, understood, and are viewed differently (Kostiainen & Tuominen, 2019) – inherent in MaaS merits further attention (Pangbourne et al., 2018).

The trajectory of MaaS publications in the scientific and grey literature, as evidenced by the chart below, shows 2014 to be a key starting point given that the same year witnessed the culmination of the *UbiGo* project (first MaaS pilot) and the publication of the first MaaS scientific document (Master Thesis) (Arias-Molinares & García-Palomares, 2020). The same uptick can be seen in peer-reviewed publications of other *Smart Mobility* subtopics such as 'Shared Mobility' between 2014 and 2019 as compiled and presented by Castellanos et al. (2022). This is testament to the recent surge in mobility innovations, which has in turn stimulated an uptick in academic attention, aimed at displacing the need of owning a personal car (Labee et al., 2022).

1.2 Research Aims and Objectives

1. Explore the barriers and drivers of bottom-up urban mobility planning and codesign in Bahrain using Multi-Level Perspective MLP theory
2. Explore the sustainability implications for MaaS-Lite from bottom-up / landscape-driven MaaS-Lite bundle design
3. Determine the potential impact of MaaS-Lite customization decisions on commuters' transportation mode choice and on the uptake of Public Transport by commuters

1.3 Research Significance

The deployment of co-design approaches – although used for many years – in transportation research, remains at a nascent stage (Brown *et al.*, 2022) and even more so in mobility solutions that involve the packaging of multimodal services (Hensher and Mulley, 2021) such as MaaS considering its 'emerging' state and the uncertainty that comes with how MaaS bundles should be designed (Matyas and Kamargianni, 2019). However, bottom-up, passenger-driven formation of MaaS bundles has been incorporated in a study, following the Sydney MaaS trial, published by Ho *et al.* (2021) only the thrust of their research centered on users' price sensitivity, willingness-to-pay, and the impact thereof on the uptake of each bundle with minimal focus on analyzing how participants rationalize each decision throughout the MaaS bundle formation and co-design process when exposed to additional variables which in this proposed study will be approximate kilometric emissions (per mode, distance, and aggregate).

Similarly, the study by Caiati, Rasouli and Timmermans (2020) explored potential MaaS users' preferences for bundle configuration, only through Stated Preference Experimentation and statistical analysis techniques without exploring factors and reasons behind participants' preferences. This has led Reck, Hensher and Ho (2020) to elucidate the importance of establishing and emphasizing behavioral attributes in the MaaS bundle design process as opposed to solely focusing on statistical attributes. Likewise, Pangbourne *et al.* (2020) have also drawn attention to the need for collective envisioning (through social simulation and engaging citizens) rather than just forecasting (and extrapolating from the current state/data) when it comes to analyzing new mobility concepts like MaaS. This proposed study will aim to fill this gap by engaging with participants during and following the codesign process through the qualitative and thematic components of this research.

On another front, this study holds the promise of acting as a conduit for exploring one of the four MaaS key integration levels. Namely, integration of societal goals as posited in the topology conceived by Sochor *et al.* (2018) – by synthesizing and triangulating input from a defined market segment (commuters) (Reck, Hensher and Ho, 2020), transport service providers, and policymakers all of which will be carried out against a geographical [non-European (Macedo *et al.*, 2022)] and socio-cultural backdrop scantly represented in the mobility literature in general and the MaaS literature in particular.

Furthermore, this echoes the recommendation to analyze the potential of MaaS in dissimilar settings with disparate institutional arrangements made by Smith, Sochor and Sarasini (2018) and the need to explore the utility of MaaS as a sustainability tool beyond just discourse was also pointed out in Hirschhorn *et al.* (2019).

The generalizability of findings from existing MaaS studies and pilots also remains skewed and hypothetical, as most studies were either carried out in countries where MaaS does not exist. Hence this has necessitated a reliance on dummy MaaS deployment (Lopez-Carreiro *et al.*, 2021), or in situations where the authors had to settle with MaaS-lite schemes comprised of limited transportation modes (Pickford and Chung, 2019; Alyavina, Nikitas and Tchouamou Njoya, 2020). Altogether, this offers ample room for further analyses that may incorporate different contexts, methodological tools, variables, and metrics.

Therefore, studies such as Schikofsky, Dannewald and Kowald (2020) and Lopez-Carreiro *et al.* (2021) have grounded their research on the tenets of transition theories such as the Technology Acceptance Model (TAM) – albeit not strictly seeing as modifications were made to the original model with Kivimaa *et al.* (2021) advocating for further bridge-building between transport studies scholars and socio-technical transitions studies.

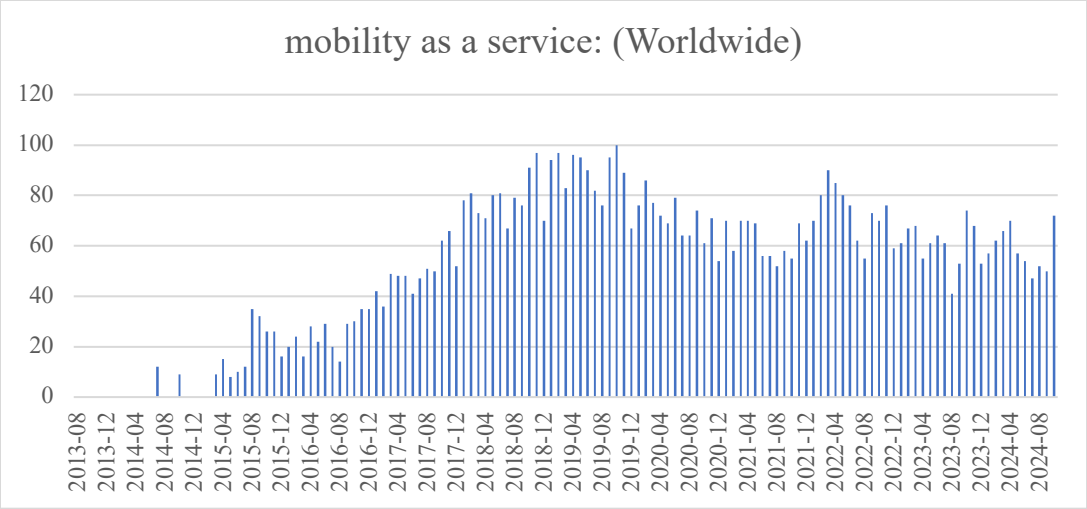


Figure 1. Google Trends (Interest in MaaS 2013 -2024)

As such, this study aims to follow the tenets of multi-level perspective (MLP) theory by populating and analyzing (MaaS codesign process) the input from the parties within the various levels comprising the theory: niche, regime, and landscape (Geels, 2019). Something, hitherto, not deployed for the sole purpose of analyzing the potential sustainability prospects of MaaS along with the interaction between different MLP levels during the bundle codesign process and ultimately, bottom-up urban mobility planning.

Fenton, Chimenti and Kanda (2020) applied the framework towards a potential roll-out and diffusion of MaaS in Stockholm, Sweden and Audouin and Finger (2019) have deployed MLP theory with a strict focus on the role of public authorities in the development of MaaS schemes in which they recommended 'governing by enabling' as the ideal approach for the development of MaaS scheme with emphasis on horizontal network governance and cross-sectoral interactions as opposed to focusing on the role and involvement of the community in the scheme design process.

Likewise, Hirschhorn *et al.* (2019) have also utilized MLP, in conjunction with other theories (governance), to explore the interactions occurring between public-sector, regional, and national actors within the MaaS ecosystem (excluding passengers). Moreover, Arias-Molinares and Carlos García-Palomares (2020) have deployed MLP theory as a lens through which to analyze the potential for a MaaS rollout in Madrid with a specific focus on the role of shared mobility. Finally, Kivimaa and Rogge (2022) have drawn on MLP to analyze the interplay of policy experimentation and institutional change focusing on a case study of MaaS in Finland and in

Pangbourne *et al.* (2020) the authors, by adopting the same theory, attempted to explore and identify the potential unintended consequences of a hypothetical wholesale uptake of MaaS and the extent to which MaaS can deliver on its promises to both cities and citizens.

Chapter 2. Theoretical Framework and Literature Review

2.1 "As a Service" and bundling

To further clarify the MaaS concept, multiple references to the telecommunications industry have been made in the literature (Alyavina et al., 2020; Kostiainen & Tuominen, 2019; Pangbourne et al., 2018). However, the use of the telecom industry as an analogy for understanding MaaS has been criticized by Pangbourne et al. (2018) on the premise that humans moving through urban transport systems cannot be conflated with data traffic managed on ICT networks since the latter is amenable to buffering, prioritization, and rerouting through potentially longer paths. Things that are difficult to replicate with humans.

The "as-a-service" component of MaaS is used to denote a time-specific subscription, hence the emphasis on mobility access as opposed to mobility ownership (Wong et al., 2020), with the ability to flexibly customize bundles based on available transportation resources across both the public and private sectors (Signorile et al., 2018). Although, "as-a-service" was originally developed in the cloud computing and IT sector, the term has been often conflated with innovation, entrepreneurship, and strong growth businesses. The versatility and wide applicability of the "as-a-service" concept is reflected in the extension developed by the consultancy firm *Accenture*, Everything-as-a-Service (XaaS), with 'X' being a dynamic component that can be adapted towards different industries and use cases such as the following: Manufacturing as a Service (Moghaddam et al., 2015), Cloud Manufacturing as a Service (CMaaS) (Hasan et al., 2021), Mobile Blockchain Mining as a Service (MB-MaaS) (Bhattacharya et al., 2022), Lighting as a Service (LaaS), Carbon Offsets as a Service (CoaaS), Platform as a Service (PaaS), and Mobility as a Service (MaaS) (Merkert et al., 2020).

2.2 Shifting from a Goods-Dominant Logic to Services-Dominant Logic in transportation: The case of MaaS

The foundation of the 'As a Service' concept, and the broader servitization business model underpinning today's sharing economy, has its roots in S-D Logic theory which has been established in contradistinction to the previously dominant G-D Logic perspective. Namely, references to G-D logic were made to denote economic activities geared towards the

manufacturing and personal ownership of standardized physical products with customers assuming a highly passive role in the market (Schulz et al., 2020).

The G-D logic perspective offers a suitable lens through which to unravel some the key enablers – i.e., facilitation and proliferation of personal car ownership (Turetken et al., 2019; Zimmermann et al., 2020) – behind the existing dominant automobility paradigm. Following the seminal work of Vargo & Lusch (2004), a rethinking of the G-D logic perspective has bred a contemporaneous alternative more befitting and reflective of visible market shifts towards services, which were originally instigated by the drop in profitability of traditional goods-dominant value-chain models adopted by manufacturing companies in the early 1990s (Turetken et al., 2019), providing the theoretical groundwork for what became known as Services-Dominant Logic.

S-D Logic, originally premised on value creation enabled through the exchange of services as opposed to goods (Vargo & Lusch, 2004), pivots away from and de-emphasizes product ownership, aligning more closely towards flexibility, ease-of-use, the service ecosystem and platform, and value co-creation (Schulz et al., 2020), by establishing a reciprocal process centered on consumers' perspective within the value creation process (Zimmermann et al., 2020).

Moreover, the service ecosystem description provided by Lusch & Nambisan (2015), "*a relatively self-contained, self-adjusting system of mostly loosely coupled social and economic (resource-integrating) actors connected by shared institutional logics and mutual value creation through service exchange*", closely mirrors the MaaS setups theorized by both (Arias-Molinares & García-Palomares, 2020), with the *MaaS Provider* positioned as the hub (resource-integrating actor) within the MaaS hub-and-spoke ecosystem (acting as the direct interface for 'spokes' within the an intermodal mobility ecosystem which range from TSPs, government agencies, industry associations, to customers (Schulz et al., 2020)), and (Smith, Sochor, & Karlsson, 2018), where the authors conceive of a *MaaS Integrator* role responsible for managing offers from several TSPs through activities such as technical integration, contract management, and financial clearing.

Conversely, it would be unduly optimistic to assume that all actors comprising a MaaS ecosystem share, and operate in accordance with, common (or at least compatible) institutional logics which in reference to an additional resource-integrating actor proposed by Smith et al. (2020), *Intermediary MaaS Integrators* (IMIs), underscores the need for IMIs to communicate

unambiguous, declared objectives across the MaaS ecosystem to harmonize cross-actor understanding and solidify trust.

The aforementioned can also serve in minimizing the risk of 'value co-destruction', the antonym of value co-creation but immensely understudied in the extant literature and not part of the original S-D Logic perspective (Schulz et al., 2021), as articulated in Plé & Chumpitaz Cáceres (2010). The risk of value co-destruction within an intermodal mobility setup might be triggered by the multiple deficiencies that tend to plague nascent MaaS rollouts – limitations in technological knowhow and implementation (crucial for the bundling of services for disparate TSPs), organizational hurdles and political prohibitions that impede full resource integration (granting access of PT information, payment, and ticketing systems to third-parties), and informational restrictions (capacity to securely store and economically analyze extensive reams of user data) (Zimmermann et al., 2020). Also, noteworthy here is that some the trigger points might directly emanate from actors' actions – misusing (Plé & Chumpitaz Cáceres, 2010), withholding, and withdrawing resources (which gets at the heart of one MaaS' most contentious flashpoints: who should own and have access to users' data?) (Schulz et al., 2021).

Reconciling the co-destruction definition developed by Plé & Chumpitaz Cáceres (2010), "*an interactional process between service systems that results in a decline in at least one of the systems' well-being*", with one of MaaS' oft-debated unintended consequences, modal displacement of PT in MaaS bundles, demonstrates the utility of this perspective in interrogating the wider impacts that might be ascribed to the scale expansion, calcification, and popularization of MaaS.

2.3 The transition from Service-Dominant Logic to Sustainable-Dominant Logic / Environment-Dominant Logic

The irrevocable ecological degradation wrought by the interdependence between the global economy and global ecology has sparked alarmist discourses on '*ability of future generations to meet their own needs*' (Quoquab & Mohammad, 2016) and, the more dire, existentialism – marked by the anthropogenic eco-crisis that is undermining the natural bases for human existence (Lindgren, 2016). The ensuant adjustments to regulatory policies, along with the gradual introduction of punitive legal action for noncompliance, has nudged companies towards cultivating an image of sustainability to hedge against the potential risk of lawsuits and cleanup costs (Watson

et al., 2012). Such shifts and developments have culminated in the paradigm shift towards Environment-Dominant Logic perspective not as an extension of S-D Logic but a more timely, needed, and holistic standalone perspective (Quoquab & Mohammad, 2016) – also not intended to invalidate S-D Logic (Schulz et al., 2020) – that can coexist, blend, or compete with other existing logics (Grinevich et al., 2019).]

2.3.1 Reconciling Institutional Logics with the three level Product Service System (PSS) Classification in the case of MaaS

Similar to transitions in institutional logics detailed in the preceding section, a parallel concept, known as Product Service System, offers an additional theoretical perspective through which to construe some of the paradigmatic shifts fueling emergent mobility schemes such as MaaS (Enoch & Potter, 2023). Contextually, the concept was developed to reflect the shift towards '*servicisation*' witnessed in predominately developed economies nearing the latter decades of the 20th century. A common motive being, notwithstanding the potential for additional value, a desire to pave the way towards dematerialization and more sustainable patterns of production and consumption (Cook et al., 2006).

The following descriptions have been sourced from Cook et al. (2006). However, the level ascribed to each PSS follows the classification adopted in Enoch & Potter (2023).

Level 1 PSS (Product Orientated): Similar to G-D Logic, the first PSS level hinges on the introduction of services that extend the lifetime of a type of good, with ownership rights belonging to the customer, ensuring its utility over a given period of time. In the mobility realm, examples might include warranty and extended service for personally owned vehicles.

Level 2 PSS (Use Orientated): In the second PSS level, the ownership rights are retained by the service provider whom grant customers access to, allowing them to make '*use*' of, a service for a specified period of time hence its alignment with S-D Logic. Mobility examples include PT, paratransit, ride-hailing, and bike-sharing services to name a few.

Level 3 PSS (Result Orientated): Slightly more opaque compared to the preceding two levels, the third PSS level, emphasizes the attainment of – as the naming of this PSS already suggests – desired results and outcomes. Like the second PSS level, the ownership rights are still retained by the service provider. Although this category seemingly casts a wide net, an example befitting of

this PSS level would be MaaS considering the emphasis placed on '*mobility*' (the result/outcome) irrespective of the modal combinations deployed in getting users from point A (Origin) to point B (Destination). Maintaining the same reasoning, shifting consumer emphasis towards outcomes such as '*Sustainable Mobility*' might offer the impetus for service providers to divest from unsustainable practices and gravitate towards, as in a hypothetical case of MaaS bundles, the inclusion of more ecologically friendly options such as Evs, PT, and active mobility. Thus, this PSS level closely mirrors some of the core elements that comprise E-D Logic.

2.4 Geographical nuances in mobility: Literature gap and the need for mobility studies from non-westernized contexts

2.4.1 Informal Transportation and Paratransit

Considering the divergence of sociodemographic, ethnocultural, economic, political, and infrastructural factors (to name but a few) between developed and developing countries (or the Global North vs. the Global South, respectively) has oftentimes lent a distinct meaning and understanding to mobility concepts especially when repurposed and applied in the latter countries: laying the foundation for what have also been referred as '*indigenous transport modes'* (Talamini & Pires Ferreira, 2019).

To illustrate, the presence of an abundance of cheap labor (Chavis & Daganzo, 2013) coupled with substandard and patchy infrastructure in the Global South along with underfunded and under-resourced PT systems have collectively given rise to informal public transport (paratransit) modes – which, oxymoronically, are privately operated in most cases and also address the spatiotemporal limitations normally associated with PT systems the demand-responsive, flexible, market-driven, and laissez-faire nature of paratransit systems (Kerzhner, 2023) which have long acted as '*a filler for most fringe areas'* (Behal et al., 2020) – with a fleet often comprised of shared auto-rickshaws, e-bike (electric two-wheelers) taxis, jitney services, mini-buses/jeepneys, and Vikrams (Alcorn & Karner, 2021; Kumar et al., 2016; Schwanen, 2020; Talamini & Pires Ferreira, 2019).

As such, the manifestation of informal transport options is also symptomatic of much wider macroeconomic issues facing governments within the Global South. Namely, the presence of restrictive fiscal and monetary policies is manifest in the resource and capacity constraints stifling

governments' ability to offer both ample transport infrastructure and reliable PT systems. Such factors provide the impetus and incentive (hence, market opportunity) for the establishment of privately-operated informal transportation networks which mark a glaring departure from a key premise guiding transportation studies produced in the Global North: that urban transfer is predominantly organized and regulated by the state (Wood et al., 2020).

Even if often associated with negative connotations (relating to inferiority due to lack of standards common in the Global North such as speed, accessibility, quality, and modernity (Wood et al., 2020); trust; reliability; comfort; legality; and safety issues) (Toro López & Van den Broeck, 2023), largely understudied, and notoriously individualistic and, hence, inefficient (Alcorn & Karner, 2021); such informal systems have in many cases been the sole option for passengers in countries such as India (Behal et al., 2020). Countries in sub-Saharan Africa face the same type of dependence on paratransit systems as india, whereas, in Latin American and Eastern European countries such systems tend to coexist with formal PT systems.

Such coexistence reflects the type of potentially synergistic relationship that can be fostered between formal and informal transportation systems and counters any notion of them being dichotomous or mutually exclusive. A point in case can be gleaned from cities such as Santiago, Chile where a previously operated informal bus network has been integrated with the city's heavy rail system creating what has been dubbed the *Transantiago system* (Alcorn & Karner, 2021).

Furthermore, Kuklina & Baikalov (2021) have expounded on the notion of embeddedness – by factoring in the diversity of religious, cultural, political, and social facets presented in each context (Wood et al., 2020) – in analyzing the interdependencies and relationship between local communities and informal usage of rail networks – a rarity in the paratransit literature – that have remained intact in a post-Socialist context and long after the dissolution of the USSR. The main takeaway from the study was the need for recognizing contextually contingent factors and linkages between communities, transport infrastructure, and policies. The lack of such recognition tends to underscore a visible chasm and mismatch between sociocultural landscapes in the Global South and policy ideas emanating from the Global North (Wood et al., 2020), hence, necessitating the articulation of new identities, actors, territorialities, and institutions to better deal with planetary scale problems such as climate change (Castro-Sotomayor & Minoia, 2024).

2.4.2 Coloniality and decolonization of the production of knowledge

Being often viewed and interpreted through the lens of hegemonic traditions of mainstream Euro-American transport knowledge, research, and planning (Wood et al., 2020); a number of existing studies downplay, if not outright disregard, key contextual factors unique to countries within the Global South such as the role of passengers' religious practices and religiosity in shaping transport practices (Schwanen, 2020) – something that stands in sharp contrast with the neoclassical assumptions (which emphasize economic efficiency, rationality, and frame the discipline as technocentric and apolitical) that underpin transportation studies promulgated by the 'Global North' (Wood et al., 2020) and other Western ideas that are also assumed to be universally applicable and naturally superior (Verlinghieri & Middleton, 2020). Such assumptions lean towards the normalization of Western modernity (van Ryneveld & Islar, 2023) and mirror biases held towards people from the Third World, or Global South, as evidenced and succinctly put forth by Mignolo (2009): "*As we know: the first world has knowledge, the third world has culture; Native Americans have wisdom, Anglo Americans have science".* Furthermore, such biases also tend to be exacerbated by narratives on climate change that marginalize post-colonial countries and are fueled by asymmetrical power matrices of control imposed by the Global North (Sultana, 2022).

In doing so a subject-expert binary problem (Alcorn & Karner, 2021) emerges where knowledge-making practices tend to marginalize and discount specific people and places which lack conformity with Westernized standards and expectations or are in misalignment with expertise that is produced and modelled, which remain heavily grounded on engineering and economics (Verlinghieri & Middleton, 2020), in the Global North (Wood et al., 2020).

Moreover, the wealth of data generated in the transport field has commonly been approached through a post-positivist lens which assumes that, one, the data reflects reality, two, the data is able to generate the most valuable and accurate knowledge, and, three, the processing of such data will allow for better decision-making. The aforementioned assumptions remain highly contested and negate the extent to which such data are skewed by, and predisposed towards, historical factors such as coloniality and the epistemic dominance of westernized economic systems and scientific interpretation approaches reflected in research agendas and supported by funding agencies (Ricaurte, 2019; Sheller, 2023).

Collectively, such violent imposition of ways of being, thinking, and feeling perpetuates the existing paucity in the transport literature – and further widens the chasm between studies within the extant literature overrepresenting the West (and Western ideologies) vis-à-vis the Global South – by limiting development in the academic field on locally-derived innovation (Wood et al., 2020) and exclusion of alternative worlds and epistemologies (Ricaurte, 2019).

Such unidirectional knowledge exchange, as deemed by Verlinghieri & Middleton (2020), has undoubtedly contributed to the worldwide uptake and cementing of the current automobility paradigm and its attendant externalities (i.e., contemporary climate crisis) further reinforcing the claim posited by Figueroa & Lindgren (2016) in that coloniality of power and Euro/Western-centric systems, based on extractive political economies of carbon capitalism (Sheller, 2023) and endless growth ideologies (Sultana, 2022), have worked to globalize a civilization which exhausts the planet through anthropogenic and socioecological pressure. Considering such paradigms entail deeply-embedded, intertwined, and complex structures, and their concomitant 'lock-in' effects, has often served as the basis for the 'Climate Delay' discourse due to their perceived insurmountable nature and, thus, ability to put off, if not outright deter, urgent climate action (van Ryneveld & Islar, 2023).

Although, the same authors continued to demonstrate, the root cause behind the damage has less to do with subjugation and more to do with the desire of countries in the Global South to emulate the living standards enjoyed by countries in the Global North through the adoption of the same hegemonic, "*ecodestructive, consumerist-centric, over-financialized, [and] climate-frying maldevelopment model" (Verlinghieri & Middleton, 2020).*

Attempting to trace the root of the problem, a key attribute of coloniality, and what is known as the 'colonial matrix of power', has been the use of transport infrastructure as an instrument to foster economic dependency and exploitation by colonial powers (Verlinghieri & Middleton, 2020).

Considered an outgrowth of Christian theology, secular science, and philosophy; such European 'Expert-Based' colonial system of thinking has been preserved by supranational entities and has gained widespread traction and uptake – even 'seductiveness' – amongst international students, especially those residing in countries within the Global South, to the point where such

knowledge has come to be viewed as a "commodity of exportation for the modernization of non-Western countries" (Verlinghieri & Middleton, 2020).

Even though the tide seems to be turning as evidenced by the skepticism harbored by representatives of the Global South towards global initiatives, such as 'carbon offsetting', that are enforced supranationally through the UN system and other international mechanisms which, along with the World Bank and IMF, have been questioned for their role in promoting neoliberal agendas that prevent total decoloniality and autonomy in national policies within the Global South (van Ryneveld & Islar, 2023). One outspoken opponent of such initiatives and policies imposed by powerful countries on historically marginalized countries – reflective of the unequal geographies of power in climate action (van Ryneveld & Islar, 2023) – has been Bolivian President, Luis Arce, who has labelled such efforts as "new carbon colonialism" (Sultana, 2022).

Similar sentiment is held by, and reflected on, the grassroots level (i.e., indigenous and environmental activists) who, following a disappointing COP26, have likened climate solutions to a mechanism for perpetuating colonialism through land grabs, extractive violence, displacement, and dispossession (Sultana, 2022). Practices that have normally been justified in the name of climate solutions (van Ryneveld & Islar, 2023).

Collectively, this reaffirms one of the critiques levelled against contemporary climate solutions that predominantly remain grounded in neoliberal global market principles that promote corporatist interests like limitless economic growth based on indiscriminate extractivism (Castro-Sotomayor & Minoia, 2024) and feeds into broader debates about 'Climate Violence' that are premised on the possibility that climate solutions might be disproportionately burdensome towards the very people, places, and environments expected to experience the worst effects of climate change (i.e., African countries) (DeBoom, 2020).

Even in postcolonial contexts, Southern elites deeply enthralled with Eurocentric ideologies and hegemonic models adopted in the Global North, have subjugated and set their populace on a course to modernization with strict adherence to the tenets espoused in such ideologies and models (Figueroa & Lindgren, 2016). Altogether, such subservient adherence lends credence to the prevalence of 'neo-colonialism' in the Global South (van Ryneveld & Islar, 2023) and can be viewed as the logical continuation of earlier works on marginalized philosophical traditions that label Western patriarchy, racism, Eurocentrism, and capitalism as the main culprits

in the planetary-life crisis discourse that has long predated the current mainstream climate change debate (Sheller, 2023).

2.4.3 Epistemological shifts

Even with repetitive calls for ontological and epistemological shifts (Alcorn & Karner, 2021; Schwanen, 2020; Sultana, 2022; Wood et al., 2020) and decolonization, or provincialization (Verlinghieri & Middleton, 2020), of transport studies and knowledge which have only intensified with urgency calls emanating from the current planetary scale of problems (i.e., climate havoc) facing humanity (Castro-Sotomayor & Minoia, 2024); the historical embeddedness, hegemonic nature, and legacy of data colonialism remain deeply entrenched and, thus, difficult to delink, disentangle, and deconstruct.

However, several counter-hegemonic shifts have been postulated as key in pivoting transportation studies away from the dominant northern ways of thinking and doing and more towards embracing pluriversal ways of being, knowing, and acting (Castro-Sotomayor & Minoia, 2024).

Namely, a geographical shift that is more inclusive and reflective of the Global South to pave the way for global cognitive justice which is central to addressing the climate crisis and achieving global climate justice (van Ryneveld & Islar, 2023). Secondly, an epistemological shift away from the current techno-centric focus in transportation studies and narratives of technological optimism that continue to dominate Western socio-climatic imaginaries (Death, 2022) and which have been found to inhibit climate action due to the socio-technological path dependency that is engendered by such an approach (van Ryneveld & Islar, 2023). Thirdly, an empirical shift away from ostensible models and more towards empirically-rigorous analyses centered on the Global South (Wood et al., 2020).

Expanding further on the second shift, the adoption of a Post-modernist stance can act as a counterbalance against the biases inherent in universalism and essentialism by allowing for epistemological skepticism (Ubach, 2004; Ulanowsky, 1998) even though the concept has been criticized for being complex, all-compassing, and thus, overlapping with other concepts such as postmodernity, poststructuralism, and pragmatism (Patton, 2015). The need for epistemological skepticism is further justified by the stance adopted by decolonial scholars in that coloniality is

projected at a cognitive level through the oppression, extraction, appropriation, and destruction of epistemologies that challenge it (Ndlovu-Gatsheni, 2021).

In addition to epistemological shifts, (Schwanen, 2020) have emphasized the need for wide-sweeping changes to the theories, ontology, and research methods as key antecedents for the decolonization of research.

An example of such repositioning is mirrored by the work of Bulkeley (2019) whom advocates for the reframing of climate discourse from a discrete climate-as-object problem towards a climate-as-condition issue. The position adopted by the author is embedded in the idea that the latter will serve by widening the catchment area and scope of existing analyses through the incorporation of climate's politics, ethics, and sensibilities vis-à-vis socio-material entities.

Likewise, authors such as Castro-Sotomayor & Minoia (2024) have advocated for a more drastic shift that seeks to disentangle dangerous dualisms (i.e., human/nature, nature/culture, nature/society) that continue to prevail in environmental narratives in favor of a more holistic approach that positions humans at the intersection of environmental and sociocultural struggles that stem from colonial systems. Towards that end and a post-development future, a bridging framework dubbed 'Ecocultural Identity' was developed by the authors to challenge the culturalism and anthropocentrism that continue to dominate how we shape our understanding of identity in relation to nature.

Such revised approaches to the climate issue are critical to the ongoing debate on the highly-touted decarbonization potential of Mobility-as-a-Service and to the broader discourse on climate coloniality.

2.5 Mobility-as-a-Service Variants

Given the predominantly European-centric context in which MaaS has been studied and piloted (Christensen et al., 2022; Hasselwander & Bigotte, 2023; Hensher, 2020; Jang et al., 2021; Storme et al., 2020) which are often premised on studies conducted in Sweden and Finland (Franco & Vitetta, 2023) – hence the need for more diverse MaaS studies that center on different user-groups, locations, and contexts (Fenton et al., 2020; Smith & Hensher, 2020), the generalizability of findings towards developing countries, or the Global South (Dzisi et al., 2022; Hasselwander et al., 2022; Hasselwander et al., 2023), and countries marked by visible heterogeneity in available

mobility options and modal share splits, institutional setups, regulatory landscapes, sociocultural characteristics and demographics, and economic trajectories and aspirations becomes all the more complicated.

MaaS Lite acknowledges the existence of such peculiarities – and other, potentially problematic, features such as high heterogeneity in mobility services (Bandeira et al., 2022) which is expected to be more pronounced as different transportation modes with new services are constantly being added (Esztergár-Kiss & Kerényi, 2020) – and offers a refined precursor to MaaS that narrows the parameters to fewer modes of transportation, based on availability and with focus on those comprising the bulk of modal share, and prioritization of mobility needs for common and predictable trips (i.e., commuting) (Pickford & Chung, 2019). Also, the preference of participants for smaller mobility packages with fewer modalities – two to three modes – has been one of key findings following a study by (Hensher et al., 2021) of the Sydney MaaS trail. This would help further the case for utilizing MaaS Lite as a 'stepping stone' towards a more scalable MaaS scheme which has been deemed of imperative research importance considering that the impact of MaaS scalability on the provision, and enabling, of sustainable value remains underexplored in the extant literature (Sarasini et al., 2017).

Reaffirming Groth's (2019) stance on the difficulty involved in fully capturing the complexity inherent in emergent Smart Mobility systems, Alyavina et al. (2020) have argued that MaaS remains at an embryonic stage of development where a number of systems have yet to be tested and studied at a full scale trail (Hensher & Hietanen, 2023) hence rendering existing findings in the literature more pertinent to MaaS Lite as opposed to full-scale MaaS and, as furthered by (Milne et al., 2024), heavily skewed towards the conceptualization stage as opposed to the Design, Development, and Marketing (DDM) stages.

2.6 MaaS variants through a Systematic Literature Review of a singular database (ScienceDirect)

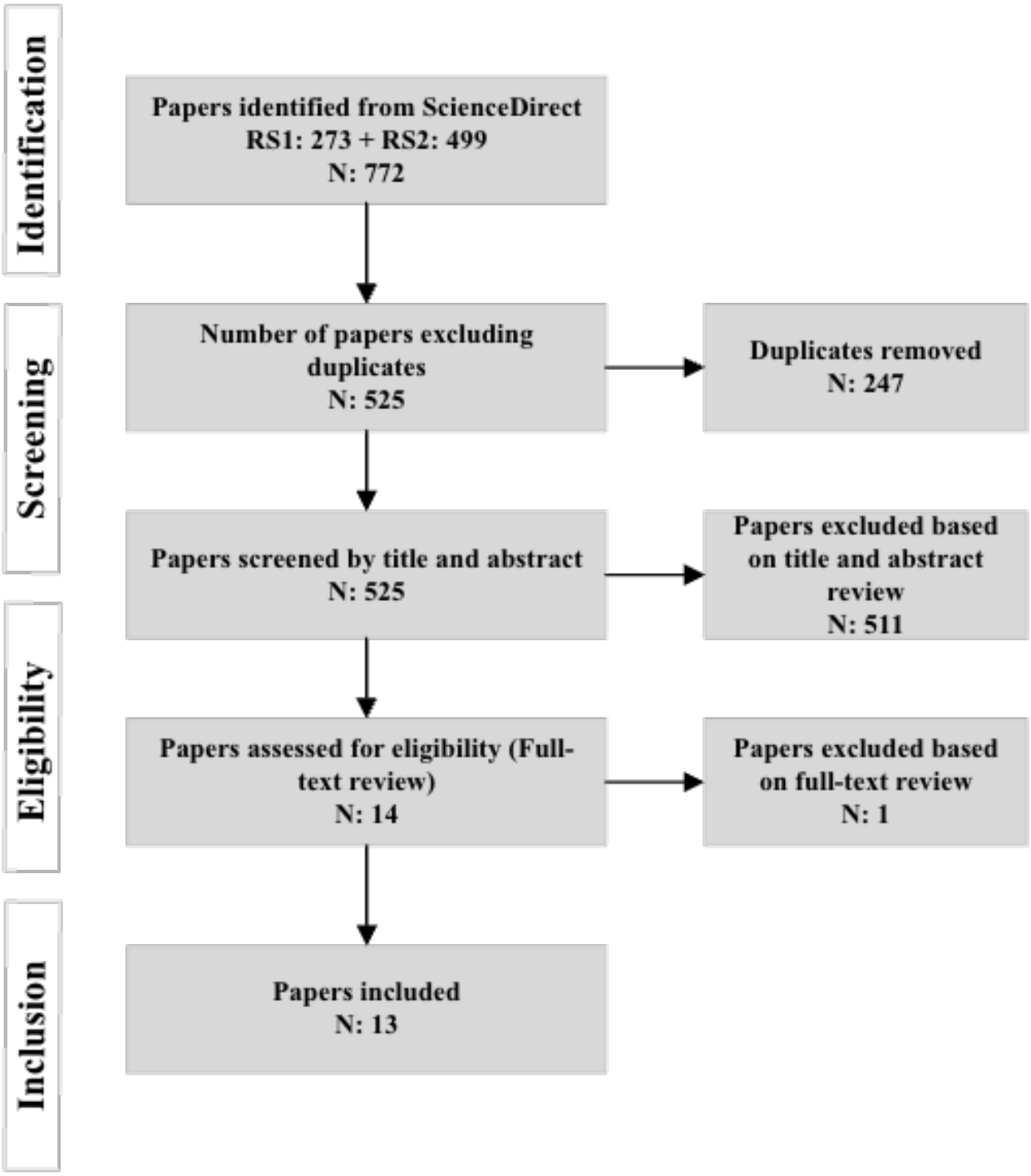


Figure 2. PRISMA steps and results

2.7 Inclusion and Exclusion Criteria

Table 1. SLR inclusion and exclusion criteria

Included	Excluded
• Research articles • Review articles • Publications in English • Publications from 2010- Feb 2024 • Modified MaaS acronyms (in line with XaaS) (i.e., LaaS) and MaaS extensions (i.e., TrustedMaaS, MaaS Lite) in the article abstract and/or title.	• Book chapters • Encyclopedia • Conference abstracts • Book reviews • Case reports • Conference info • Correspondence • Data articles • Discussions • Editorials • Errata • Examinations • Mini reviews • News • Patent reports • Practice guidelines • Product reviews • Short communications • Software publications • Video articles • Others • Publications in French and Spanish • Publications pre-2010 and after 10 Feb 2024

2.7.1 Identification: Database and keyword strings

Prior to the selection of the filter settings listed in the Included/Excluded section on the *ScienceDirect* database, the following keywords were used through the ScienceDirect 'advanced search' function:

Research String 1 (RS1): "Mobility as a Service" in the main 'find articles with these terms' search box and "MaaS" in the 'Title, abstract or author specified keywords' search box. This resulted in 273 papers.

Research String 2 (RS2): "MaaS" in the main 'find articles with these terms' search box and "Mobility as a Service" in the 'Title, abstract or author specified keywords' search box. This resulted in 499 papers.

Total (RS1 + RS2) = 772 papers.

2.7.2 Screening: Duplicates

All results were downloaded (.ris file) and added to EndNote20. Two separate groups were created on EndNote20 – one for results from RS1 and the second for results from RS2. Next, the references from both groups were merged into a single group and using the library 'Find Duplicates' functionality, 247 duplicates were identified and removed (772 minus 247) leaving the total at 525 papers.

2.7.3 Screening: Abstract and title review

Both the title and abstract for each of the 525 papers have then been screened for author conceptualizations extending on the original MaaS paradigm. Namely, modified MaaS acronyms (in line with XaaS) (i.e., LaaS) and MaaS extensions (i.e., TrustedMaaS and MaaS Lite). In some cases, the acronym MaaS appeared but in reference to conceptualizations from domains other than transportation i.e., MB-MaaS (Mobile-Blockchain based Mining-as-a-Service, shorthand MB-MaaS, (Bhattacharya et al., 2022)). Such results were excluded from the study. On this basis, 511 papers were excluded, leaving the total at 14 papers for full-review screening.

2.7.4 Eligibility: Full-text review

Only one paper, by Dadashzadeh et al. (2022), has been excluded considering it centers on proposing a framework – labelled as MaaS Inclusivity Index or MaaSINI in short – to evaluate the inclusivity (an outcome) levels of MaaS schemes as opposed to putting forward a reconceptualization of the original MaaS paradigm with clear alterations to the scope of the concept. Therefore, it has been deemed ill-suited for analysis through the smart mobility taxonomy developed by (Cledou et al., 2018). Thus, 13 papers have been selected for analysis in this study.

Results

Table 2. Breakdown of MaaS variants by theme, country, and article type

Theme	MaaS Extension/ Acronym	Source type	Country	Reference	Match with 'MaaS' OR 'Mobility as a Service' in abstract, title, and keywords
Freight	MaaS4PaF	Research article 'Conceptual'	Italy Netherlands	(Le Pira et al., 2021)	Title ☒ Abstract ☒ Keywords ☐
	LaaS	Research article 'Conceptual'	Belgium Sweden Italy	(Beckers et al., 2023)	Title ☐ Abstract ☒ Keywords ☒
Electrification	eMaaS	Research article 'Empirical/ Conceptual'	Norway	(Anthony, 2023)	Title ☒ Abstract ☒ Keywords ☒
Corporate Mobility	CMaaS	Research article 'Empirical'	Sweden	(Hesselgren et al., 2020)	Title ☒ Abstract ☒ Keywords (Not provided)
	CMaaS	Research article 'Empirical'	Sweden	(Zhao et al., 2020)	Title ☒ Abstract ☒ Keywords ☒
	CMaaS	Research article 'Empirical'	Germany	(Klopfer et al., 2023)	Title ☒ Abstract ☒ Keywords ☒
Collaboration (Institutional Integration)	CaaS (Collaboration as a Service)/MaaS 2.0	Research article 'Conceptual'	Australia	(Merkert et al., 2020)	Title ☒ Abstract ☒ Keywords ☒
	CaaS (Collaboration as a Service)/MaaS 2.0	Research article 'Empirical'	Australia	(Bushell et al., 2022)	Title ☒ Abstract ☒ Keywords ☒
Cycling (Micromobility)	CaaS (Cycling as a Service)	Research article 'Empirical'	Netherlands	(Petzer et al., 2020)	Title ☐ Abstract ☐ Keywords ☒
Walking (Active Mobility)	WaaS	Research article 'Conceptual'	England	(Lyons, 2020)	Title ☐ Abstract ☒ Keywords ☒
MaaS Precursor	MaaS Lite	Review article 'Conceptual'	Hong Kong	(Pickford & Chung, 2019)	Title ☒ Abstract ☒ Keywords ☒
Accessibility	MaaSINI	Research article 'Conceptual'	England Germany	(Dadashzadeh et al., 2022)	Title ☒ Abstract ☒ Keywords ☒

Theme	MaaS Extension/ Acronym	Source type	Country	Reference	Match with 'MaaS' OR 'Mobility as a Service' in abstract, title, and keywords
Blockchain	TrustedMaaS	Research article 'Conceptual'	Finland	(Nguyen et al., 2023)	Title ☒ Abstract ☒ Keywords ☒
Tourism	Tourism MaaS	Research article 'Conceptual'	Australia	(Leung et al., 2023)	Title ☒ Abstract ☒ Keywords ☒

2.8 Identified Variants

Table 3. Description of different MaaS variants

Code	MaaS Extension (Full abbreviation)	Definition/Description	Reference
	MaaS4PaF (Mobility-as-a-Service for Passenger and Freight)	"a user-oriented integrator of passenger and freight transport services enabling searching, booking and payment through a single digital platform for door-to-door customized trips. The users are both passengers and shippers, and those who perform the delivery (i.e. MaaS carriers) could be passengers, passenger transport operators, and freight transport operators."	(Le Pira et al., 2021)
	LaaS (Logistics-as-a-Service)	"When looking in detail, however, the MaaS4PaF adopts mainly the passenger transport perspective. It focuses more on the potential carriers and their role in the deliveries while neglecting the decision power of the receiver of the goods. In contrast, we perceive the LaaS as a freight-only system at this stage. Consumers are individuals or households that place an order which requires delivery. In the most simple case, LSPs make the deliveries."	(Beckers et al., 2023)
	eMaaS (Electric-Mobility-as-a-Service)	eMaaS involves the integration of multiple forms of electric transportation modes involving public transport and shared electric mobility services (e.g., e-scooter sharing, e-car sharing, e-bus, e-bike	(Anthony, 2023)

Code	MaaS Extension (Full abbreviation)	Definition/Description	Reference
		sharing, e-taxi), into a particular mobility service that allows citizens to plan and go from one point to another in a seamless and sustainable way.	
	CMaaS (Corporate Mobility-as-a-Service)	"We introduce here the concept of Corporate MaaS (CMaaS), by which we mean: • A MaaS service owned or commissioned, or in other ways controlled, by a corporation. • A MaaS service focused on transport within, to and from a work site or campus, or between work sites or campuses. The users of the service are the people working at or visiting the site."	(Hesselgren et al., 2020)
	CMaaS (Corporate Mobility-as-a-Service)	"CMaaS is mainly under the context of a company and enables mobility both within and to and from a worksite for employees (Hesselgren et al., 2019). CMaaS uses a business-to-employee model instead of a general business-to-consumer model."	(Zhao et al., 2020)
	CMaaS (Corporate Mobility-as-a-Service)	"CMaaS describes a multimodal mobility system that can be deployed in companies to meet the corporate mobility demand (cf. Hesselgren et al., 2020). In contrast to traditional fleet management, where owned or leased cars are the only available mobility options, CMaaS provides further alternatives to carry out a corporate trip. First, a CMaaS system can comprise all kinds of mobility modes, e.g., allowing for trips with micromobility modes like bikes and scooters in addition to car trips. Second, CMaaS combines the advantages of company-exclusive and public mobility services. Herein, company-exclusive mobility services are exclusively available to company members, e.g., vehicles that are owned or leased by the company, while public mobility services are available to all members of society, e.g., carsharing or taxi services."	(Klopfer et al., 2023)

Code	MaaS Extension (Full abbreviation)	Definition/Description	Reference
	MaaS 2.0/ CaaS (Collaboration-as-a-Service)	"Drawing from aviation experiences, we propose that smart ticketing systems, providing Software-as-a-Service (SaaS) can be extended with governance and operational processes that enhance their ability to facilitate Collaboration-as-a-Service (CaaS) to offer a reimagined $MaaS_{2.0}$ = CaaS + SaaS. Rather than using the traditional MaaS broker, CaaS incorporates operators more fully and utilises their commercial self-interest to deliver commercially viable and attractive integrated public transport solutions to consumers."	(Merkert et al., 2020)
	MaaS 2.0/ CaaS (Collaboration-as-a-Service)	Follows the above (Merkert el al., 2020) definition.	(Bushell et al., 2022)
	CaaS (Cycling-as-a-Service)	"Cycling as a Service (CaaS), referring to services such as bikeshare that provide users with temporary access to a bicycle, has been promoted around the world as a low-carbon form of urban mobility that is cost, energy and space-efficient."	(Petzer et al., 2020)
	WaaS (Walking-as-a-Service)	"WaaS has a very different business model underlying it to that of MaaS: MaaS is founded upon selling access to mobility WaaS is founded upon selling access to geography and access to consumers"	(Lyons, 2020)
	MaaS Lite (Mobility-as-a-Service Lite)	"The varying levels of success of MaaS and Mobility on Demand (MOD) lead the authors to propose MaaS Lite, which reflects an incremental approach to MaaS based on a simpler organisational arrangement that does not depend upon the introduction of a Mobility Operator as a new player. MaaS Lite also recognises that most trips are not complex at all, often based on one or two connected mechanised modes that meets highly local needs, including FM/LM service connectivity."	(Pickford & Chung, 2019)
	TrustedMaaS (Blockchain-Based	"[…] a blockchain-based MaaS system is an advisable means of supporting the rise	(Nguyen et al., 2023)

Code	MaaS Extension (Full abbreviation)	Definition/Description	Reference
	MaaS or Decentralized MaaS)	of the transportation company network. Blockchain technology, as the next generation of connectivity, is a unique public database maintained by network participants in a decentralized environment. A blockchain-based system emits most data to all participants for validation, resulting in a transparent set of data. Additionally, the formation of a unique database requires immutability to prevent any late modification by leveraging cryptographic schemes. As a promising perspective for trust formation, a decentralized MaaS system can be deployed by utilizing blockchain technology to achieve and guarantee trust among participants."	
	Tourism MaaS	"Given that the concept of tourism MaaS is relatively new, this research is motivated by the need to understand current transport challenges and how MaaS can be an opportunity for tourism development through improved mobility and better visiting experiences."	(Leung et al., 2023)

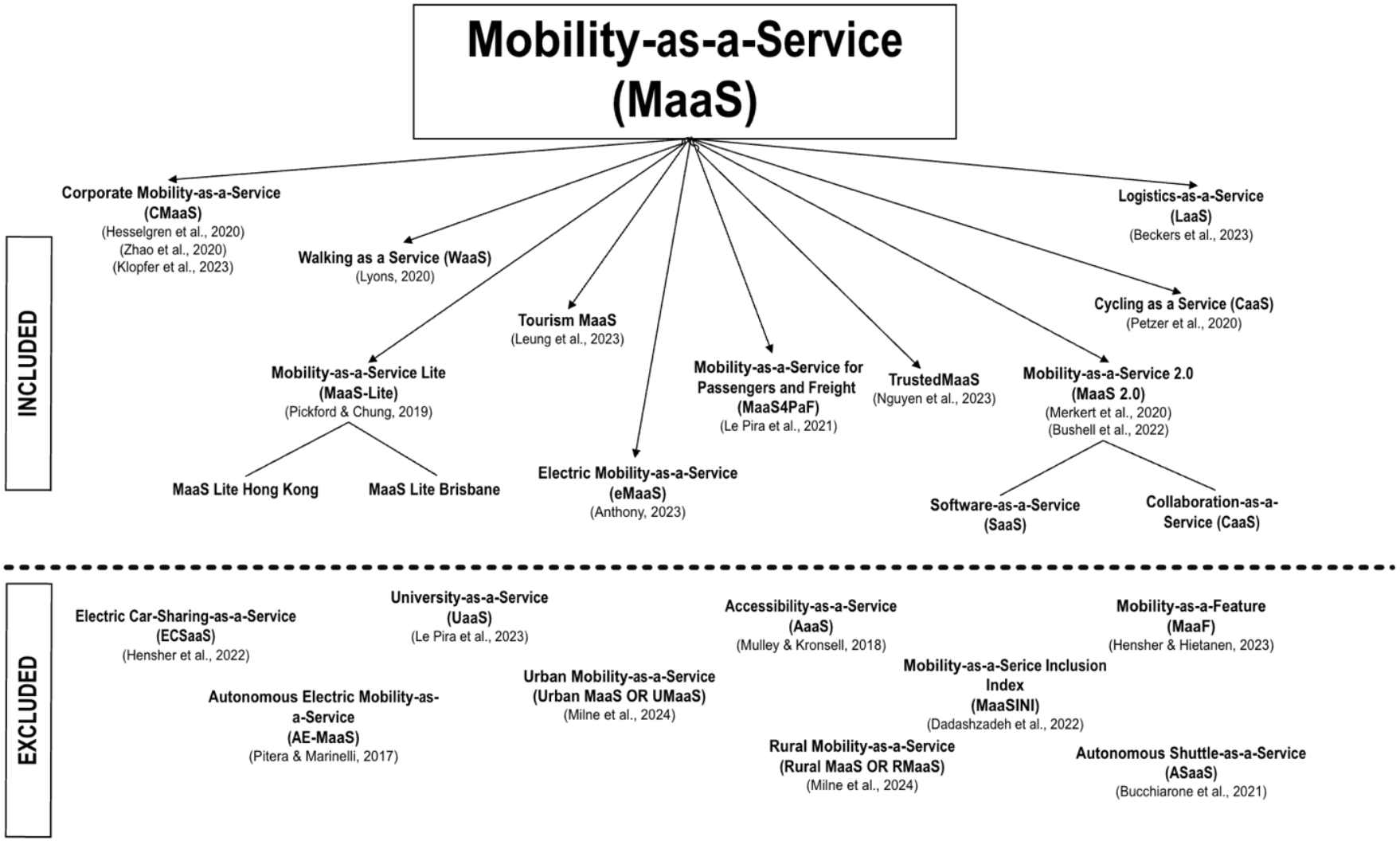


Figure 3. MaaS Varaints Covered under ScienceDirect SLR (created by the Author)

2.8.1 Mobility-as-a-Service-for-Passenger-and-Freight (MaaS4PaF)

MaaS4PaF is an expansion of the MaaS scope, theorized by (Le Pira et al., 2021), towards the handling of freight (cargo or goods) transportation. The conceptualization entails the inclusion of consigners, consignees, and Freight Transport Operators (FTOs) along with their respective logistics platforms into the MaaS ecosystem. Integration of MaaS and FTOs range from high (Passenger-Driven MaaS4PaF) to intermediate (PTO-Driven MaaS4PaF) to low (FTO-Driven MaaS4PaF).

He value proposition underpinning MaaS4PaF is premised on the possibility of achieving much needed downstream cost savings within last-leg, also known as 'Last Mile', deliveries in supply chains. Through full integration (Passenger-Driven MaaS4PaF) users will be able to draw on and combine services of Transportation Service Providers from MaaS, such as PT or ride hailing, and MaaS passengers (engaging in parcel delivery) in conjunction with FTOs. The emergence of MaaS4PaF further blurs line between MaaS and other emergent mobility concepts such as Mobility-on-Demand (MOD). As highlighted by Shaheen & Cohen (2020), the focus on the transportation of both passengers and goods is what sets MOD apart from MaaS.

Overall, it should also be noted that the flexibility enabling the provision of additional functionalities (Smith & Hensher, 2020) and services through MaaS such as shopping discounts, accommodation and restaurant booking (Liu et al., 2020), parking and, in the case of MaaS4PaF, delivery of goods has been established as one of its distinguishing characteristics through a thematic analysis conducted by Alyavina et al. (2022), a review of MaaS topological frameworks by (Bandeira et al., 2022), and as part of the 'User-Centricity' tenet on which MaaS is premised based on the work of Wittstock & Teuteberg (2019). Further validating this perception of MaaS has been feedback collected from respondents in a tourism -based MaaS, labelled *Tourism MaaS*, offering study whom indicated offering non-transport value added services, such as the aforementioned examples, as key in ensuring a successful MaaS scheme (Leung et al., 2023).

2.8.2 Logistics-as-a-Service (LaaS)

A similar concept to MaaS4PaF, premised on the tenets of MaaS, has been put forward by Beckers et al. (2023) in the form of Logistics-as-a-Service. To clearly delineate between LaaS and MaaS4PaF, the authors have conceived LaaS to be a freight-only – centered on the triadic

relationship between consumers, shippers, and Logistics Service Providers (LSPs) – system as a key distinguishing factor from MaaS4PaF which, the authors posit, mainly adopts a passenger transport perspective. Likewise, the authors have repurposed the MaaS integration index developed by Sochor et al. (2018) to establish key parameters for the different LaaS integration levels.

- Level 0 (No integration): Information from single LSPs available to consumers.
- Level 1 (Integration of Information): Information on delivery alternatives and tracking data from several LSPs available to consumers.
- Level 2 (Integration of Booking and Payment): Offers the option for consumers to pay for selected services, although, multiple online deliveries are considered individually.
- Level 3 (Integration of Services): Enables consumers to consolidate multiple shipments for last-mile delivery although this level of integration hinges on shared contracts and responsibilities between several shippers and LSPs.
- Level 4 (Integration of societal goals, policies, and incentives): Allows for the establishment of a broader organization of urban freight through clear policy regulations and micro-consolidation hubs which has been theorized to reduce the societal and environmental impact of urban freight.

Moreover, the multi-sectoral interest shown in the MaaS model – and more specifically, it's potential in opening new sales channels, if not outright new markets (Mulley, 2017) hence the partnerships the have been struck between the Sydney MaaS trail/Insurance Australia Group (IAG) and MaaS Gobal/Unipol in Italy (Hensher & Hietanen, 2023) – paves the way for further service integration from industries such as health-care to tourism (such as hotel reservations) (Jittrapirom et al., 2018) to entertainment (cinema tickets) (Storme et al., 2020) and other services such as gym and restaurant bookings (Pangbourne et al., 2018). The same logic has also been mirrored in the **Mobility as a Feature (MaaF)** conception put forward by Hensher & Hietanen (2023) in which the authors posited that the realization of sustainability objectives via MaaS is more likely to occur under conditions where both financial and non-financial incentives are used. Focusing on the latter, this is where parallels between MaaS4PaF and MaaF can be drawn; namely, non-financial incentives centered on non-transport offerings such as discounts on retail purchases and broad-based tourist expenditures. Although, Chen et al. (2023) have concluded that the inclusion of

discounts for shopping and tourist attractions as part of a MaaS bundle has little bearing on users' price elasticity thus demonstrating that users are mobility options.

2.8.3 Electric Mobility-as-a-Service (eMaaS)

Another MaaS variation, **eMaaS – short for electric-Mobility-as-a-Service**, has been proposed by Hensher et al. (2022) in which the authors envision the prioritization, and extensive use, of shared electric vehicles – which may also include electric bicycles, Segway, and other forms of electric micromobility (Anthony Jnr et al., 2020) – as a means towards enabling sustainable mobility by acting as a stepping stone away from the dominant regime of private car ownership towards increased MaaS uptake. This type of scheme has been accordingly modified and christened as **'Electric-Car-Sharing-as-a-Service' (ECSaaS).** Adopting the same rationale, albeit published in the grey literature, (Pitera & Marinelli, 2017) have investigated the feasibility of a reconfigured MaaS setup premised on both electric and autonomous mobility – what the authors aptly labelled as **Autonomous Electric-Mobility as a Service** or **AE-MaaS** in short.

2.8.4 Rural and Regional Mobility-as-a-Service

Likewise, on the basis of geography, Mulley et al. (2023) were able to analyze and categorize MaaS pilots as either **'Rural MaaS'** or **'Regional MaaS'** – A differentiated approach that according to Storme et al. (2020) will very likely be required considering that sparsely populated areas outside of cities that lack critical mass hamper the viability and widespread uptake of MaaS. Expanding on this strand of the MaaS literature, (Milne et al., 2024) present the standard MaaS conception, which the authors implicitly inferred as Urban **MaaS (UmaaS),** in contradistinction to **Rural MaaS (RmaaS)** on the basis of tailoring MaaS offerings to reflect common attributes within these distinct geographical areas.

2.8.5 Accessibility-as-a-Service (AaaS)

Aiming to further crystallize the prospect of MaaS in stimulating the transition from the currently dominant 'ownership of transportation' model towards a 'usership of transportation' model (Jang et al., 2021) based on accessibility, (Mulley & Kronsell, 2018) have even floated the question of whether the concept should be relabeled as **'Accessibility as a Service'**.

2.8.6 Corporate Mobility-as-a-Service (CMaaS)

Corporate MaaS (CMaaS) which has been conceived and described by Hesselgren et al. (2020) as a MaaS service owned, or commissioned, by a corporation that focuses on transport within, to, and from a work site or campus with the users being people working or visiting the site.

Similar to MaaS Lite it acts as a precursor to, or a 'sandbox' version of, full-scale MaaS with clearer parameters and lower barriers in respect to aspects such as ridesharing where user uptake may be less of an issue considering that in this type of MaaS users are more likely to be familiar with one another hence minimizing the risk of *Human Element Externalities* – as posited by Alyavina et al. (2020) where negative human behavior such as discourtesy, abuse, disobedience, and negligence act as deterrents to MaaS. Similarly, the ride-matching process is further simplified due to the number of overlapping trips that are generated through CMaaS given it is premised on the location of the corporation (or organization) deploying this type of MaaS – this promotes the use of 'casual carpooling' which can be regarded as a subset of ridesharing with the main distinguishing feature being that both the driver and passenger share the same (or similar) destination (Wong et al., 2020). Although CMaaS has been trailed in a company in Sweden, one of the conspicuous omissions was the exclusion of PT integration due to taxation issues (Zhao et al., 2020) – this may seem problematic considering the central role PT is set to play in MaaS; where in some cases such as the Finnish *Whim* MaaS experience, PT has been shown to cover 95.2% of all *Whim* trips (Christensen et al., 2022). The CMaaS concept has gained further traction in the literature based on the work of Vaddadi et al. (2020) whom managed to expand on CMaaS by constructing a multi-tier evaluation framework that gauges its social, economic, and environmental impact on individuals, companies, and society.

From a practice theories perspective, CMaaS fulfils the vision of MaaS, as posited by Christensen et al. (2022), where the mobility solutions are directly predicated on, and tailored to, people's everyday routine – in this case focusing primarily on commuting. This is important given how the confluence between everyday activities and routinized mobility, highlighted by the authors, currently advantages and solidifies the position of the private car regime. Lastly, the focus on routinized mobility inherent in reconceptualized forms of MaaS – i.e., either CMaaS for commuting needs or Tourism MaaS (Leung et al., 2023) for leisure, touristic transport related

needs – has been posited based on findings from Hoerler et al. (2020) to simplify the as-of-yet daunting task of designing policy measures that meaningfully regulate MaaS.

2.8.7 Walking-as-a-Service (WaaS)

The emphasis placed by WaaS on monomodal transportation – namely on walking – necessitates alterations to some of the values under the 'Type of Service' dimension. To illustrate, the emergence of apps such as Google Maps have been deemed central to the WaaS conception in that such app-navigation tools allow for more seamless wayfinding and lowering of cognitive barriers that might deter people from relying on walking as a modal option for short-distance trips due to their unfamiliarity with both spatial (i.e., ideal route) and temporal (i.e., time requirement) factors needed for navigating journeys solely covered by walking.

The enabling role played by app-navigation tools in WaaS further accentuates the importance of key antecedents needed for access to, and adoption of, tools such as Google Maps. These range from smartphone ownership and technological proficiency to internet access through both Wi-Fi and cellular data allowing for key functionalities such as Global Positioning System input supporting app-navigation tools. Nevertheless, GPS-dependency has also been challenged considering the emergence of Visual Positioning Systems (VPS) – an option for horizontal extension – which are claimed to be more capable of estimating precise positioning and orientation (Lyons, 2020).

As the entire WaaS conception is centered on wayfinding the emphasis becomes on not only providing users with concrete information but also dynamic information that is updated in real-time to accurately reflect the state and usability of the infrastructure (such as sidewalks and road crossings which might be blocked due to no-notice construction work or accidents) in a given WaaS journey. Although this does not necessitate the need for either vertical or horizontal expansion, such data is important for WaaS to be perceived on par with navigation functionalities (information from Traffic Incident Management systems) that are available for other, more dominant, forms of transport such as private car use.

2.8.8 Cycling-as-a-Service (CaaS)

In their analysis of different business models adopted by Dutch CaaS providers, Petzer et al. (2020) have elucidated on the bundling of support services (such as bike repair) as part of the CaaS value

proposition offered to users. In addition to reshaping the relationship between users and powerful regime actors (which based on the study context referred to bicycle retailers and local repair shops). Furthermore, this represents another example of a non-mobility value added service, similar to those discussed under MaaSPaF and Tourism MaaS, that can be considered under MaaS.

2.8.9 TrustedMaaS: Mobility-as-a-Service with Blockchain

The introduction of blockchain technology in MaaS has been heralded on the basis of the immutability and decentralization that the technology would enable in a complex transport ecosystem such as MaaS. Yet, such benefits, that might accrue from decentralization as an example, threaten to complicate other facets central to the MaaS conception. To illustrate, the authors Nguyen et al. (2023) have cautioned of the potential for heterogeneous routing information (formats) across several TSPs within a MaaS ecosystem as a byproduct of the decentralization enabled by blockchain technology. If unabated, key MaaS functionalities such as integrated journey planning and seamless single payment options for multimodal bundles are at risk of becoming unattainable. Nevertheless, once standardization is in place, the decentralization enabled by blockchain bolsters the availability of multisource data and speed of retrieval (albeit dependent on pre-determined agreements between MaaS players within a given blockchain scheme) all of which act as key antecedents for services/functionalities such as transport sharing, intermodal interchanges, and monitoring and optimization of traffic flows. Although far from introducing new functionalities, the reliance on cryptographic schemes that underpin blockchain technology in MaaS systems present unique opportunities prime for further exploration i.e., the adoption of cryptocurrencies as a payment option.

Focusing on the innovative aspect dimension of TrustedMaaS and it's immutability – again, a hallmark of blockchain technology – could potentially be considered as a conduit for further 'Transparent' considering the central of blockchain within such platforms. Similarly, the decentralization and absence of intermediaries within blockchain platforms are enabled by consensus mechanisms which, altogether, is testament to the participatory nature of TrustedMaaS.

2.8.10 Tourism Mobility-as-a-Service (Tourism MaaS)

Passengers in Tourism MaaS are assumed to exclusively be, as the title suggests, 'tourists', focusing on subcategories such as *Free Independent Travelers*, whom might have unique

mobility/recreational needs. Thus, the focus goes beyond simply meeting mobility demand from origin to destination and towards meeting recreational needs. Thus, the scope of journey planning is inadvertently broadened to encompass data relating to events, accommodation, attractions, additional Points-of-Interest (POI) (i.e., shops and dining), and Destination Marketing Organizations (DMOs) synthesized with traditional multimodal travel data.

The same reasoning extends towards both transport authorities and resource owners where in the case of the former the catchment area is potentially horizontally extended to also include governmental tourism bodies as an equal governing and regulating body alongside transport authorities.

Tourism MaaS may act as a conduit through which passengers/tourists can be nudged, and incentivized, towards adopting more environmentally friendly transportation options Thus, Tourism MaaS, in addition to delivering the standard MaaS benefits can also serve as a stepping stone towards the realization of sustainable/eco-friendly tourism objectives. A feat (secondary and cross-sectoral benefits such as ‘Supporting Green Tourism’) not reflected in the current scope of the literature.

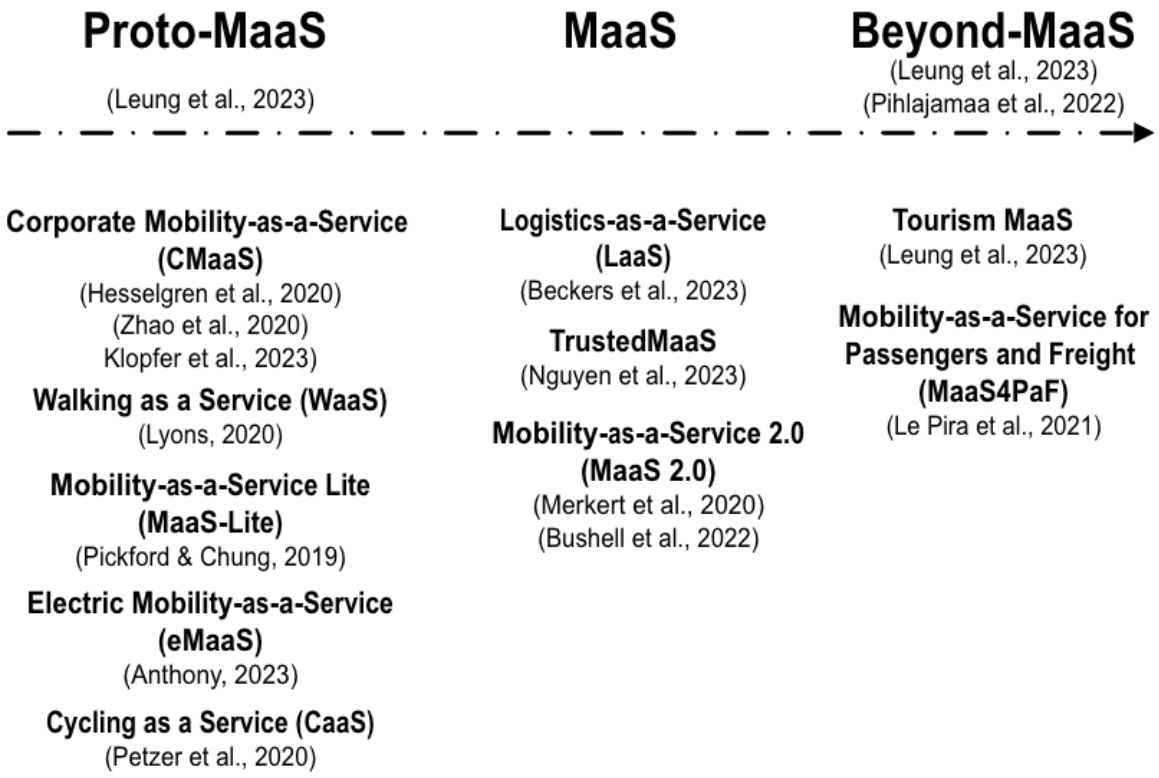


Figure 4. Classification of MaaS variants

2.9 Car-substitution effects: The case for MaaS Lite and CMaaS

Through the four cross-mode relationship scenarios posited by (Mokhtarian, 2002), and cited in (Storme et al., 2020), it has been determined that an outright substitution or replacement of car travel by MaaS is unlikely and that one of the more plausible scenarios would be a substitution effect that takes place on a short term basis and for specific applications only (Storme et al., 2020) – which in this case can be construed as applicable towards commuting purposes.

Following the same line of reasoning, Zhao et al. (2020) have also underscored the need for constructing other variants of MaaS geared towards meeting complex travel needs within specific contexts which is the aim of this study. Altogether, this has led Pritchard (2022) to caution against conflating 'MaaS enabling a reduction in car use' with 'MaaS completely substituting car use' especially as evidence for the latter remains less compelling – this further necessitates that the overly positive rhetoric (Pangbourne et al., 2018) behind how MaaS is marketed (i.e., 'better than owning a car', 'the end of private car ownership', or as MaaS Global advertises itself 'mobility on

a whim') should be carefully tempered (Smith & Hensher, 2020). Similarly, Hensher et al. (2022) have echoed that sentiment by stating that the car "as an entity" is not about to disappear and emphasized the need for repurposing car use towards the attainment of sustainability outcomes. Complicating the matter even further is the lingering 'chicken and egg' dilemma facing MaaS: where, through the balancing of supply and demand, it becomes difficult to offer MaaS services at a competitive price point whilst ensuring sufficient added value that is comparable to that offered by private car ownership (Kostiainen & Tuominen, 2019). This is something that might continue posing downward pressure on MaaS preventing it from expanding beyond being a niche development (Labee et al., 2022).

2.10 Level of Integration and MaaS Integration Topology

Note: In Dadashzadeh et al. (2022), the authors have mistakenly conflated the MaaS Integration Index (MII), developed by Kamargianni et al. (2016) and discussed below, with the MaaS Maturity Index (MMI) that has been originally termed and developed by MaaSLab (MaaSLAB, 2016).

2.11 MaaS Integration Index (MII) (Kamargianni et al., 2016)

Drawing on the extant mobility integration literature, the MaaS Integration Index – developed and proposed by Kamargianni et al. (2016) – was initially geared towards distinguishing between the different levels of integration within various MaaS pilots. The proposed index branches out into three categories:

MaaS pilots with partial integration: Encompasses mobility schemes where integration of some, but not all of the following is achieved: ticketing, payment (single-invoice), and ICT.

MaaS pilots with advanced integration: Encompasses mobility schemes that are able to achieve full ticketing, payment, and ICT integration.

MaaS pilots with advanced integration and mobility packages: This category is designated for mobility schemes that are able to achieve institutional integration – in addition to full ticketing, payment, and ICT integration – and offer monthly subscription plans to households tailored towards their mobility needs. Additionally, bonus points are awarded to users to incentivize the use of sustainable choices i.e., electric cars and bikes – although few MaaS projects have attempted to incorporate pricing strategies and incentives that stimulate the uptake of more sustainable modes

(Bandeira et al., 2022), resorting to intervention options (factoring in congestion charges, taxes, and parking fees) and encouragement options such as introduction of free access to PT – or as suggested in Ho et al. (2018), lowering of PT fares – are instrumental in pivoting the travel behavior of passengers towards more sustainable transport modes (Alyavina et al., 2020; Esztergár-Kiss & Kerényi, 2020).

Although, such incentive mechanisms (i.e., free PT tickets) hold the potential for disrupting the prevalent and stable automobility context – which has even been described as "*the foundation of urban development on a worldwide scale*" (Metz, 2013) – by helping overcome the social barriers posed by personal car ownership (Zhao et al., 2020) and nudge habitual car users towards more sustainable modes, there is a high risk that any benefits that are yielded by such incentives would remain temporary (Storme et al., 2020) along with critical questions on the cost-effectiveness of adopting such an approach on the long-term commercial viability of MaaS (Ho, 2022).

This type of gamification approach that aims to influence travel behavior to obtain societal and sustainability goals has been partially tested in a Sydney MaaS trail, through a smartphone app called *Tripi*, but has been cut short due to the pandemic. Nonetheless, some interesting findings did emerge from that study, by Hensher et al. (2021), after a group CO_2 challenge has been introduced in March 2020 where, by the end of each month, a $1 incentive is offered for every percentage reduction in average CO_2 emission per km travelled. Due to the governmental lockdowns and restrictions introduced following March 12, the authors were forced to infer CO_2 emission levels based on the travel data of the preceding month [February], where emissions have increased by 1% hence rendering the group ineligible for the financial reward. Altogether, these initiatives evidence the potential use-case of MaaS as a conduit for enforcing location-and-time specific mobility measures aimed at promoting the use of sustainable modes (Storme et al., 2020).

With the gradual removal of lockdown restrictions, Ho (2022) was able to further analyze data from the resumption of the Sydney MaaS in-field trial and richer data collated by the *Tripi* app. Some of the key overall findings include the ability to reduce CO_2 emissions by 3kg for every 1$ spent incentivizing subscribers – which equates to $333/tCO_2e$.

2.12 The 4 service layers of the MaaS value network:

First layer (producers and manufacturers): this category encompasses vehicle manufacturers (OEMs), components providers, and system integrators – key players within the MaaS ecosystem that are only limited to the provision of the physical assets (i.e., vehicles) needed to operationalize transport services but with minimal to no involvement in how those assets are utilized.

Second layer (transport services): this category includes TSPs from both public and private sectors. The authors have also emphasized the role assumed by public sector TSPs (and public authorities) in tackling transportation-related externalities and ensuring the provision of transportation services in areas that might be deemed commercially infeasible and hence unattractive to private sectors TSPs.

Third layer (supporting services): players within the category can be construed as auxiliary service providers such as suppliers of the software, hardware, and overall IT infrastructural requirements needed for MaaS and other smart services (Anthony Jnr et al., 2020). These players can help minimize technological heterogeneity and promote cross-organizational interoperability through the standardization of data and APIs (that include different protocols, data formats (i.e., comma-separated values (CSV), text file format (TXT), JavaScript object notation (JSON), and more (Anthony Jnr et al., 2020)), and service types and features) of different entities within a MaaS scheme.

Fourth layer (MaaS operators): this where MaaS-unique roles such as MaaS operators, brokers, and integrators serve as one-stop shops by amalgamating the services and resources offered by individual TSPs into multimodal subscription packages that can be procured by customers through a single interface (API) with a single transaction.

Level of Integration (Sochor et al., 2018)

To add further structure to the MaaS concept, Sochor et al. (2018) have to constructed a multi-tier topology delineating the different levels of integration within MaaS.

Starting off with ***Level 0*** where all resources, services, interfaces, information, and payment mechanisms are fully fragmented and separated from one another.

Level 1 Integration of Information*:* the authors have highlighted the importance of seamless information sharing, with data of varying degrees of sensitivity, but have also laid bare areas of concern such as increased use of centralized ICT-based transport services such as MaaS (Jittrapirom et al., 2018) and data ownership – which derives from the broader and contentious asset ownership debate within MaaS (Pickford & Chung, 2019) along with the benefits that might be accrued from owning extensive amounts of data; user reticence in sharing personal data due to qualms on how such data will ultimately be stored and handled; and adherence to regulatory policies, which vary according to jurisdiction, such as the General Data Protection Regulation (GDPR) in the EU which has prompted authors such as (Cottrill, 2020) [1] to explore the compatibility of the privacy policies of an existing MaaS app, Whim, with GDPR requirements.

Overall, users' declining to share personal information will result in data incompleteness and deteriorate data quality which will only serve to undermine the development and feasibility of MaaS (Huang, 2022; Servou et al., 2023) and not to mention the quality and resilience of the service offered to users: "*Also, a user that provides permission for his/her ETA* [Estimated Time of Arrival] *to be disclosed by a rail operator for a pre-booked bi-modal trip, could enable a interconnecting taxi service to be alerted as needed, reducing taxi driver waiting time whilst avoiding the need for the user to manage the train-to-taxi transfer*" (Pickford & Chung, 2019). Two types of data categories have been identified as central to MaaS. Firstly, Historical (Conventional) data which ranges from GIS and scheduling to survey data. And, secondly, Dynamic data (Big Data) which ranges from GPS data, data fed from built-in sensors positioned across the transport network, public transport data, mobile phone and social media data (Servou et al., 2023), to data from EV meters, weather stations, and other geo-location enabled devices (Anthony Jnr et al., 2020).

Level 2 (Integration of Booking and Payment) places added emphasis on the need for accurate information sharing as this stage focuses on operationalizing and channeling such data towards

[1] The author has also adopted the evocative term 'MaaS Surveillance' within the title of the article as testament to the potential of data mishandling that might be engendered by MaaS

enabling prospective MaaS users access to multimodal services – accessing the services of different Transport Service Providers (TSPs) but through a single transaction and interface.

Level 3 (Integration of Service Offer) further builds on the preceding two levels by facilitating contract and risk sharing between a multiplicity of TSPs, management of revenue streams, as well as bundling of disparate resources and services into what would ultimately be offered to users as unified MaaS bundles or subscription packages – which has led some authors to even refer to MaaS as the "*Netflix of Transportation*" (Ho, 2022). This is also where posited roles within the MaaS ecosystem such as a MaaS Broker feature heavily in carrying out fundamental tasks to ensure the commercial viability of a MaaS business model by, for example, capitalizing on market competition through continuously screening and enlisting suppliers (TSPs) that may further enrich, and maintain, the value offered to users.

Level 4 (Integration of Societal Goals) is where commercial viability is superseded by societal objectives which, even if formulated on a national level, are often distilled from broader commitments such as, in the case of MaaS, fulfilment of pertinent Sustainable Development Goals (SDG) targets such as SDG Target 11.2 which centers on expanding the uptake of, and reliance on, public transportation that should be accessible (Indicator 11.2.1: 500 m walking distance to low capacity PT or 1 km walking distance to high capacity PT), affordable, safe, and inclusive. Similarly, Bahrain's commitment to total net-zero decarbonization by 2060 along with a 30% reduction in emissions by 2035 as a milestone target following COP26 would lend further urgency to attain this level of integration within MaaS. MaaS has already been cast in a similar light. Namely, as a disruptive socio-technical system (Fenton et al., 2020; Smith & Hensher, 2020) that can contribute towards the 1.5 degree goal set out in the Paris Agreement (Wilson et al., 2019). However, a more concerted effort at integrating MaaS into transport, environment, and energy policies within cities is required considering that the lack therefore has been viewed as a strategic omission that inhibits the ability of MaaS from contributing towards sustainable urban mobility by authors such as (Pangbourne et al., 2018)

This topology has gained traction in the literature as demonstrated by the work of Mulley et al. (2023) whom utilized the topology to distinguish between different levels of integration of MaaS pilots within rural and regional areas in Finland, Sweden, and the USA – none managed to get beyond levels 1 and 2.

Level of MaaS Integration (LMI) Taxonomy (Lyons et al., 2019):

The LMI taxonomy formulated by Lyons et al. (2019) – originally inspired by the SAE taxonomy for vehicles' automation (Bandeira et al., 2022) – starkly differs from the preceding MaaS Integration multi-tier topology, by Sochor et al. (2018), in light of one key omission: societal and sustainability goals. Instead, the LMI taxonomy offers a more comprehensive and granular framework (ranging from 1 – 5) that can more accurately capture the level of informational, transactional, and operational integration across modes and journeys within a MaaS platform. The three aforementioned facets of MaaS integration also double up as the basis for determining '*Cognitive User Effort'* – a metric developed by the authors to reflect the effort involved in obtaining and relying on MaaS services with minimal reliance on private cars. The authors also posit a negative correlation between LMI and Cognitive User Effort (CUE) – i.e., as LMI increases, CUE decreases.

2.13 Sustainable-MaaS (or S-MaaS) (Vitetta, 2022)

Vitetta (2022) further broadens the MaaS integration scope by building on the work of Sochor et al. (2018) and Lyons et al. (2019). Namely, the author proposes a more granular classification system which establishes subsets under the various MaaS integration levels and calls for the inclusion of a Decision Support System (DSS) as a conduit for embedding Transport System Models (TSM) and sustainability objectives which incorporate Space Economic Transport Interaction (SETI) models and Environmental Impact Functions (EIF) within MaaS. Below are the proposed MaaS categories along with subset examples put forward by the author:

Table 4. MaaS Categorization as 42established in Vitetta (2022)

Category	**Subset example**
MaaS 1.0 or I-MaaS (ICT-MaaS)	MaaS 1.1: Basic Integration MaaS 1.2: Limited Integration
MaaS 2.0 or T-MaaS (ICT+TSM-MaaS)	MaaS 2.1: Supply Design MaaS 2.2: Demand Management
MaaS 3.0 or S-MaaS (ICT+TSM+Sustainability-MaaS)	MaaS 3.1: Agenda 2030 MaaS 3.2: Smart planning

In line with the DSS elucidated by Vitetta (2022), Alyavina et al. (2022) and Kostiainen & Tuominen (2019) have further supported the premise of using MaaS as a decision-making support

tool to catalyze the transition towards sustainable mobility through incentives, subsidies, regulations, and informational campaigns which influence end user trip decisions. This, in turn, reinforces the need for delineating between policy-orientation and business orientation when offering mobility services, as posited by Ikezoe et al. (2021), with particular emphasis on the former in order to attain societal and sustainable goals such as reduction in private car use and congestion.

Similarly, Pritchard (2022) has also envisaged some of the key characteristics that should be enabled by a 'sustainable MaaS system'; namely, the de-normalization of private car use in society – by, as an example, meeting the practical needs of users by eliminating unnecessary journeys, such as the bundling of errands for single items seen in the *UbiGo* trial (Christensen et al., 2022), through offering non-mobility services such as grocery deliveries as part of MaaS which is consistent with the MaaS4PaF construct put forward by Le Pira et al. (2021) –, encouraging modal efficiency, lower access barriers, facilitating active travel, and being viable to all stakeholders – something that may potentially pit commercial objectives against sustainability targets (Jittrapirom et al., 2018) which might cause fissures between stakeholders, with incompatible and conflicting institutional – economic, social, and green (Grinevich et al., 2019) – logics (Schulz et al., 2020), within a MaaS ecosystem and result in outcomes similar to that of *UbiGo* which saw its abrupt discontinuation following irreconcilable divisions between key stakeholders (Fenton et al., 2020).

Moreover, Ho (2022) and Hensher & Hietanen (2023) have also called into question the ability of MaaS in instigating a shift in travel behavior towards more sustainable modes while, concurrently, delivering the promised commercial benefits to transport providers where the realization of the latter is also likely to necessitate cross-subsidization. Similarly, the role of broader markets trends, in this case liquidity, has also been emphasized in the work of Servatius et al. (2023) as a key factor in determining the successfulness of monetary incentives such as 'Tradable Mobility Credit' schemes.

The importance of de-normalizing private car use has also been expounded in findings by Christensen et al. (2022) in which the embodied routinization of everyday mobility (currently dominated and contributing towards the 'lock in' effect induced by private car use) and its entanglement with daily routines and practices stands in sharp contrast with current MaaS

schemes. The idea of de-normalization can also be construed as a key precursor phase that complements the three phases articulated during MaaS trials, as expounded by Signorile et al. (2018), such as *UbiGo* which are '*Acclimatization*' which pertains to learning from new behavior, '*Normalization*' which focuses on the implementation – or routinization – of new habits based on daily needs, and lastly, '*Stabilization*' in which new habits fully displace old ones and are firmly 'locked-in'. Moreover, these can also been seen as strategies of legitimation to increase trust and, more importantly, 'buy-in' towards MaaS (Fenton et al., 2020).

2.13.1 Additional Indices (on MaaS User Profile)

2.13.2 Latent Demand for MaaS Index (LDMI) (Zijlstra et al., 2020).

Innovativeness: This characteristic is manifest in individuals that can be considered as 'Early Adopters' – in accordance with Diffusion of Innovation Theory – of new technologies.

Tech-Savviness: Although the authors have raised concern over the potential for significant overlap between this indicator and *Innovativeness*, the authors have clearly distinguished between the two by defining 'Tech-Savviness' as '*people who are willing and able to easily navigate new technologies*' also referring to those that possess '*the skills with respect to digital technologies.*' Alyavina et al. (2020) in their thematic study have also identified '*Technological Readiness'* as a key antecedent for the uptake of MaaS highlighting a clear disparity between younger and older generations with the former deemed more capable in that regard which can even be evidenced by terms like hyper-connected and hyper-mobile used by Servou et al. (2023) and Labee et al. (2022), respectively, to describe this group. This digital gap has also been singled out by Pangbourne et al. (2018) and Servou et al. (2023) as a potential risk that may exacerbate existing mobility inequalities by enabling accessibility for the more predisposed younger, hyper-connected, user base. Fundamentally, this discussion harkens back to emphasis placed on Techno-specific knowledge, literacy, and access as one of the key pillars towards ensuring the successfulness of smart innovative solutions – also echoed in the 'smart cities for smart citizens' debate (Sharmeen & Meurs, 2019).

Altogether, this, coupled with the central role played by technology in enabling smart mobility schemes such as MaaS, has also brought further concerns of transport disadvantage fueled

by digital inequality (defined as vulnerability to digitization of transportation services), such as the exclusion of the unbanked or people that lack access to banking/credit card lines and who are unable to register on the MaaS app from benefits such as discounts – a key tool for stimulating the use of sustainable modes as evidenced by, for example, HANNOVERmobil where the inclusion of discounts for car rentals, taxis, and rail services in all public transport annual passes has resulted in half the users abandoning their car (Kostiainen & Tuominen, 2019) – available only for those holding a smartcard and registered on the app (Pangbourne et al., 2018), to the fore (Dadashzadeh et al., 2022). And, hence, the need for conducting more inclusive MaaS studies that do not heavily gravitate towards relying on input from younger people, or Millennials, which might skew findings considering that this population subgroup is more predisposed to using schemes such as MaaS (Signorile et al., 2018).

The same indicator can also be explored through one the analytical lenses used in Hesselgren et al. (2020); namely, the '*Competence'* lens – which in the CMaaS study was used to assess users' familiarity of technologies within the MaaS system with some interesting findings emerging such as users' obtaining and cycling using electric bikes without actually switching the electricity on to benefit from extra help offered by the battery.

Need for Travel Information: This indicator is premised on the notion that the presence of information and data offer added value to customers and is deemed central to the lifestyles they lead. (This indicator only focuses on assessing respondents' Willingness-To-Pay (WTP) for information by presenting the following questions (Indicator abbreviation as used in the original article: ranging from S22 to S25):

S22. *I would use a (smartphone) travel app if it were to give me an overview of all the possible travel options.*

S23. *I would be willing to pay for more precise and reliable travel information.*

S24. *I would pay more for personalised travel information.*

S25. *How often do you look for travel information?*

The phraseology used to frame the aforementioned informative variables (S23 – S25) (statements/questions) remains open to interpretation as 'Travel Information' could have also

included an additional variable on the inclusion of emissions data (both on the total journey – aggregate emissions – and on a mode-by-mode basis –disaggregate emissions) as part of the Confirmatory Factor Analysis (CFA) conducted by the authors.

Multimodal Mindset: Consistent with other findings, this indicator holds that 'Early Adopters' of MaaS are more predisposed towards experimenting with different modes and can be deemed to possess a 'Multimodal Mindset' with a higher likelihood of using MaaS.

The same has been supported by the classification of MaaS user clusters proposed by Chen et al. (2023) – *MaaS Skeptics, MaaS Supporters, and MaaS Enthusiasts* – and Lopez-Carreiro et al. (2024) – *Short-term Commuters*, *Active Travelers*, *Traditional Car-Supporters*, and *MaaS Admirers* – where users within the MaaS Supporters and Enthusiasts categories (the two most likely to adopt MaaS) have expressed distinct interest in the inclusion of shared cars and e-mopeds as part of MaaS bundles which also reinforces the importance of the next point: Choice within Modes. Worth mentioning also, is that the MaaS user topology presented by Chen et al. (2023) and Lopez-Carreiro et al. (2024) also reflects the categories set out in Nobis (2007). Namely, *MaaS Enthusiasts* and *MaaS Admirers* would most closely mirror the '*Multimodal Greens'* category which captures passengers with minimal reliance on car use (<10% of all trips). Likewise, the '*Multimodal Core'* in the study by Nobis (2007) is oxymoronically is used to capture passengers whom rely on a single mode of transportation for more than 70% of all trips and this description brings this category in line with both the *MaaS Skeptics* and *Active Travelers*/*Traditional Car-Supporters* categories.

Choice within Modes: Lastly, this indicator emphasizes the importance of offering variety within transport modes as opposed to across transport modes i.e., different types of vehicles for car-based schemes such as ride-hailing and ride-sharing.

2.14 MaaS Inclusion Index (MaaSINI) (Dadashzadeh et al., 2022)

Given that one of the key propositions underpinning Sustainability Transitions studies is the societal threat posed by sustainability issues such as the threat of climate change and social injustice (Smith & Hensher, 2020). The latter has laid the groundwork for the MaaS Inclusion Index (MaaSINI) which has been developed by Dadashzadeh et al. (2022) and centers on gauging

the accessibility of MaaS for Vulnerable Social Groups (VSGs) such as People with Disabilities (PwDs), Low-Income People (LIP), and the Elderly.

Such inclusivity criteria should also be reexamined, reconciled with, and discussed in relation to existing accessibility factors such as those put forward by the seminal work of Lucas (2012) who has coined the term '*Transport Poverty'* and demonstrated the multidimensional nature of this issue by elucidating on the seven factors below:

1. **Physical Exclusion**: represented by lack of appropriate infrastructural and tangible design within the transport network (i.e., vehicle design, wheelchair ramps, Braille signage etc.) inhibiting passengers' ability to both physically access the service and obtain pertinent information (fare rates, schedules, service updates etc.)

2. **Geographical Exclusion**: This stems from the lack of spatial coverage of the PT service network which results in the exclusion of those living outside the confines of the PT service area. This is most common in peripheral regions such as suburban and peri-urban areas. A useful metric that can be deployed to gauge the extent of geographical exclusion would be indictor 11.2.1 under the United Nations SGD Goal 11 which aggregates the number of people living within 500 meters (walking distance) from a low-capacity transit stop and 1000 meters (1 kilometer) from a high-capacity transit stop.

3. **Exclusion from Facilities**: Similar to the above, this type of exclusion is common for people living in remote regions (potentially suburban and peri-urban areas) where access to key facilities and services (i.e., healthcare, education, retail stores, pharmacies, supermarkets etc.) is extremely difficult and challenging due to the remoteness of where they reside.

4. **Economic Exclusion**: Probably one of the main drivers of PT subsidization, this type of exclusion is brought on by exorbitant transportation rates and fees that may be out of reach – or at a minimum, highly burdensome – for those that fall under the 'Precariat' category heralded by (Groth et al., 2021): defined as those who are socioeconomically marginalized within a society and are represented by a lack of formal education and job/income insecurity.

5. **Time-Based Exclusion**: Also dubbed as 'Time Poverty' in the literature, this type of exclusion is brought on by work and family demands that may significantly diminish passengers'

available time for transport further exacerbating the temporal limitations of traditional PT services.

6. **Fear-Based Exclusion:** This type of exclusion can be more prevalent and pronounced in contexts where lawlessness is endemic and crime rates are high. As such, this would only serve to deter usage of public facilities and spaces, such as PT networks, altogether or at least during certain time periods (after sunset due to heightened risk).

7. **Space-Based Exclusion**: Lastly, this type of exclusion is engendered by the improper space management that may prevent certain user groups for accessing public spaces (i.e., gated communities or first-class waiting rooms at stations.)

Further complicating matters would be the potential for different exclusion types intersecting to compound existing limitations and accessibility issues. This has been vividly illustrated by Velaga et al. (2012) in their work on the convergence of both '*Transport Poverty*' (spatiotemporal and infrastructural limitations of existing PT networks and lack of variety, or *multioptionality* as expounded by Groth (2019), in PT options) and '*Digital Divide*' (absence of requisite ICT and/or technological proficiency) amongst commuters within rural settings.

2.15 Sustainability and Environmental impacts of MaaS (Metrics)

To begin with a clear distinction between the different facets under the umbrella term 'sustainability' should be made. This is important consider the broad and heterogeneous interpretations of the term that can be inferred. These range from:

1. **Environmental Sustainability**: centers on the reduction of externalities such as various tailpipe or exhaust emissions, air and noise population, energy consumption, and transport mileage (Kostiainen & Tuominen, 2019).

2. **Social Sustainability**: premised on the provision of equitable (i.e., ensuring service coverage in underprivileged communities) and affordable access to mobility – refer to Dadashzadeh et al. (2022).

3. **Economic Sustainability**: ensuring the long-term economic feasibility of the transportation services and reduction of mobility costs for both users and TSPs.

4. **<u>Sustainable Public Transport Management</u>**: aimed at garnering greater cost-benefit efficient through the synergistic integration with MaaS.

Table 5. MaaS KPIs as developed by Vaddadi et al. (2020)

Level	Theme	Impact	KPI
Individual	Environmental	Travel Behavior	Total travel per individual per month % of multimodal trips Total number of trips per individual per month
Company		Energy Use and Emissions	CO_2 emissions of the company Fossil fuel energy use of the company
Societal			Total emissions Total fossil energy use

Further expanding the process of holistically gauging the environmental and sustainable impacts of novel mobility services, (Severengiz et al., 2020) have demonstrated the multifactorial nature of mobility emissions through a Cradle-to Grave Life Cycle Analysis (LCA) perspective – something that has been called for in the literature (Labee et al., 2022). Namely, the authors were able to delineate between the key LCA mobility phases such as Well-to-Wheel (WtW), along with sub-phases like Well-to-Tank (WtT) and Tank-to-Wheel (TtW), and Cradle-to-Gate (CtG) and Recycling.

Although MaaS has the ability to reduce private car use and associated emissions, as Eckhardt et al. (2020) has demonstrated through increased resource efficiency borne through higher occupancy levels and fewer kilometers driven gleaned from a comprehensive analysis of rural MaaS pilots in Finland, Ho (2022) have cautioned of an 'Offset effect' which may occur in cases where car-based options within MaaS are disproportionately favored by users – the same concern has been highlighted by Pangbourne et al. (2018) and Servou et al. (2023) but instead was referred to as a 'Rebound effect'. A concurrent uptick in both PT and car-sharing usage within MaaS pilots and studies has been one of reasons behind the lingering ambiguity regarding the environmental impact of MaaS (Klopfer et al., 2023).

Mirroring the same concern, Labee et al. (2022) have also warned against using short-term reductions of CO_2 equivalent tailpipe emissions as the sole metric for determining long-term sustainability considering that MaaS also engenders the risk of inducing an uptick in Vehicle Kilometers Travelled (VKT) which has, in general, thought to be a potential and unanticipated risk inherent in multimodal transportation (Nobis, 2007).

2.16 Is the MaaS set-up/ecosystem conducive for the attainment of societal goals?

The potential of MaaS in fulfilling societal objectives, such as emission reductions and transitioning towards more sustainable urban mobility, as posited in Level 4 MaaS and S-MaaS – christened by Sochor et al. (2018) and Vitetta (2022), respectively – should not be construed as a foregone conclusion (Pritchard, 2022), which already seems to be the case with MaaS (Pangbourne et al., 2018), considering the limited evidence (Labee et al., 2022) and lack of systematic assessments (Wittstock & Teuteberg, 2019) and substantial insight to support such claims, mainly, due to an overreliance on stated choice methodology (Wong et al., 2020) – i.e., Stated Preference (SP) experiments and surveys, which notoriously suffer from hypothetical bias (Ho, 2022), where the risk of inconsistency between what people say and do exists (Labee et al., 2022; Servou et al., 2023) – instead of Revealed Preference (RP) techniques which are challenging if not impractical considering the novelty of the MaaS concept and small-scale pilots (Labee et al., 2022). And the counterargument presented by Jittrapirom et al. (2018) in which commercial interests in MaaS (such as deciding where the service should be offered) might clash with, even potentially overriding, sustainability goals.

Moreover, the authors have also cited an example from the *Ubigo* trail where even though a reduction in car use has been reported, a desirable societal objective, the uptick in the use of PT has lowered revenue for the platform owner (Jittrapirom et al., 2018) which, along with emissions reduction potential of MaaS as reported in Ho (2022), further bolsters the case for the subsidization of MaaS (Pangbourne et al., 2018) – although the amount of subsidy allocations by governments have been limited to those earmarked for PT systems (Hensher & Hietanen, 2023), they are by no means fail-proof provided given that, if allocated poorly, they can limit opportunities for competition and curtail innovation (Kostiainen & Tuominen, 2019). Altogether, such risks have been attributed to unaligned commercial behavior, a phenomenon if left unchecked might result in

the sidelining of non-motorized transportation such as walking and bicycling purely on the basis that they do not generate sufficient revenue for MaaS (Pangbourne et al., 2018). As such, this has furthered the case for a government-contracted model of MaaS put forward by Wong et al. (2020)

Conversely, Ikezoe et al. (2021) have highlighted the potential risk posed by the niche status of smart mobility services such as MaaS where their commercial longevity of such schemes might inextricably hinge on attracting customers away from PT systems – something that can, if improperly governed, potentially result in MaaS succumbing to ideological pressure to create revenue streams out of previously public goods/services (Pangbourne et al., 2018) – which was used to further emphasize the need for publicly managed development of MaaS in order to ease the existing gap between business and social goals.

The same emphasis has been echoed by Pangbourne et al. (2018) in which the setting of minimum service-standards should be prioritized by the public sector involvement in MaaS to ensure the continuation of socially necessary services along with widened accessibility to the service. Or – as recommended by Hensher et al. (2023) – a MaaS tendering authority should be appointed, given the responsibility of establishing a slew of societal Key Performance Indicators (KPIs), and entrusted with the power to leverage financial and non-financial rewards to incentivize MaaS operators and subscribers to meet such KPIs.

2.17 MaaS and key theories

- Multilevel Perspective Theory used in Fenton et al. (2020)
- Neo-institutional Theory used in Smith, Sochor, & Sarasini (2018)
- Multi-governance Theory used in Audouin & Finger (2018)
- Unified Theory of Use and Acceptance of Technology (UTUAT), including extensions of the original model UTUAT2 and UTUAT3 in Lopez-Carreiro et al. (2024), and Technology Acceptance Model (TAM) Kriswardhana & Esztergár-Kiss (2024)
- Socio-technical Systems Theory and Actor Network Theory in Anthony Jnr et al. (2020)

2.18 The emergence of MaaS as a disruptive technology

Mobility-as-a-Service (MaaS) is technologically deterministic (Pangbourne et al., 2018) and is viewed as an outgrowth of convergent socio-technical trajectories (Fenton et al., 2020; Pangbourne et al., 2020; Smith & Hensher, 2020; Vaddadi et al., 2020; Wilson et al., 2019) and megatrends such as the servitization or the sharing economy (Alyavina et al., 2020; Arias-Molinares & García-Palomares, 2020; Kostiainen & Tuominen, 2019; Pangbourne et al., 2018; Smith, Sochor, & Sarasini, 2018; Xi et al., 2022) and collaborative consumption (Castellanos et al., 2022; Christensen et al., 2022; Mulley & Kronsell, 2018) which are driving the shift away from the current 'mobility ownership' model towards the more versatile 'mobility access' model (Audouin & Finger, 2018; Christensen et al., 2022; Hensher et al., 2020b; Ho et al., 2018; Jang et al., 2021; Kamargianni et al., 2016; Utriainen & Pöllänen, 2018).

Hence eliminating the 'sunk costs' associated with the former model (Jittrapirom et al., 2018) which might help alleviate the financial burden placed by *'forced car ownership'* on low-income groups, whom are already forced to live on urban peripheries poorly connected to PT systems (Cass & Manderscheid, 2018) hence suffer from *transport poverty* (Milne et al., 2024), without engendering the risk of isolating them economically and socially (Remme et al., 2022).

MaaS is also brought on by the rapid uptake and development of Information Communication Technology (ICT) (Boutueil, 2019; Signorile et al., 2018), digitized services and processes (Jang et al., 2021; Jittrapirom et al., 2018; Kriswardhana & Esztergár-Kiss, 2023) such as ride-matching algorithms (Hensher et al., 2020b) enabled through real-time information such as availability and location of vehicles, intermodal connections, routes, schedules, disruptions, and more (Servou et al., 2023) along with instant communication and dispatch (Shaheen & Cohen, 2020). Moreover, improved cellular connectivity i.e., 3G, 4G, and 5G networks, smartphone technology (APIs) (Alyavina et al., 2020; Hensher et al., 2020b; Ho, 2022; Mulley & Kronsell, 2018; Pangbourne et al., 2020; Signorile et al., 2018) are also central developments that feed into the MaaS ecosystem.

The *'Millennial Factor'* is used to denote marked changes in attitudes towards car ownership amongst the millennial generation (Mulley, 2017), such as cars no longer being held as status symbols (Wong et al., 2020), something that is also heavily driving MaaS research (Mulley et al., 2020) with the majority of MaaS uptake expected to be comprised of people within the 20-

30 age range (Dadashzadeh et al., 2022; Signorile et al., 2018) and urban dwellers (Labee et al., 2022). And national shifts in mobility and consumption patterns (i.e., the levelling off in car ownership rates in some countries leading to what has been dubbed as '*Peak Car'* (Bastian et al., 2016; Goodwin & Van Dender, 2013; Mulley et al., 2020), drop in license holding (driving license) (Kostiainen & Tuominen, 2019; Signorile et al., 2018), and the cessation of growth in per capita travel demand which has been conceptualized as the '*fourth era*' of travel (Metz, 2013)), collectively, render this a prime topic for continuous research.

The emergence of new and disruptive mobility schemes, heralded by the convergence of the aforementioned developments and technologies, such as MaaS has been met with raised, and even alarming, concern as to the future of traditional PT systems within this new and fluid mobility landscape – to further exemplify this point, notwithstanding the spatiotemporal limitations of traditional PT systems, emergent schemes such as MaaS have also brought into question the need for traditional 'brick-and-mortar' infrastructural requirements by introducing innovative alternatives such as 'Virtual Stops' (completely void of any of the physical elements of a conventional bus stop) that are exclusively visible through an electronic interface (smartphone app) (Harmann et al., 2022). Such shifts derive from a broader transition within the transport sector which is pivoting away from the 'hardware-centered' approach (vehicles, roads, general-infrastructure etc.) towards a user need-driven MaaS approach (Milne et al., 2024).

Altogether, this phenomenon has been encapsulated by a term that has been gaining gradual traction in the literature: the '*Uberisation*' effect (Alyavina et al., 2020; Hensher, 2020; Mulley & Kronsell, 2018; Wong et al., 2020) and specifically what it spells for the future of mainstream PT systems.

2.19 Terminological heterogeneity in the MaaS conceptualization

Testament to the fluidity of this burgeoning concept, and Wittstock & Teuteberg's (2019) claim that MaaS still remains fuzzy and ill-defined, would be the overlapping names (i.e., *Transport as a Service* being (Arias-Molinares & García-Palomares, 2020; Maas, 2022) and *Transportation as a Service* (Ho et al., 2018) being a less commonly used alternative reference to MaaS), and divergent characteristics (Fenton et al., 2020; Wittstock & Teuteberg, 2019; Wong et al., 2020), still ascribed to MaaS, with the most-cited definitions along with significant coverage stemming from the grey literature (Ho et al., 2018; Smith, 2021; Smith & Hensher, 2020; Utriainen &

Pöllänen, 2018; Wong et al., 2020) which authors such as Wittstock & Teuteberg (2019) have argued remains key for shaping greater conceptual clarity of the situational context of MaaS even though they remain riddled with assertions (travel time savings and impact on congestion and transport externalities) that lack rigorous empirical support Wong et al. (2020). Exacerbating the definitional dilemma has been the apparent proclivity of most authors to propose a new definition for MaaS (Daniela et al., 2022). This has fueled both contention and disagreement in academic and practitioner circles seeing as definitions are normally constructed on the basis of what different authors perceive to be the core element of MaaS (tech-based solution (app or system) and 'as a service' (integration of different services).

A more invasive examination of the MaaS phraseology by Milne et al. (2024) deduced from expert feedback, collated via interviews, has further accentuated the schisms (in how MaaS is defined, described, and perceived) that continue to fuel discord in the transport and mobility sector as evidenced by one of the more telling expert statements "*that it is different things to different people. It is not a single definition*". An additional statement obtained from the expert interviewees highly resonates with the state of research claiming that the concurrent development of both the MaaS concept and socioeconomic/technological changes over the last decade has inadvertently steered the broader MaaS discourse towards defining a second iteration of MaaS or what the authors have labelled as MaaS v.02.

Sarasini et al. (2017) have even cautioned against the pre-emptive development of a MaaS definition, at this stage, alluding to the high risk of such a definition becoming redundant given that MaaS is premised on the convergence of multiple innovative solutions which are currently in a state of fluidity (Wittstock & Teuteberg, 2019) something that is derived from the broader belief that data and information produced by ICT enhance the capabilities of Transport System Models (TSM) casting the mobility phenomenon as a dynamic and continuously evolving system (Russo & Rindone, 2023).

One of the key implications of the 'definitional gap' (Wong et al., 2020) posed by not having unanimity, or at least common understanding, on the definition (Christensen et al., 2022; Zijlstra et al., 2020) and core components that make up MaaS, along with what its core objectives should be, is that it simply generates barriers moving forward (Fenton et al., 2020) and paves the way for more questions than answers – leading TNCs, vehicle manufacturers, consultancies, and

think tanks, amid the hype and dogma, to portray and promote new technologies (Wong et al., 2020) like MaaS as a panacea for all of the externalities associated with the current mobility landscape (Labee et al., 2022; Mulley & Kronsell, 2018; Pangbourne et al., 2018). The same criticism of MaaS has also been raised by both Ho et al. (2018) and Storme et al. (2020) in which the key purported benefits of MaaS remain nothing more than forward-looking expectations, based on conceptualizations (Wittstock & Teuteberg, 2019), that have yet to be clearly framed and empirically supported (Ho, 2022) rendering them at best, in the words of Storme et al. (2020): "*sales pitches by commercial organizations, think pieces or theoretical exercises*". The same has also been considered to be true with the SDGs enshrined under the Agenda 2030 framework where the lack of a clear and well-defined path towards the attainment of their subcategories, targets and indicators, has rendered them as simply declarations of principle (Russo & Rindone, 2023).

With the impact of MaaS on sustainable mobility still unknown (Servou et al., 2023), this collectively lends credence to one of the points emphasized by Docherty et al. (2018) in which the framing of clear overarching goals along with a stringent commitment to realize those goals will allow innovative schemes such as MaaS to flourish while simultaneously enhancing public value. Smith & Hensher (2020) have even come to see the development of a shared terminology for MaaS as one of its key antecedents considering that the entire premise underpinning this concept hinges on multiple actors pooling their resources, a requisite that may be jeopardized by inter-organizational cognitive distance caused by lack of communication and shared language.

On a philosophical level, the nature of this topic merits its classification as "highly fluid" hence deserving of continuous corroboration and empirical research. This is coupled with the visible shift in passenger travel behavior triggered by COVID-19 (Duan et al., 2022) which has created a marked before-and-after effect in the literature and impacted most of the ongoing MaaS pilots in terms of attracting users and subscribers (Labee et al., 2022). Although this has been deemed a temporary effect which should abate as more people get inoculated, authors such as Pritchard (2022) have cautioned that explicitly linking behavioral change to a MaaS trail might be further complicated in a post-pandemic setting.

2.20 Bahrain's Commitment to Sustainable Mobility

The spiraling increase in transportation activity and demand reflected, as a case in point, by the 37 percent increase in private cars registered under the General Directorate of Traffic (between 2013

and 2019) [an upward trend that has emerged in tandem with GDP and population figures in Bahrain (Alsabbagh, 2020)] along with the corresponding demand inevitably created for constantly constructing more parking space/buildings, ramping up car production and initiating road capacity expansion projects (AlNuaimi, Mohammed and Ismael, 2019) which further stimulate demand, hence emissions, in other industries i.e., iron, steel, cement, ethylene, and propylene extraction, transportation, and production (Akimoto, Sano and Oda, 2022). One of many externalities that will be later unpacked and a response that has long been associated with creating a counterproductive feedback loop with further traffic growth and resulting congestion being some of its unintended consequences (Tennøy, Tønnesen and Gundersen, 2019).

Similarly, the provision of parking space simply invites more traffic/cars leading to the need for additional parking space creating a feedback chain as posited by Trombino and Trono (2020) – have provided the impetus for local authorities to pursue policies, strategies, and investments that will set in motion a transition towards a more sustainable transportation paradigm.

Bahrain has strengthened its bent on challenging the existing local transportation status quo [with hallmarks such as underutilized public transport (PT) systems marked by low ridership levels <5%, high vehicular ownership rates (avg. 2 vehicles per household in Bahrain) (AlNuaimi, Mohammed and Ismael, 2019), reliance on subsidized fuel (Al-Saidi, 2020), absence of Transportation Demand Management (TDM) Strategies [i.e., surge pricing] (Gao *et al.*, 2022) and stringent policies such as parking fees and registration fees based on vehicle emissions (Alsabbagh, 2020), and cities with a poor walkability index (Atef Elhamy Kamel, 2013) and infrastructure (Shaaban and Maher, 2020)] by committing to decarbonization targets stemming from the various Sustainable Development plans adopted since 1992 following the Rio Summit which led to the establishment of the 8 Millennium Development Goals (MDGs) in 2000; 17 Sustainable Development Goals (SDGs) in 2015 (Al Khalifa, 2019); and culminated, most recently, in the pledge made by HRH Prince Salman bin Hamad Al Khalifa, at the United Nations COP26 in Glasgow, to slash emissions in Bahrain by 30% by 2035 and achieve net-zero emissions by 2060 (Zawya, 2021).

Table 6. Key Transport National and Supranational Policies

	Description
National Strategic Plan **Strategy 04 (UPDA, 2022)**	Developing a Coherent and Diverse Transportation and Communications Strategy. Inadequate transportation options exacerbate traffic problems by causing delays and overcrowding. Furthermore, the current proposed development strategy will place an additional burden on the transportation network. It is, therefore, vital to have a multimodal transportation network that ensures safe, comfortable and efficient mobility as part of an integrated transportation system. This will improve efficiency, which will, in turn, increase foreign investment in Bahrain significantly. A dedicated bus and train system along with marine transportation will support Bahrain's sustainable development and strengthen Manama's role as a vital hub in the region. A complete transportation strategy must include special programmes aimed at diversifying transportation.
Sustainable Development Goal 11 **Target 11.2**	By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.
Strategic Objectives **Land Transport Affairs (under MTT) (MTT, 2021)**	Regulate the land transportation sector by setting the regulatory framework and governance that aims at increasing the sector's efficiency, safety, and competitiveness. Develop the sector's infrastructure and diversify the modes of public transport to enhance Bahrain's economic position and regional standing. Enhance land connectivity between Bahrain and its neighboring Gulf States

In pursuit of such commitments, Bahrain has sought to influence a departure from the current private-car dominant transportation model by bolstering existing PT capacity and introducing new PT systems.

However, progress remains patchy seeing as the country has made more strides in the former than the latter. Namely, the appointment of the Bahrain Public Transport Company (BPTC)[2] in 2015 by the Ministry of Transportation and Telecommunications (MTT) (BahrainBus,

[2] A private consortium between Bahrain-based construction company Ahmed Mansour Al Aali (AMA) group and UK-based transportation provider National Express

2022) on a 10-year concession to operate public inter-urban bus services has since led to key improvements that range from the introduction of new buses with free WIFI; expansion of the public bus network through the servicing of new routes/areas (al-aali, 2015) and introduction of new schedules; piloting of air-conditioned bus stops – a step recommended in (Hamad, Htun and Obaid, 2021); digitization of timetable, route, and fare data leading to the deployment of the "BahrainBus" app; and the roll-out of top-up GO Cards. Even with the revamped bus network which provides access to around 77% of inhabited (MTTb, 2021) areas in Bahrain, convenient accessibility to PT – measured as a percentage (%) of the population living within 500m[3] (UN, 2021) walking distance from a low-capacity PT system and as per the 2018 figures for SDG indicator 11.2.1 published by the Information and eGovernemnt Authority – remains low with all Governorates – apart from the Northern Governorate – serving PT to less than 25 percent of inhabitants (SDGs, 2021). Still, the marginal accessibility edge the Northern Governorate has over the other Governorates is offset by it also ranking highest for presence of pollutants such as PM_{10} (Jassim and Coskuner, 2017).

On the other hand, attempts at diversifying existing urban transit systems have yet to progress beyond "feasibility" stages – refer to the scrapped Bahrain Integrated Transit Lines project.

Nevertheless, traction in the ongoing Bahrain Metro project may offer ample ground to counter this claim but even if and when this project comes to fruition, fixed-route, stop-based (Zwick *et al.*, 2021), heavy-transit PT systems have long been characterized as both spatially (transit stops and stations) and temporally (schedules/timetables) inflexible (Al-Rashid *et al.*, 2020; Bree, Fuller and Diab, 2020; Weinreich *et al.*, 2020; Brown, Manville and Weber, 2021; Grahn, Qian and Hendrickson, 2021). Hence, it becomes difficult to envision how the project will live up to its promise of alleviating congestion by reducing Vehicle Kilometers Travelled (VKT), kilometric emissions, and thus, promote sustainable transportation. Likewise, another potential

[3] 1KM for high-capacity PT systems (i.e., Metro, rail, ferry)

derailment facing both future and currently available PT systems alike is First Mile Last Mile (FMLM) issue.

2.20.1 First Mile/Last Mile (FMLM) Discontinuities

The predominant[4] term, *First Mile* is used to reflect the time and distance passengers are expected to cover from their point of origin to the nearest PT ingress point, whereas *Last Mile* refers to the time and distance passengers are expected to cover from the PT egress point to their final destination (Hussin *et al.*, 2021; Kumar and Khani, 2021) – or as (Park, Farb and Chen, 2021) more succinctly described it "[…] *the distance traveled before and after using a transit system*". The distance passengers are expected to cover in both FM/LM legs has long been thought of as a key determinant influencing PT ridership rates, namely, the lack of *Transit-Oriented Development* (TOD) – this detachment of both urban and transport planning has laid the groundwork for the numerous PT challenges Kuwait faces today (AlRukaibi and AlKheder, 2019) – has been singled out as one of the key factors that may discourage prospective PT users if they perceive walking distances, under normal conditions (Shrestha and Zolnik, 2013), to be lengthy and impractical (Al-Atawi and Saleh, 2014; Zuo *et al.*, 2020; Brown, Manville and Weber, 2021; Halawani and Rehimi, 2021; Park, Farb and Chen, 2021; Razak, 2022). All of which is not dissimilar to the findings cited in Malekzadeh and Chung (2020), where the authors demonstrate how desirability for PT "[…] *drops sharply after the first 0.06 miles* [distance between passengers and the nearest PT stop]*, and gradually diminishes beyond 0.36 miles*" which also resonates with one of the key findings from Youssef, Alshuwaikhat and Reza, (2021) where the study identified an increase of approximately 22% in metro ridership levels which can be realized through the reduction of walking time to metro stations by 5 mins. This might be further explained by passengers' perception of PT, where the attractiveness of the service is determined by, amongst other factors, passengers' experience through all phases of their commute including FMLM journeys which tend to also be underrepresented – namely, LM – in the literature (Razak, 2022).

[4] Authors such as (Walton and Sunseri, 2010) have used alternative terms i.e., 'access sub-mode' in reference to "[…] walking to and from public transport." instead of FMLM

Although SDG indicator 11.2.1 relies on a distance computation of 500m and 1km as a measure for convenient access to low-capacity and high-capacity transit, respectively; authors such as Walton and Sunseri (2010) have demonstrated, based on survey input from 348 respondents in New Zealand, that 820m was the mean 'reasonable' distance respondents were willing to walk in order to access PT. Yet such 'willingness-to-walk' figures, given the dearth of FMLM PT research in Bahrain, need to be further scrutinized when discussed in relation to conditions more applicable to Bahrain i.e., susceptibility to relatively high humidity values, Middle Eastern sand storms, and high temperatures that limit the pursuit of outdoor physical activity for approximately half of the year – even if it necessitates extrapolating based on studies conducted in neighboring countries i.e., KSA, Qatar, and other GCC countries, as posited by (Al-Atawi and Saleh, 2014) due to similar economic, environmental, and sociocultural conditions (Pinelo Silva and Akleh, 2018; Al-Rashid *et al.*, 2020; AlKhars *et al.*, 2022).

2.20.2 Sustainable Mobility within the GCC

Although not a perfect fit, some inferences can be drawn from studies conducted within the wider GCC to shed light on some of the factors underpinning the current modal split in Bahrain. Namely, a recent study published by Al-Thawadi, Banawi and Al-Ghamdi (2021), assessing people's social awareness of sustainable urban mobility in the neighboring country of Qatar, might[5] help provide a lens into the future in terms of determining some of the facets Bahraini passengers will be considering when deciding whether to use, as an example, major heavy-transit projects that are in the pipeline such as the Bahrain Metro. However, the findings of the authors can still be used to explain the underwhelming ridership levels of existing PT systems (i.e., Bahrain Bus) and, ultimately, the overall modal split within Bahrain. The main reasons respondents provided for their high dependence on automobiles are privacy (≈23%), weather conditions (≈17%), culture (≈14%), and luxury (≈12%) amongst other reasons.

[5] Although just a small minority, results might be slightly skewed and less generalizable towards Bahrainis given the study also incorporated input from respondents originating from non-GCC countries

As for public perspectives on the factors that might make metro systems less attractive, respondents – although 23% preferred not to judge before the local Metro project in Qatar became fully operational – cited the lack of integrated transport feeder options due to stations being positioned far apart as the second-most (≈17%) factor potentially derailing uptake for a future metro project. The third (≈16%) – *I prefer to drive myself* – and fourth-most (≈10%) – *Metro doesn't go with my status* – cited reasons can be viewed as self-reinforcing seeing as connotations of car ownership have long been intertwined with social status (Shaaban and Maher, 2020; Gatersleben, 2021; Li, Guan and Wang, 2022).

Similarly, another study conducted by Shaaban and Maher (2020) has sought to predict how prospective PT users in Qatar might react to the upcoming Qatar Metro through the theory of planned behavior. Some of the takeaway points consistent with the preceding study – Al-Thawadi, Banawi and Al-Ghamdi (2021) – include a lower perception of behavioral control by Qatari women on whether they will be able to use the metro system due to the protective status females hold within Qatari society thus resulting in a higher likelihood of men, especially non-Qatari men, using the metro for work and leisure purposes. Apart from the identified sociocultural barriers, the authors have indicated the need for exploring factors that consumers may perceive as an impediment to the use of the metro, i.e., infrastructural barriers such as the lack of adequate sidewalk and pedestrian infrastructure to allow further accessibility – and hence, indirectly emphasizing the importance of integrated mobility and FMLM connectivity.

Furthermore, Al-Thawadi and Al-Ghamdi (2019) have contrasted the environmental impacts (per functional unit of passenger kilometers) of transitioning towards the Doha metro (ongoing project) with the resumption of the current status quo in Qatar which is the overwhelming reliance on private automobiles to meet urban mobility needs. The comparison was drawn through a modelling technique enabled by the GaBi 6.0 software which has led the authors to posit that, annually, cutbacks of around 19.42kt of CO2 emissions, 11.45 tons of Sulphur Dioxide, 3.15 tons of PM10, 3.02 tons of nitrogen – amongst other reductions – can be achieved through a public transportation metro line. Similarly, Al-Thawadi, Weldu and Al-Ghamdi (2020) through the same modelling software (GaBi 6.0) but instead focusing on the LCA cradle-to-grave method, were able to report consistent results – 12.3 Mton of CO2 emissions, 457.13 ton of human health particulate

matter, and 0.061 Mton of smog air annually. Both studies have also cautioned for the use of renewable energy sources for generating electricity used to power the metro line.

To further explore the impact of sociocultural barriers on PT ridership within a GCC context, Al-Rashid *et al.* (2020) have attempted to shed light on the sociocultural issues women face in Dammam, Saudi Arabia[6] and have continued to float the idea of establishing Gender-Responsive Public Transportation to appease some of the sociocultural limitations women face. Moreover, accessibility limitations in line with the aforementioned studies were also identified. However, the authors also incorporated certain accessibility dimensions such as 'Provision of storage space for baby strollers onboard buses operated by the Saudi Public Transport Company (SAPTCO) to accommodate the needs of childrearing mothers – although this applies to parents more generally – using the PT system in addition to highlighting key infrastructural and spatial limitations of the existing service such as the lack of barrier-free walkways to transit stops – another potential FMLM issue – and insufficient spatial coverage (the bus service operates on a 24km single alignment/line). Altogether and coupled with the absence of Gender-Responsive Public Transit, the authors were able to use such factors to explain why 48% of respondents avoid travel in the absence of a private vehicle and for the 52% that did travel, 74.1% chose taxis as their second preferred option with only 7.3% resorting to SAPTCO public bus services.

Shifting from Dammam to Riyadh, Youssef, Alshuwaikhat and Reza (2021) in their study have attempted to explore prospective commuters' perception of the ongoing Riyadh metro project to further understand the tradeoffs commuters make when considering several mode characteristics – namely; travel time, walking time, fare cost, fuel price, and parking cost were found to be positively correlated with commuters' choice mode. In line with the previously cited and discussed studies, improving accessibility – and FMLM connectivity – by reducing walking time to the nearest metro station by 10% was correlated with a 7.2% increase in ridership levels. Whereas –

[6] Findings from this study might be slightly skewed and less generalizable to Bahrain given the severity of sociocultural barriers in KSA vis-à-vis other GCC countries (i.e., the need of women travelers to be accompanied by a male family figure) (Although this has been revised following the issuance of a Royal Decree on women's driving in May 2018)

the inverse was also witnessed in this study – an increase of walking time to 11mins was correlated with a drop in the preferred choice for the metro service by 4.2%. Likewise, to instigate a shift towards the Riyadh Metro and away from automobiles, the authors have demonstrated how a 10% increase in fuel price might potentially lead to a 5.3% increase in metro ridership levels with the imposition of a parking charge of 1SAR[7]/hour in the Central Business District (CBD) being correlated with a 14% drop in car dependency. Lastly, an increase of metro fares by 10% has been correlated with a drop in metro ridership by 6.9%.

Still, additional studies incorporating hypothetical PT systems still abound – as evidenced by the work of Halawani and Rehimi (2021), although this time focusing on commuters' travel behavior and mode choice to and from Taibah University (TU) located in Medina (a car-oriented city with no PT[8]) and the largest in northwest Saudi Arabia. In total, 953 respondents were involved in this study, which aimed to gauge participants' Willingness-To-Use (WTU) PT through administering Stated Preference (SP) surveys and in conjunction with spatial analysis. Additional participant data was also obtained – i.e., Origin-Destination (O-D) points of commuters to TU[9], vehicle occupancy rates (of trips to TU), and participants' vehicle characteristics (model, manufacture year, and vehicle brand) – to compute fuel consumption and kilometric emissions using the COPERT 5 model. Overall, 53% of participants were willing to switch to PT yet – in stark contrast with findings from the aforementioned studies – the percentage of females willing to use the PT system outnumbered males by 64% to 48%, respectively – a finding consistent with Hamad, Htun and Obaid (2021). Higher vehicle occupancy rates were also found to be correlated with a higher WTU for PT. Finally, the authors highlighted how a 0.79% reduction in fuel

[7] Saudi Riyal

[8] The authors pointed out the absence of a formal PT system except for 10 public express-shuttle lines which were described as "*nonstop point-to-point services that connect the center of the city to locations on the edges of the city*"

[9] In order to sidestep the privacy issue caused by having participants disclose their exact residential addresses (which some weren't comfortable with) the authors instead asked participants to identify nearby bus stations, landmarks (Point of Interest), or their neighborhood name.

consumption and CO2 emissions can be obtained for every 1% of commuters willing to use PT under the assumption that the PT Euro 6 type urban buses.

Moving on to another study centered on university commuters, Hamad, Htun and Obaid (2021) investigated and characterized the travel behavior of commuters (A total of 1,970 responses from students [84%], faculty [7%], staff[7%], and visitors[2%]) travelling to and from Sharjah University City (SUC) in the United Arab Emirates (UAE) which hosts the following campuses:

University of Sharjah (henceforth abbreviated as 'UoS') Men Campus (52.5% of respondents)

UoS Women Campus (26.8%)

UoS Medical Campus (9.6%)

American University of Sharjah (7.7%)

UoS Fine Arts Campus (2.2%)

Higher Colleges of Technology (henceforth abbreviated as 'HCT') Women Campus (0.3%)

HCT Men Campus (0.2%)

Other academic institutions (0.7%) – 'passing through' was allocated (0.1%)

Another noteworthy aspect of the study is that 74.2% of the respondents were non-Emirati but ex-pats – a recurring phenomenon amongst PT studies within GCC i.e., majority non-Kuwaiti respondents in (AlRukaibi and AlKheder, 2019).

Some of the commonalities that can be drawn with the preceding study by Halawani and Rehimi (2021) can be evidenced by the higher usage of PT by females vis-à-vis males but the authors have cautioned that this may simply come down to cultural strictures that prevent females, especially young girls, from driving (although only 3% chose as their reason for using buses) – nevertheless, the study by Sultan, Katar and Al-Atroush (2021) further confirms the higher utilization of both active transportation and PT by female commuters vis-à-vis males albeit focusing on respondents from Prince Sultan University (PSU) in Riyadh, KSA. Harsh weather conditions and inconvenient bus services – all against the socioeconomic backdrop of high-income participants with higher private car ownership rates – were also found to deter SUC commuters from using PT and active transportation (walking and bicycling). Therefore, when tasked with

choosing their 'preferred sustainable transportation strategies', the majority of respondents (33%) chose improving bus services to and from SUC followed by improving shuttle bus service on-campus (26%) and improving sidewalks [greening sidewalk pathways to improve ventilation and "cooling air"] and bike lanes (23%).

Focusing on participants from Najran University in Saudi Arabia, AlQuhtani (2022) – through the collection of survey data which were analyzed through a binary logistic regression model – were able to further shed light on key determinants that might aid in the further uptake of ridesharing. Namely, the authors identified fixed work/class schedules, lack of PT, homogenous social backgrounds amongst attendees, and long distance to campus as positive factors stimulating the use of ridesharing. Nevertheless, in terms of likelihood of uptake the authors identified females, non-Saudis along with students and faculty – as opposed to other university staff – to have a higher propensity of using ridesharing. Likelihood of uptake was also found to be higher amongst younger participants. Although ridesharing holds the potential to curb Vehicle Miles Travelled (VMT) and Single Occupancy Vehicles (SOV), the authors have emphasized the importance of passengers willing to rideshare to live within close proximity of one another otherwise the need to cover long distances will simply negate the benefits of ridesharing.

In another study conducted by AlKheder (2021) focusing on public transportation (exclusively buses) in Kuwait as a means of tackling both congestion and emissions, the author has – deduced from the survey and PT operational data – that having more than one Transport Service Provider (TSP) contracted to provide PT services on behalf of the government might prove to be counterproductive. Namely, the lack of coordination between different TSPs has often resulted in them operating within the same routes with the expected end result being a further contribution to traffic – such findings lend credence to the work of AlKheder *et al.* (2019) whom developed a model that enables offering the same service coverage but through a fleet of 176 buses instead of 457 and also recommend the elimination of closely located bus stops (increasing the distance from 500m to 1-1.4km) – which diverges from standards adopted in neighboring countries i.e., 500m between PT stations is espoused by authorities in Riyadh, KSA (Sultan, Katar and Al-Atroush, 2021) – and augmenting the service by building pedestrian bridges to enable walkability. Findings from surveyed commuters also highlighted their dissatisfaction with the punctuality of service (which seems so rampant that AlRukaibi and AlKheder (2019) have proposed financial

fines be imposed on drivers that do not adhere to station instructions and starting times), especially during on-peak time intervals (6 am – 9 am) where almost 20% have highlighted that the bus service fails to reach the destination on schedule – another indication of the PT underperforming when under pressure can be evidenced by the observation reported in AlRukaibi and AlKheder (2019) where the authors have witnessed a tandem movement in both passenger numbers and dwell time; as the former increases, the latter follows suit. Moreover, the author was able to demonstrate potential reductions in emissions (Carbon Monoxide, Nitrogen Oxides, and Volatile Oxygen Compounds), fuel consumption (up to 45%), and congestion (46%) using the Synchro software as part of a simulation of future network conditions based on higher uptake of PT.

Finally, AlKheder, Abdullah and Al Sayegh (2022) have also examined the ongoing Kuwait metro project's socioeconomic attractiveness to further solidify this project's value proposition for both prospective end-users (passengers and operators) alongside key financing bodies. Several cost categories were incorporated into the study: operational costs for other transport modes; travel time; accident rates; noise and atmospheric pollution; climate change, nature, and landscape; effects on urban areas; and traffic. Collectively, these cost categories were discussed in conjunction with several alternative management options which concluded with the authors advocating the BOT (Build, Operate, and Transfer) setup under a consortium comprised of a single builder, operator, and mobile material manufacturer.

2.21 The Environmental Value Proposition of MaaS

Unsurprisingly, the notion that MaaS can alleviate the externalities stemming from the overuse of personalized ICEVs has been heavily contested in the literature due to the inherent variations and multiple transport combinations – entailing the use of zero-emissions modes (i.e., cycling/walking) in conjunction, and in varying degrees with, emissions-heavy options like passenger ICEV – that may comprise a given MaaS bundle. This can be further evidenced by the work of authors such as Labee, Rasouli and Liao (2022) in which conservative, balanced, and optimistic scenarios have been concluded with emission reductions of 3-4%, 14-19%, and 43-54% respectively – the optimistic scenario is predicated on the lowest use of the private car and maximum utilization of PT.

Similarly, Zhao *et al.* (2021) further elucidate on how four potential MaaS diffusion scenarios – 1- Private vehicle addiction, 2- the rise of private sharing services, 3- MaaS wins out

over policies, and 4- MaaS wins out over the masses – may lead to different reduction outcomes. Namely, the first scenario (private vehicle addiction) assumes the continuation of the private car as the predominant mode of transport with no integration of PT with MaaS, and under the absence of subsidies/incentives to stimulate a shift to alternate modes renders the impact on key matrices – Reduced of Car Ownership, Private car Usage, Gasoline consumption, diesel consumption, VKT, and CO_2 emissions – negligible – 2.5% across all elements (only due to this being the presumed reduction rate in private car use by authors for this scenario). Conversely, the scenario on the opposite side of the spectrum, and the one holding the most promise, 'MaaS wins over the masses' – where seamless and on-demand transportation services across both public and private providers are consolidated with proactive policies and incentives to further entice prospective MaaS users – has the potential for generating reductions upwards of 16% in car ownership, upwards of 50% in private car usage, gasoline/diesel consumption, VKT, and CO_2 emissions. As a note of caution the authors have also highlighted a key assumption that may skew findings, and their generalizability, specifically that "*all vehicles included in the MaaS services are assumed to be environmentally friendly, using green fuel and producing zero CO2 emissions*". Although Hensher, Ho and Reck (2021) have concluded – based on a 2-year MaaS trial in Sydney, Australia – the potential of MaaS in contributing toward a reduction in VKT and attendant tailpipe emissions, Li and Voege (2017) and Alyavina, Nikitas and Tchouamou Njoya (2020) have cautioned that the overuse of taxis, carpooling, and ride-sharing – which are valued significantly higher in comparison to bike-sharing as concluded in studies such as Guidon *et al.* (2020) – as part of a MaaS bundle may counterproductively result in heightened VKT hence, worsening congestion. Yet, uptake results for individual modes from existing studies and pilots remain contradictory due to discrepancies in MaaS bundle design techniques (rollover, customizability, and adopted metrics) (Reck, Hensher and Ho, 2020).

2.22 Neglect towards the ecological impacts of MaaS in the extant literature

From the outset, pilot (since *UbiGo* Project in Gothenburg, Sweden in 2014) and conceptual studies of MaaS have been slanted towards a plethora of endpoints ranging from gauging demand-side functional factors (Bretones & Marquet, 2022) such as price sensitivity of prospective MaaS subscribers towards specific price-points (Willingness-to-Pay) and different pricing structures such as Dynamic and Differentiated pricing (Vij & Dühr, 2022), modes (Willingness-to-Use), and

supply-side incentives for individual Transport Service Providers (TSPs) to offer and pool their services as part of a MaaS bundle (Willingness-to-Sell) (Xi et al., 2022) to exploring the potential implications of MaaS, along with some of its key antecedents (i.e., smartphone ownership and technological proficiency), on vulnerable social groups (Dadashzadeh et al., 2022).

Nevertheless, MaaS suffers from asymmetrical coverage in the literature seeing as disproportionate attention is evident between certain areas; heavily skewed towards the operationalization and commercial viability of MaaS (Pangbourne et al., 2018; Vij & Dühr, 2022) overshadowing the attendant societal and ecological implications and unintended consequences (Pangbourne et al., 2018) posed by this emerging alternative mobility arrangement – especially seeing as it has been consistently heralded as the long-awaited remedial mobility scheme with the potential for curbing externalities stemming from the overdependence on private car ownership such as congestion (the cost of which can be quantified in terms of a reduction in economic productivity and increased operational expenses due to additional fuel consumption (Pritchard, 2022)), tailpipe emissions (Smith, 2021), noise pollution, and encroachment on wildlife spurred by ever-increasing demand for infrastructure (such as road/parking space (Vaddadi et al., 2020) which may typically account for 30% of urban land use in cities (Pritchard, 2022) or in some extreme cases such as Los Angeles as much as two-thirds of land use is allocated to transportation (Hensher et al., 2020b)) development and expansion (Gössling, 2020; Remme et al., 2022; Storme et al., 2020) further stimulating upstream demand for concrete, asphalt, and steel hence shifting emissions to other polluting industries (Hensher et al., 2022).

Even in the political realm, the durability of relying on continuous road expansions to counter ever-increasing congestion levels within cities in developing countries is now being brought under scrutiny seeing as it engenders a downward spiral that may ultimately lead these cities to run out of space (Mulley, 2017) – altogether this has created the impetus for introducing newer approaches, such as MaaS which has even been floated as a potential solution for recovering urban spaces (Labee et al., 2022), to overcome the limitations associated with conventional approaches focused on countering congestion and transport policies that have generally been ineffectual when it comes to stimulating a modal shift away from private motorized travel (Pritchard, 2022).

2.23 Modal displacement effects of MaaS: Impact on PT systems

As consolidated and reported in Smith et al. (2022), a number of MaaS trails have demonstrated positive signs in reducing the reliance on private vehicles (In the *Ubigo* trail, 48% of participants reported a reduction in personal car use – although this should be scrutinized more carefully given that a precondition for participating in the *Ubigo* trail was that participants had to abnegate the use of their private car (Alyavina et al., 2020) which might have had an undue influence on some of the endpoints reported – and in the *Touring* trail, hosted in the city of Ghent in Belgium, 74% of participants managed to commute without using their private vehicles) and how private vehicles are viewed (17% of participants in the *Tripi* trail reported a change in how the view car ownership).

Altogether, these findings reinforce similar outcomes seen in studies assessing the impact of more simplified mobility services such as *Uber* and *GoGet* – the emergence of which have delayed users' decision to purchase a private car (Ho et al., 2018). Still, a more holistic analysis into not just changes in private car use but overall travel behavior, as singled by (Ho, 2022), should be considered in future trails.

Findings, however, remain inconsistent, if not, outright contradictory; given that MaaS has been promoted as a transport demand management tool (Servou et al., 2023) and viewed as a solution for widespread private vehicle ownership – something that cannot be automatically assumed (Storme et al., 2020) – on one hand but also, paradoxically, as a risk to PT as concerns about point-to-point, car-based MaaS options (ride-hailing, ride-sharing) cannibalizing, or displacing (Wong et al., 2020), the market share of PT systems – coined as the '*Uberisation*' effect – emerge (Alyavina et al., 2022; Alyavina et al., 2020; Kostiainen & Tuominen, 2019; Pangbourne et al., 2018; Utriainen & Pöllänen, 2018; Wittstock & Teuteberg, 2019; Wong et al., 2020).

All of which further accentuate some of the key limitations of PT systems: namely, the first and last mile gap (Kostiainen & Tuominen, 2019) coupled with spatial (fixed route) and temporal (fixed schedule) inflexibility (Shaheen & Cohen, 2020; Utriainen & Pöllänen, 2018) which have been viewed as inimical to the flexible customer-focused mobility model underscored by MaaS (Hensher, 2017) and has led authors such as Ho & Tirachini (2024) to emphasize the importance of carefully positioning them within the broader mobility landscape.

This has even been mirrored in the language used to market the services of car-based TNCs – i.e., "taxi-like services at bus prices" – which not only implicitly reveals their stated objective of wanting to displace traditional PT services but highlights another key asymmetrical advantage enjoyed by these car-based TNCs, namely, that they are able to undercut PT services on prices simply due to their business model which centers on relying on drivers to use their own car – eliminating the need of procuring, maintaining, and operating an expensive fleet of vehicles – and treating their employees as 'gig workers' which excludes the need of offering their personnel with benefits commonly included in full-time employment (Wong et al., 2020).

The likelihood of a rebound effect (Servou et al., 2023) towards car-based options, further exacerbating the risk of displacing the modal share of PT, can be expected to be greater in high-end MaaS bundles that offer 'unlimited trips' (Esztergár-Kiss & Kerényi, 2020) where, in accordance with the *Theory of Loss Aversion* (premised on the human cognition being more attuned to avoiding losses than achieving a gain), users might be uniquely inclined to make extra discretionary trips through ride-hailing services – which have been criticized for not increasing vehicle occupancy (Hensher et al., 2020b) – or other induced trips on available car-based options (Pangbourne et al., 2020) placing unnecessary strain on the system (Pangbourne et al., 2018).

The prevalence of car-based services over PT systems within MaaS pilots has also been reported in Mulley et al. (2023) which might also be attributable to factors such as willingness of users to adopt and share services (Jittrapirom et al., 2018), geographic environment and demographics (Hensher et al., 2020b), and target customer segments, location, and public transport service levels (Kostiainen & Tuominen, 2019). Hensher et al. (2020b) have also elucidated on a negative feedback loop between Public Transit (PT) and Transport Network Companies (TNCs), such as ride-hailing services within MaaS, where the emergence of services such as ride-hailing cut into the fare-box revenue generated by PT systems which in turn leads to their gradual deterioration further bolstering the attractiveness, commercial viability, and growth of TNCs. A similar destructive cycle has been expounded by Wong et al. (2020), further mirroring the above, in which the emergence of TNCs might intensify communal pressure for PT systems to '*Uberise*' their services, through as an example, by offering integrated on-demand microtransit which will further undermine the impetus for subsidizing PT systems and accelerate their decline.

Whereas Frost et al. (2021) and Remme et al. (2022) have cautioned about the heightened specter of further degrading PT services, deepening socio-economic divisions, increasing car agglomeration (Alyavina et al., 2020), and exacerbating road congestion as unintended consequences of policies (i.e., subsidization of EV purchases and road expansion projects to accommodate more Evs) promoting the widespread adoption of electric vehicles (within MaaS – christened as ECSaaS) especially in lieu of biosecurity concerns presented by COVID-19 and the drop in both social activity (Christensen et al., 2022; Khatun & Saphores, 2023) and, as a consequence, the use of high-occupancy transport modes such as PT systems coupled with advancements in vehicle automation and electrification (Hensher et al., 2022).

Altogether, such findings lend further credence to the uncertainty posed by emergent mobility schemes such as MaaS – where research and development remain at an embryonic stage with the concept being far from mature (Alyavina et al., 2020; Esztergár-Kiss & Kerényi, 2020; Fenton et al., 2020; Pangbourne et al., 2018; Smith & Hensher, 2020; Utriainen & Pöllänen, 2018) and findings from existing studies mired by regional and methodological differences (Reck & Axhausen, 2020) – on, and the type of relationship that might be fostered with, PT systems which as posited by Hensher et al. (2020b) might range from being synergetic to competitive or leading to either modal convergence (synergetic) or modal displacement (competitive) according to the terms used in Wong et al. (2020).

Moreover, Storme et al. (2020) have leaned towards viewing private vehicles as complementary, or synergetic, to MaaS as opposed to competitive given the low car-substitution effect of MaaS reported in that study. Whereas, Hensher & Hietanen (2023) have even attributed the lack of private vehicle integration into the MaaS mix (bundles) as one of the main reasons why there is limited support for the MaaS environmental proposition of reducing private car use and promoting sustianble modes such as PT transit and micromobility.

In certain contexts, the synergetic relationship through spatial integration between car-based TNCs and PT within MaaS might be more clear-cut than others, as an example, the population decline unfolding in Japan, with other Asian countries likely to follow suit, has already ignited concerns about the provision of standalone PT services in rural regions within such countries where low population density, which entails low fare-box revenue, is already detrimental the economic viability of such services (Fujisaki et al., 2022).

Maximizing the temporal efficiency of PT systems through the deployment of shared modes (car-based TNCs) as top-up services to meet temporary spikes in transport demand that are commonplace throughout the day, i.e., peak hours, can alleviate pressure off of PT systems and presents another positive scenario for a synergetic relationship that can potentially be forged between the two (Wong et al., 2020) – the authors have also pointed that this may necessitate additional tailoring, i.e., type of vehicle used, based on the nature of the journey, i.e., journey-to-work (CMaaS) vs leisure travel (shopping).

Yet, this uncertainty – stemming from, in part, contextual issues such as future car use levels and saturation levels in car ownership (Goodwin & Van Dender, 2013), types of impacts assessed, quality of data, and methodological choices (Fenton et al., 2020; Reck & Axhausen, 2020) and limitations such as self-selection bias (Ho, 2022) and data collection bias (Dadashzadeh et al., 2022) in some MaaS studies/surveys coupled with people's insecurity and reluctance to relinquish the convenience offered through private car ownership (Caballini et al., 2023) with the extent of which already evidenced in trails such as *Ubigo* where participants have overestimated their need for car-sharing services which resulted in them spending more on car hours than what they actually needed (Utriainen & Pöllänen, 2018) and a study into the attitudes of 1570 car-owning and non-car-owning Londoners' towards MaaS which revealed that 61% of car-owners were still reluctant to sell their car with 64% of non-car-owners refusing to delay purchasing a car (Alyavina et al., 2020).

This has also been mirrored by how such disruptive mobility schemes have been approached by regulators and incumbent TSPs in different countries as some have been stymied following intense clashes (Mulley & Kronsell, 2018) while others have been facilitated through acts such as:

- the revision of outdated and unsuitable legislation, for example, through the introduction of the Act on Transport Services (effective 2018) allowing resale of PT single journey tickets by 3rd parties in Finland (Kostiainen & Tuominen, 2019) and Denmark
- the establishment of a MaaS Integrator in Sweden and integration of private mobility services in the public national travel planner in Denmark (Smith & Hensher, 2020) and

- the earmarking and channeling of ‘seed capital’ and funding by the governmental Swedish Innovation Agency, VINNOVA, towards projects focused on sustainable urban mobility in Sweden with *UbiGo* being one of the recipients (Fenton et al., 2020)
- lastly, the active engagement of the Finnish Ministry of Transport in facilitating marketplace access for MaaS via free market tools such as the provision of innovation and funding along with the minimization of ‘red tape’ in hopes of establishing ‘another Nokia’ (Pangbourne et al., 2018).

Chapter 3. Methods and Procedures

The novelty behind emergent mobility schemes such as MaaS has commonly been construed as a limiting factor for both practitioners and researchers when choosing robust methodological tools.

In the absence of large-scale implementation, uptake, and common understanding of MaaS – with the resultant absence of sufficient longitudinal datasets which would allow for more robust Revealed Preference (RP) studies (Reck & Axhausen, 2020), researchers were often confined to relying on experimentation settings in which hypothetical MaaS scenarios are presented to study subjects (Chen et al., 2023) – in which case, SP methods are viewed as the most suitable (Ho et al., 2020).

A number of key limitations undermine the validity, generalizability, and robustness of data obtained from SP techniques which include, one, users' inability to accurately perceive a given phenomenon (which is why a MaaS introduction video has been provided to respondents in Ho et al. (2020) – click for video hyperlink); two, high subjectivity involved; and, three, the possibility that some stated preferences or attributes may not be reflective of actual situations (Hadiuzzman et al., 2017) something that has also been emphasized by Rose et al. (2008) in light of the key role play by specific contextual factors in determining users' selection decision. Factors one and two can further be exacerbated in experimental settings where MaaS bundles/combinations are excessive due to the inclusion and bundling of a wide variety of attributes and levels (Matyas & Kamargianni, 2019) which may simply serve to fatigue respondents (Frei et al., 2017). In this context, MaaS attributes can include different features (MaaS integration level), modes, ticketing options and fare structures, along with financial and non-financial incentives. As for MaaS levels, this represents bundles positioned across a spectrum that ranges from low-end to high-end which will determine the type and extent of MaaS attribute included in the bundle. Still, the aforementioned risk can simply be outweighed by the practicality and convenience offered by SP, vis-à-vis RP, given it allows researchers to efficiently manipulate attributes with greater speed and statistical efficiency (Matyas & Kamargianni, 2019).

3.1 Review of Mobility-as-a-Service Revealed Preference survey studies

Some of the limited but key studies incorporating RP data stem from the Sydney MaaS Trail in Australia. The trail commenced in 2019 and through the partnership established between SkedGo

(the entity responsible for providing the MaaS App, *Tripi,* used in the trail), Institute of Transport and Logistics, University of Sydney, and the Insurance Australia Group (IAG).

In order to track participants' revealed preference in this longitudinal study (Hensher et al., 2021), researchers onboarded all participants on a single default scheme – namely, Pay As You Go (PAYG). Afterwards, a new bundle option would appear for participants to consider with each passing month until participants were presented with a total of 5 options (PAYG and four bundles). Consequently, monthly booking information generated through the *Tripi* app were analyzed, and used as RP data, to gauge participants modal/bundle preferences through WTU, WTP, and other key metrices such as Intra-personal Week-to-week Travel Variation (IWTV). To further augment the aforementioned pilot data, additional tracking and car use data extracted from the Safe Journeys program (run under IAG) along with data from the pre-trial survey were also incorporated into the Discrete Continuous Choice and Binary Choice models adopted in the study (Hensher et al., 2021). In another exploratory analysis conducted by Ho et al. (2021), data from Sydney MaaS trail were also fed into a Mixed Logit Choice Model.

Focusing on data from a longitudinal study collected from undergraduate students in Copenhagen, Denmark – the Copenhagen Network Study (CNS) – Reck & Axhausen (2020) have constructed MaaS bundles based on participants' travel patterns that disaggregate each journey into stages based on mode of transport adopted (Car, PT, bike-sharing, Taxi, ride-hailing, walking etc.). Subsequently, the authors went to on to assess the viability of substituting car stages, within all journeys, with other best alternatives with the highest viability being ascribed to PT (83%) and to a lesser extent, car-sharing and bike-sharing, 35% and 31%, respectively.

3.2 Constructing Robust SP and Stated Choice Experiments

This study centers on data collection from a survey containing a versatile range of questions covering those that are *stated preference* in nature touching on core tenets and functions of MaaS, such as single payment/booking modal combinations, to those that are more along the lines of *revealed preference*. Under the latter, questions aiming to illuminate pro-environmental perceptions, behaviors, and attitudes are incorporated into the survey such as frequency of recycling and importance ascribed to fuel-efficiency labelling. Thus, the survey comprises of a combination of questions that target both respondents' mobility and environmental habits and perceptions.

Also, respondents will be required to disclose an approximation point for their location – normally a nearby landmark area, seeing as the disclosure of respondents' exact location of residence may infringe on their privacy and present a significant ethical hurdle to the study – along with other attributes (i.e., inclination to use ridesharing or ride hailing through an app, PT, and micro- and active- mobility etc.) and personal information (socioeconomic factors such as age, working status, income, car ownership, gender (Xie et al., 2019), residential location, level of education, and household composition (Alyavina et al., 2024)) which will feed into the development of reference alternatives that are pivoted around users' actual experience and characteristics – and of course, reflective of the mobility options available in Bahrain and/or, as adopted by Reck & Axhausen (2020), substitution of car stages (of respondents' journeys) with the best alternative shared mode based on attributes such as travel time or cost.

To help obtain RP data from Pre-survey information authors often required respondents to validate some of the information (i.e., location, activity, purpose, trip start/end and duration, origin/destination etc.) collected in what are referred to as *'Trip Dairies'* prior to proceeding to the second data collection phase targeting SP data (Xie et al., 2019). However, the need for doing so in this study considering the focus is on CMaaS, compared to traditional MaaS, is less substantive seeing as the parameters are more confined: destination workplace/University already predetermined, same as with commute timing which remain fairly predictable.

3.3 SP and RP questions

In line with the sociodemographic drivers outlined in both Xie et al. (2019) and Alyavina et al. (2024) along with some of the core MaaS antecedents discussed in the literature review section, a mixed (structured and unstructured; SAQs, MCQs, and LAQs; SP and RP) questionnaire comprised of 39 questions was created and disseminated through different channels (discussed in more detail below) to eligible participants in the Kingdom of Bahrain. None of the questions exceeded the recommended 9-16 options as advised by Richardson et al. (1995) for SP surveys.

3.4 Ethical Approval and Considerations

The survey questions have undergone rigorous review and amendments as part of the University of Bahrain's ethics requirements for graduate studies. In total, the undertook process consumed a total of 3 months and 15 days from initiation (2nd of January 2024) to approval (17 March 2024).

Also, to hasten the approval process, ethical and pragmatic considerations have been at the forefront of the survey development process. To illustrate, the survey completely omits inputs from respondents that can be classified as Personally Identifiable Information, or PII, such as email addresses, names, and most importantly commute information (residential and commercial locations) and other sensitive forms of data such as income level. In reference to the latter, the inherent privacy risk engendered by asking respondents to disclose their exact residential and commute (workplace or higher/tertiary education provider) locations was sidestepped by replicating the solution adopted in (Hamad et al., 2021) in which, as an alternative, respondents were simply asked to name a nearest point of interest close to both of their commute O-D locations.

Similarly, other contemporary tools for analyzing travel behavior – such as GPS, mobile phone, and circulation of banknotes (although less pertinent in the case of CMaaS given the predetermined and, more or less, fixed daily commuting O-D points) (Illenberger et al., 2011) – have been replaced with the snowballing (otherwise known as, or sometimes classified under (Heckathorn, 1997), chain-referral (Beauchemin & González-Ferrer, 2011) method or ascending sampling strategy or expanding sampling or network sampling (Doreian & Woodard, 1992)). Addressing this issue was key considering that one of the key limitations of the snowball sampling method is participants unwillingness to freely share information due to confidentiality concerns (especially in qualitative studies) (Valerio et al., 2016).

3.5 Sampling size, method, and period

Starting off with the established sample size, and by extension the targeted survey response rate, the study attempted to incorporate a 'middle-ground' sample size that can be deemed not too small – in which case, concerns of variability, generalizability, and validity of conclusions arise – and not too large – in which case, the specter for statistical sensitivity is heightened which leads to a higher possibility of 'Type 1' errors being committed – whilst maintaining the robustness of the study (Memon et al., 2020) through reliable and unbiased analyses (Ampt & OrtÚZar, 2004). Still, a degree of subjectivity and arbitrariness is starkly evident – an issue that is not uncommon in Stated Choice (SC) experiments considering that researchers have often been forced to make sample size assumptions on data which rarely hold, or are replicable, in the real world (Rose & Bliemer, 2013).

Collectively, this sheds clarity into some of the reasons why determining the acceptable sample size, and associated standard error for studies heavily reliant on statistical inferences, has often been left to the discretion of clients (Ampt & OrtÚZar, 2004) and students' supervisors/external examiners (Memon et al., 2020). For MaaS surveys that incorporate semi-structured questions, allowing for thematic analyses, such as that adopted in Alyavina et al. (2020), reaching saturation (the point in which no new information emerges) can be set as a barometer for determining the sufficiency of a sample size required in a study.

The US-based Road Research Laboratory offers a type of rule-of-thumb recommendation on sample size based on the study area population for transportation and traffic surveys which, in the case of this study, is 4% of the total population that is comprised of people (both nationals and foreigners – which makes approximating a number difficult) working or studying in Bahrain and with a valid driving license (above 18 years). Apart from setting a highly cost and time prohibitive threshold, Ampt & OrtÚZar (2004) have also reaffirmed the minimum 4% requirement as being central to producing 90% confidence and 25% standard error. However, such a figure through random probability sampling is simply unattainable within the scope and confines of this research and program and, as already suggested above, is considered to be both cost and time prohibitive (Lunneborg, 2007) when factoring in the total time required to thoroughly complete the survey (approx. 25 mins). Nevertheless, this by no means implies any form of superiority when opting for a non-probabilistic sampling method, as they introduce difficulty in determining the exact population size, sampling error, variability estimates, and response rate paving the way for misleading inferences to be drawn and the need for postsurvey adjustments (Link, 2018).

With 302 responses, the sample size in this study is comparable to sample sizes adopted in other MaaS research papers, focusing on countries with a significantly larger population in relation to Bahrain, with the work of Liljamo et al. (2021) (focusing on Finland, approx. 5.5 million inhabitants, with 530 respondents) and Ho et al. (2018) (focusing on Sydney, approx. 5.3 million inhabitants, with 252 respondents) being two prime examples and with Liljamo et al. (2021) demonstrating the use of a significantly lower, albeit for a pilot survey that was conducted on the basis of a 'face-to-face' dialogue, sample size (47 responses within the territories of two cities, Reggio Calabria and Messina, in Southern Italy).

Table 7. Eligibility Requirements and Rationale (Sampling)

Eligibility Requirements	Rationale
Age baseline set at 18 and above	Considering the sensitivity associated with data collection from minors (<18 years of age) and the overarching premise of this research which centers on exploring the concept of Corporate/Commute Mobility as a Service (CMaaS) – namely, adults whom are legally eligible to drive and commute to work and/or university on a daily or, at least, frequent basis – the appropriate age group has been deemed 18 and above.
Location: Resident in Bahrain	As indicated by the title of this study, the geographical parameters have been limited to the Kingdom of Bahrain. However, in order to further enrich the data obtained for this study, the scope for commuters has been kept open without any restrictions based on nationality. The key impetus underpinning this decision was that this would enable the assessment of response variability on the basis of the three nationality categories embedded in the questionnaire: Bahraini, Other GCC Country, and Non-GCC Country.
Commute	Similar to the '*location*' criterion, the last – albeit loosely applied – eligibility requirement was to ensure that respondents are actively engaged in the process of commuting (seeing as this comprises the entire premise of the CMaaS variant). However, a 'none of the above' option has been included under the '*employment and enrollment status*' question to allow for responses from people that may have previous experience in commuting (i.e., two such scenario cases can be a person that may have retired from work or an individual that may have graduated from university but is still in the process of job hunting). Even though nostalgia bias might potentially skew the input provided by such participants, the potential of '*pastcasting*' (the potential for evaluating gaps between desired and actual outcomes) (Bendor et al., 2021) should not be underestimated.

Although a form of non-probability sampling, the snowballing technique has been adopted in this study for a number of key reasons. Firstly, it capitalizes on and counterbalances between both first-degree and second-degree connections with the former stimulating a higher response rate (albeit at the expense of coverage and data that is more representative of, and generalizable towards, the wider population (Link, 2018)) and the latter (which has been incorporated into the study by encouraging respondents to share the survey link/QR (more on mode of data collection below) with friends and relatives, and asking them to also share the survey with friends and relatives, that meet the eligibility requirements) allowing for more diversity and representativeness

in the obtained data by at the expense of a lower response rate, higher risk of attrition, and ultimately, potential non-response bias.

However, by encouraging respondents to share the survey with second-degree connections (referrals), i.e., some of their acquaintances, on the basis of the eligibility criteria inadvertently brings into focus two additional non-probability sampling methods: Purposive sampling and convenience sampling (Valerio et al., 2016). The use of purposive sampling, another non-probabilistic technique less known and understood compared to probabilistic sampling methods, allows for the selection of well-informed cases (Serra et al., 2018) and of a sampling frame that is most affected by a specific issue (Valerio et al., 2016) which in the context of this study pertains to commuters suffering from the externalities generated by the dominant automobility paradigm in Bahrain and forming the core uptake group for a potential MaaS roll-out in the Kingdom.

Likewise, the adoption of convenience sampling, as suggested in Belwal & Belwal (2010), although faced with severe limits due to non-randomness – again, a non-probabilistic sampling technique – and potential response homogeneity through increased risk of selection and exclusion biases (Link, 2018), still offers a pragmatic, less time- and cost- consuming lens (Hansen & Nielsen, 2014; Matubatuba & De Meyer-Heydenrych, 2022) through which to glean scientific knowledge on a given phenomenon by benefitting from the expedited reach to participants based on existing, first-degree, connections. Important to also disclose here is that no form of respondent incentivization strategy – primary incentives (researcher directly offering a reward to respondents) OR secondary incentives (respondents being rewarded by the researcher for additional responses they elicit from their peers) (Heckathorn, 1997) – was adopted throughout the data collection period in this study.

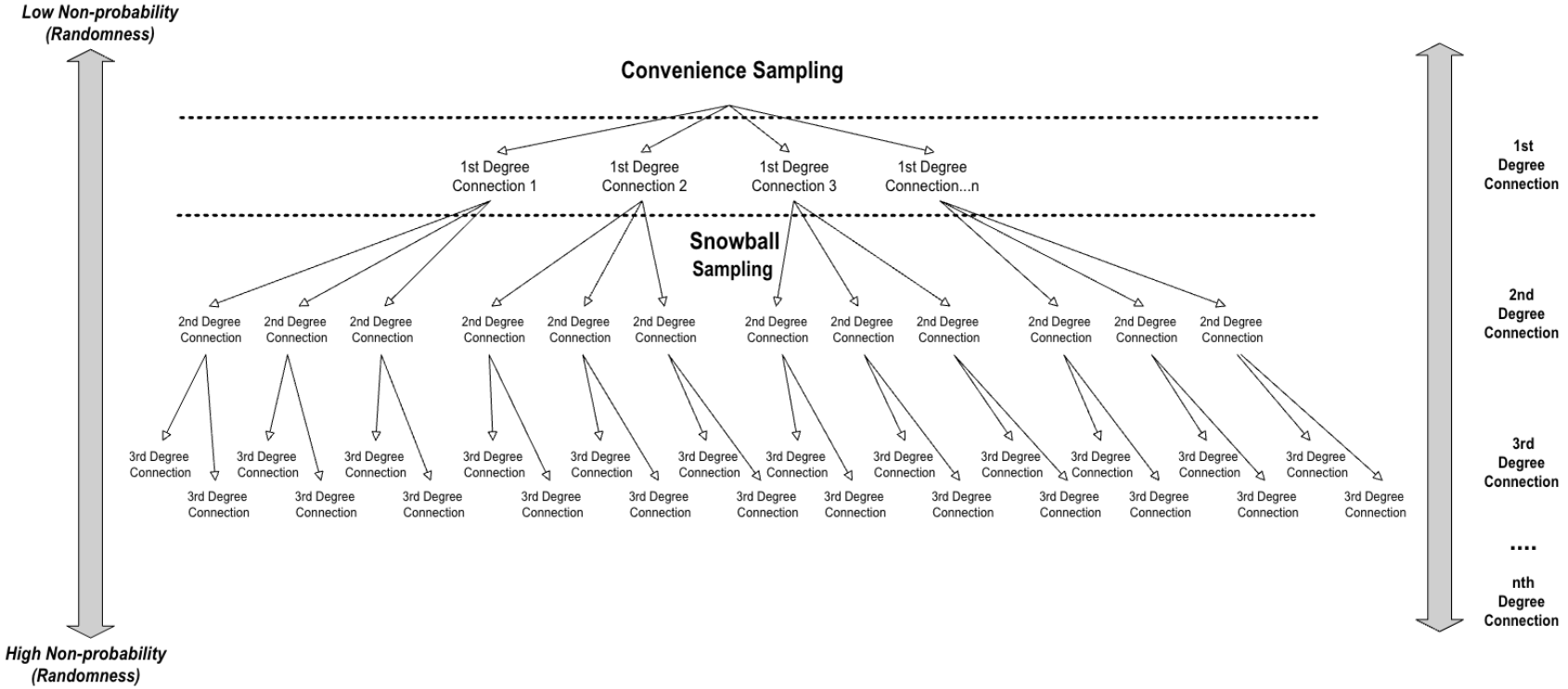


Figure 5. Schematic illustration of Sampling Technique (created by the Author)

Non-probability sampling methods have already been adopted in explorative MaaS studies, such as the work by Alyavina et al. (2020), where the emphasis was less on the robustness of statistical inferences and Cassar (2023) where a similar research approach (convenience sampling, use of semi-structured interviews, and targeting of specific population subgroup) has been utilized to assess the potential adoption of MaaS amongst workers and university students.

Similarly, the adoption of non-probability homogenous convenience sampling methods has also been adopted, again under the pretext of time-efficiency and cost-effectiveness, in studies, such as Matubatuba & De Meyer-Heydenrych (2022), which aimed to analyze the willingness-to-use for non-users of BRT systems. The authors here, fully cognizant of the limitations such a methodological approach would entail, have introduced safeguards to minimize the negative aspects associated with convenience sampling and that would bolster the generalizability of their study. Specifically, the authors relied on trained fieldworkers for the recruitment and selection of respondents and a screening question was included in the questionnaire to ensure that only targeted respondents, non-users of BRT systems, participated in the study.

Likewise in another study by Hansen & Nielsen (2014), snowball sampling was adopted to identify the population of interest in a research undertaking focusing on the exploration of characteristics and motives of long-distance (>5kms) of commuter cyclists – further reaffirming the widespread utility of such a sampling approach in contemporaneous behavioral research (Johnson, 2014). Acknowledging the notoriety of producing biased results associated with such a sampling approach, the authors defended their selection criteria, which included participants from different age groups and educational attainment levels, as sufficient for allowing an analysis of diverse practices and motives.

Focusing on a more specific subgroup of the commuting population through the adoption of a snowballing approach, authors such as Montoya-Robledo & Escovar-Álvarez (2020) and Møller et al. (2022) have delved into the role of commuting for domestic workers in Bogota, Columbia and rural nurses with jobs in capital regions, respectively. Both studies demonstrate the utility of the snowballing method in particular, and chain-referral approaches in general, in soliciting responses from a very narrow/specific population sample, or what can be described as ‘Hard-to-reach Populations’ (although such groups are accorded this name due to a number of other reasons as well i.e., unwillingness to participate in research or gain any form of publicity

further explaining why they are also interchangeably referred to as 'Hidden Populations') within a commuting context – even when tainted by well-documented biases linked with such sampling techniques (Heckathorn, 1997).

In deciding between the different survey modes available, an online (internet) survey (created through Google Forms) was selected instead of other options such as face-to-face interviews and telephone interviews considering as both alternatives present cultural issues and sensitivities – i.e., difficulty in soliciting and obtaining individual responses in patriarchal societies, religious strictures on cross-gender information sharing (Wolf et al., 2013), and other potential ethnocultural sensitivities. Additionally, response bias in face-to-face and telephone interviews, stemming from social desirability, also remains an area of concern (Chang & Krosnick, 2009). As for the remaining paper-and-pencil survey alternative in relation to the online survey option adopted in this study, both have tended to yield similar results according to Zhang et al. (2017).

Lastly, a data collection period was approximately 4 months and 3 days spanning from the date in which formal approval has been obtained, and communicated by, the University of Bahrain's Ethics Committee till the 20th of July 2024.

3.6 Additional limitations of snowballing/chain-referral sampling

A fitting starting point on the limitations of snowball sampling can be derived from the seminal work of Heckathorn (1997) in which one of the main methodological arguments presented in this research is countered. Namely, the cascading of the survey from first-degree connections on towards second and third (and beyond) degree connections, as shown in Figure 5, might not necessarily result in higher non-probability (randomness) due to the initial sample (1st degree connection) not being drawn randomly. This tends to magnify a number of inherent biases – i.e., subjective judgements used in selecting first stage informants (1st degree connections) (Johnson, 2014) such as assuming that the sampled respondents and their wider networks offer a veridical image of the wider population (Doreian & Woodard, 1992) – that mainly results from the oversampling, and the resultant overrepresentation (Shay et al., 2016), of the researcher's personal networks. Another somewhat similar critique is that the size of a respondent's social network can also play a highly influential role in determining whether that particular respondent will be sampled or 'referred'; individuals with larger social networks are more likely to be sampled in

relation to individuals with smaller social networks (Johnson, 2014). Altogether, this creates the underlying basis for the heightened risk of selection bias.

To exemplify a practical implication of the aforementioned issues, certain subsets of the population (PwDs, people not proficient in a certain language, people from certain sociodemographic/ethnic/economic/cultural backgrounds etc.) might be completely, or poorly, represented in the study (Shay et al., 2016). Although, this need not detract from the robustness of this study, or from the overall value of such a sampling approach, considering the research parameters and scope outlined in the constructing of the study explicitly focus on able-bodied commuters within a certain range (>18 years).

3.7 Participant Familiarization Strategy

From the onset of the survey, introduction page, the participants were introduced to the aim of the survey (stated 'verbatim' in the text box below) in addition to a short and simplified explanatory video on the concept of Mobility-as-a-Service. The inclusion of an introductory video is, as alluded to earlier, consistent with a similar approach adopted by authors such as Ho et al. (2020) and with an almost similar duration – the video adopted by the aforementioned authors is exactly 2 mins and 2 secs in length whereas the video adopted in the survey adopted for this study runs for exactly 2 mins and 49 secs. The main reason why a different video has been opted for in this study is that the one adopted in Ho et al. (2020) is solely centered on the Ubigo (Swedish MaaS) app which if introduced to people unfamiliar with MaaS might lead them to conflate Ubigo, as a brand, with the fundamental concept of MaaS adding unnecessary information and complexity to their initial understanding and comprehension of what MaaS actually is.

As a concluding statement in the survey, final page, the participants were also introduced two paradoxes that are befitting of the automobility-dominant paradigm gripping Bahrain and the attendant externalities and negative feedback loops such a system would engender.

3.8 Thematic Analysis (use of Nvivo) in the MaaS Literature

The latest Nvivo software (Nvivo 14) was adopted in this study in order to draw thematic patterns from open-ended questions that have been incorporated into the survey. Nvivo is a powerful quantitative analysis tool that enables the tracking of interview parts (and emerging themes and codes) without losing access to the source data (Sepasgozar & Davis, 2018).

Following the tenets of grounding theory, the open-ended and descriptive inputs provided by respondents were rigorously analyzed and contrasted, often sentence by sentence, in order to determine key themes and codes under each theme (Van Cauwenberg et al., 2012). Although, the original intention was not to establish hierarchal order within the different codes established under each theme as has been done in other predominantly qualitative research papers on MaaS such as Matyas (2020), the coding matrix functionality of Nvivo still allows for hierarchization based on response numbers under each code with an extent of granularity determined by the attribute levels incorporated into the original survey design (different genders, age ranges, employment/enrollment status, household size, etc.) as shown and discussed in section. Likewise, the inclusion of direct quotes from respondents, as has been adopted in MaaS studies such as the work by Matyas (2020), has been considered as impractical give the high number of respondents in the survey. Instead, visualizations (such as Word Trees, Word Clouds, Sunburst Diagrams, Tree Maps, etc.) generated through the Nvivo software were adopted to reflect some of the most common words, codes, and themes emerging from the survey data.

3.9 Statistical Method

The main statistical technique that has been adopted for the analyzing the relationship, and inference, between the several survey components is the chi-square test of independence. As such, the utility of the method has already been demonstrated in other MaaS-centered studies that were based on survey data collection methods – such as the work by Khaimook et al. (2019) which focused on establishing the statistical significance in the relationship between app usability and traffic behavior change, recognition of safety, and application usage retention. Likewise, the study conducted by Papagiannakis et al. (2018) also deploys the same statistical method towards establishing the relationship strength between income and willingness to preserve reduced car use. As part of a similar crosstabulation analysis conducted in Yeboah et al. (2019), the authors have also resorted to the use of the chi-square test of independence method to establish the relationship between multiple sociodemographic and travel behavioral factors on pre-travel information seeking behavior.

3.10 Sample Characteristics and Descriptive Statistics

3.10.1 Researcher's Network

Beginning with the family connections, the author has predominantly relied on purposefully sharing the survey with first-degree, second-degree, and third-degree family connections. In contradistinction to the connection levels discussed earlier, a first-degree family connection could be an individual's siblings, parents, or children. With second-degree family connections, the scope extends towards the inclusion of aunts, uncles, nieces, nephews, and grandparents. Lastly, third-degree family connections include a person's first cousins. Altogether, all three family degrees would classify under 'first-degree' connections as per the connection levels discussed in the preceding section. Another source of first-degree connections, and source of respondents based on the author's acquaintances, has been co-workers from the workplace – mainly academics (input from administrative staff also incorporated) from a technical higher-education tertiary institution located in Bahrain.

3.10.2 Sample (Respondents) Age

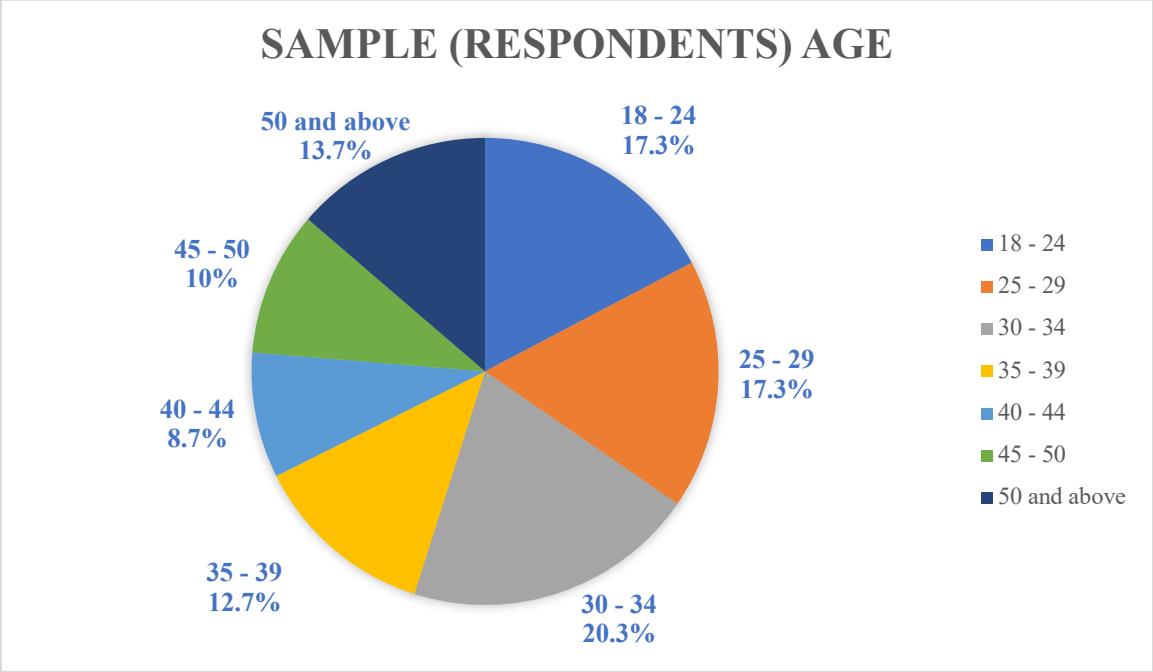


Figure 6. Age distribution of surveyed sample

Beginning with the age demographics of the surveyed respondent, the pie-chart above demonstrates a more or less consistent distribution across the 30-34 (20.3%)/ 18-24 (17.3%)/ 25-29 (17%) and 50+ (13.7%)/ 35-39 (12.7%)/ 45-50 (10%) age brackets. Such a comparable distribution among the different age groups, as can be gathered from Figure 6, ensures the input of respondents across different generational periods – a well-documented variable in how MaaS, in particular and personal mobility, in general, are perceived. This is key for confirming patterns emerging from other studies that observe an inverse correlation between age and desirability for using MaaS for social, general, and work trips (Duan et al., 2022) which, the authors posited, is due to the inertial embeddedness towards private car use that is more discernible within older generations considering they have been travelling in private cars for a longer period (Schikofsky et al., 2020).

Important to also acknowledge here is that the age groupings adopted in the study might detract away from some of the age categorizations adopted in other research work on MaaS. Namely, the use of different generations – such as Millennials (’81 – ’96), Gen X (’65 – ’80), Boomers II (’55 – ’64) etc. – seeing as these overlap with multiple age groupings adopted in this study i.e., (25 – 29), (30 – 34), (35 – 39) all falling within the ‘Millennials’ category.

To exemplify the issue at hand, Siren & Haustein (2013) focused solely on the travel patterns of the so-called baby-boomers’ mobility patterns and the implications thereof on for the future of transport. In so doing, the authors have managed to, through a cluster analysis, establish three distinct clusters within the baby-boomers age range – the “Flexibles” cluster was used to represent people who use all modes of transport along with the internet for banking transactions (a key MaaS primer also adopted in the survey) as for the “Independents” cluster it was coined to represent people relying predominantly on monomodal transport options and also contemplate using the internet for online banking transactions and lastly, the “Restricted” cluster is adopted for the baby-boomers with the lowest level of car access and car use, highest dependency on others for transport, and an aversion towards using the internet for online banking services.

3.10.3 Note on omitted age group (<18) from the studied sample

In one of the very few studies that explore the MaaS conceptualization in specific reference to perceptions, needs, and usability (WTU) amongst minors (below 18 years of age), the research published by (Casadó et al., 2020) fills a critical gap – and still an underserved area – in the

literature by incorporating empirical data worth briefly recounting here in light of the <18 subgroup omission from this study. Here, the authors deduce a number of areas where perceptions of MaaS amongst children and adolescents both converges with, and diverges from, those of adults. In reference to the former, the basis from which choices are made – built on perceptions, affective desires, and the experience of practice – are seen to be similar when contrasting inputs from both adults and children/adolescents. Additionally, lingering anxieties surrounding safety, privacy, and space along with perceived advantages of flexibility when contrasting between both private car usage and reliance on shared transport highlight some of the key areas where convergence is visible – and reconcilable with findings from other published works. Yet, the divergence in perceptions is discernible when considering things such as weightage given to certain factors, perceived risk factors in certain transport modes, and, expectedly, fears of incorrectly navigating through the transport network that may result in them, children and adolescents, ending up in the wrong place. In response to which the authors here aptly invoked the stage at which such respondents are expected to be in where their sense of location and place remains at a developmental level with Marzi & Reimers(2018) and Riazi & Faulkner (2018) also furthering the discussion by highlighting the role of Children's Independent Mobility (CIM) towards their psycho-social and cognitive development. Thus, the exclusion of such an important subgroup of the population prevents such nuanced children/adolescent-specific inputs, perceptions, and differences from being captured within the scope of this study. Likewise, the potential role of MaaS in promoting CIM, a gap in the extant body of literature, is also abandoned by the decision to omit those under 18 years of age from this study.

3.10.4 Sample (respondents) Gender Split

The comparable split between males and females in the obtained sample responses (with male responses exceeding those of females by 7.6%), as can be gathered from Table 8, is of utmost importance considering that the implications of a MaaS system deployment on gender equity in transport – similar to the issue of MaaS vis-à-vis CIM discussed in the preceding section – remains as another area that has received scant attention in the literature. In that vein, the work produced by McIlroy (2023) has focused on filling the aforementioned gap by carrying out a comprehensive review of 420 MaaS peer-reviewed articles – from which only 141 allude to the term 'gender' in

specific reference and even fewer have substantively articulated gender-specific issues in text – with a few key findings.

Perceptions of, and by extension WTU, MaaS among females has often been divergent, if not contradictory, when contrasting findings from studies conducted in different cities which, in order to exemplify, the authors have cited the higher proclivity amongst female participants to adopt MaaS in a study conducted in Madrid compared to an equal proclivity (no difference) among both sexes in a study conducted in the Randstad region of the Netherlands – and lower interest in adopting MaaS in the study carried out by Ko et al. (2022).

Such reported differences between two distinct countries, although both residing within a European/Westernized context and viewed through a euro-centric lens, lend further credence and urgency to the need for empirical input from countries and regions less represented in the extant literature – a limitation of the study openly acknowledged by the authors. Additionally, perceptions and acceptance towards the deployment of national strategies to support pro-environmental behavior (PEB) (i.e., through dis-incentivization policies for private SOVs) have been resulted in varied responses by males and females in a study conducted in Norway by Nordfjærn & Rundmo (2019). With females exhibiting stronger bio-spheric (values that tend to focus on the welfare of the environment) and altruistic (demonstrating concern for the welfare of other human beings) values compared to males whom demonstrated traits and values concomitant with heightened egoism (focus on promoting oneself) and hedonism (focus on attaining personal gratification). This, in turn, has been highlighted as the main impetus behind the recommendation for gender-tailored policies put forward by the authors which also lays the groundwork for further exploration of pro-environmental MaaS policies (that focus on simulating uptake of sustainable transport options available within a given MaaS ecosystem) that are more targeted and preceptive towards specific genders.

Table 8. Gender split for surveyed sample

Gender Split	Percentage
Male	53.8%
Female	46.2%

Although this has already been thoroughly elaborated on in the literature review section, it is still worth reiterating the ethnocultural and socio-religious peculiarities that continue to characterize not only Bahrain by the majority of countries with predominantly Muslim populations.

Focusing on the role of Islamic strictures in specific mobility situations for female passengers, the work of Bagheri (2019) tellingly elucidates on the nexus between "gender, mobility, and the adaptation of the 'proper' Muslim woman" within the context of Tehran's subway network. Therein, and with significant implications to the MaaS conceptualization, the authors were able to analyze the preferences of female passengers towards women-only and mixed-gender cars (both of which were available under the Tehran subway system); an adaptation of the PT system towards a socio-religious factor dominant in an Islamic country such as Iran and a peculiarity emblematic of the broader Islamic World that has yet to be captured within the overwhelmingly euro-centric MaaS body of knowledge.

Reverting back to the study – by Bagheri (2019) – the authors collated and presented lucid responses solicited from female passengers that firmly establish the rationale behind their aversion towards, or rather abstinence from, using the mixed-gender cars – namely, out of fear of harassment and exposure (to both the 'Fashion Police' and male citizens).

Likewise, another seemingly blind spot within MaaS research involves understanding how female passengers in countries such as Saudi Arabia – where up until June 2018, women were prohibited from driving and hence were dependent on male relatives, hired drivers, and private transportation to cover their mobility needs (Williams et al., 2019) – can access, and perceive of, different individual urban mobility options that might be congregated to form a MaaS bundle. With upcoming large-scale transportation projects ongoing across the GCC (Gulf Railway, Bahrain Metro, etc.), the issues brought to light herein under this section present an intriguing question that can be surmised from the title of the conference paper published by Shaaban (2019) prior to the opening of the Doha Metro in Qatar: "Who Is Going to Ride the Upcoming Metro in Qatar?".

3.10.5 Sample (respondents) Nationality

It is befitting to start this subsection by answering the question posed in the title of the conference paper prepared by Shaaban (2019); the use of public transportation in Bahrain, and within the

broader GCC, has often mirrored the socioeconomic polarization that is becoming ever more conspicuous within the country and region. Anecdotally, this can be viewed in the staggeringly disproportionate use of public transport options between Bahraini nationals and nationals from non-GCC countries with the latter comprising the core ridership base for the main, and arguably only, comprehensive PT option operational in Bahrain: The Public Bus Service. Comparably, the work of Qamhaieh & Chakravarty (2017) further expounds on, what the authors claim to be, a societal dividing line evidenced by the overwhelming uptake of public transport by low-wage, blue-collar works (which based on the context of the study, Abu Dhabi, comprise 40% of the population) by bringing into focus the distinction between 'Choice' and 'Captive' riders in public transportation (Fang et al., 2021) – (Qamhaieh, 2022) also report similar findings within the context of Dubai.

Starting off with 'Captive' riders, and as the phraseology strongly suggests, the term is used to describe passengers without the necessary wherewithal (i.e., financial, legal etc.) to access other forms of transportation (implicitly referring to accessing and using a private car) and are, thus, held 'captive' by their need to use public transportation out of sheer necessity and involuntariness (Zhao et al., 2014). Conversely, the term 'Choice' riders, again as the naming strongly suggests here as well, is used to describe passengers with the requisite wherewithal to access alternative and diverse modes of transportation which altogether allows them to make trade-offs and 'choices' between the offerings under different mobility options (Fang et al., 2021).

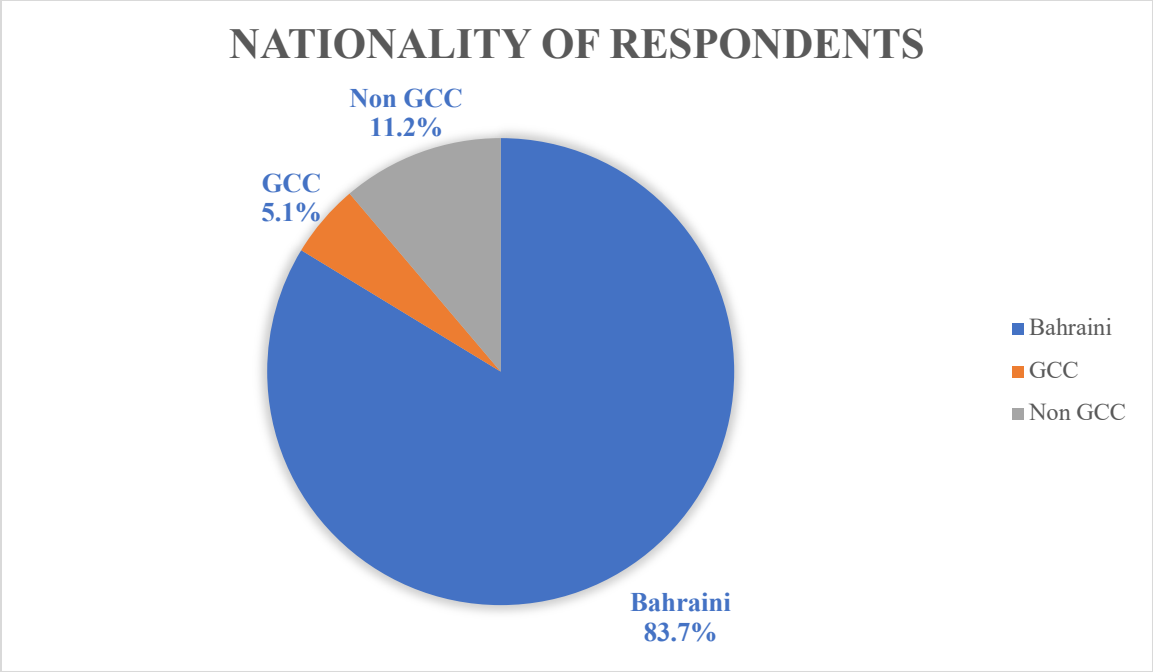


Figure 7. Nationality of Respondents Bahraini (83.7%), Other GCC (11.2%), Non-GCC (5.1%)

The nationality split shown in Figure 7 evidences an overwhelming majority in responses from Bahrainis (at 83.7%) and, overall, GCC nationals (88.8%) in relation to input from non-GCC nationals (11.2%). An inherent limitation of the nationality composition incorporated into this study is that it generates heavily skewed and slanted findings towards Bahrainis, and by extension GCC, nationals as opposed to respondents from non-GCC countries.

Nevertheless, the high representation of overall GCC nationals offers ample input to scrutinize and analyze a phenomenon that has become worryingly symptomatic of the deeply rooted and entrenched dependence on automobility within the region, a term that has been coined by Qamhaieh & Chakravarty (2020) as '*exaggerated automobility*' in their highly illuminating work on the issue of automobility within the emirate of Abu Dhabi. The term has been developed by the authors to encapsulate "significant attachment to cars, and a combination of social, cultural, and demographic factors, [that] have created unique expressions of automobility". An interesting observation captured by the authors who also expounded on the dichotomy between choice and captive riders and the space for perpetuating and exacerbating social injustices within mobility. Namely, the authors articulated how car-owners tended to flaunt their superiority and sense of entitlement towards non-drivers or captive riders – whom, again, happen to be predominantly low-

income, migrant workers. One of the blatant manifestations of such behavior has been the practice of ‘stop-and-honk’ curbside delivery with the expectation of service.

3.10.6 Implications of ‘Captive’ and ‘Choice’ Riders (Classification)

Another limitation of the sampling methodology adopted in this study is that, as already discussed above, the selected non-probability method inadvertently magnifies, inflates, and homogenizes the socioeconomic, amongst other, characteristics of the sampled pool seeing as their selection originates and extends from (through first degree connections) the author’s personal and professional network (Johnson, 2014). Therefore, a restricted sample variance might, in this particular case, lead to the underrepresentation, if not outright omission, of captive riders which, even if unquestionably disadvantageous towards the generalizability of the study, might also inadvertently result in a more concentrated focus on nudging MaaS Skeptics whom, according to the classification of potential MaaS users outlined in Chen et al. (2023), are theorized to be deeply entangled within the current paradigm of personal car ownership. Also, the inclusion, or overrepresentation, of captive riders, whom in the literature have been shown to have higher tolerance for transit services and are less sensitive towards service changes (Fang et al., 2021), might skew results that pertain to the uptake of PT, and other alternative modes, as part of MaaS.

3.10.7 Mobility in Bahrain: Driven towards the private-car paradigm by ‘choice’ or ‘captivity’?

The prevailing assumption underpinning the contrast between ‘choice’ and ‘captive’ riders is that it implicitly suggests the inability of the latter group to access private forms of mobility (mainly, the private car). Yet, it fails to acknowledge, let alone capture, the possibility of the inverse as being just as equally true. Namely, that riders are often – through the overwhelming predominance of the existing socio-technical automobile regime and entrenched path dependencies and lock-in mechanisms (Hoffmann et al., 2017) – inhibited from accessing and using alternative forms of mobility other than the private car. A description that seems to be all too fitting for the urban mobility landscape in Bahrain. A statement from an expatriate interviewee (without a car), originally quoted in Salim (2022), offers a rather telling representation of the situation in Bahrain: “I’ve never been so isolated in my life… it gives me the sense that I’m in a desert”.

The tone evident in the aforementioned quote certainly evokes a sense of involuntariness and helplessness – additional hallmarks of car dependence and 'captivity'.

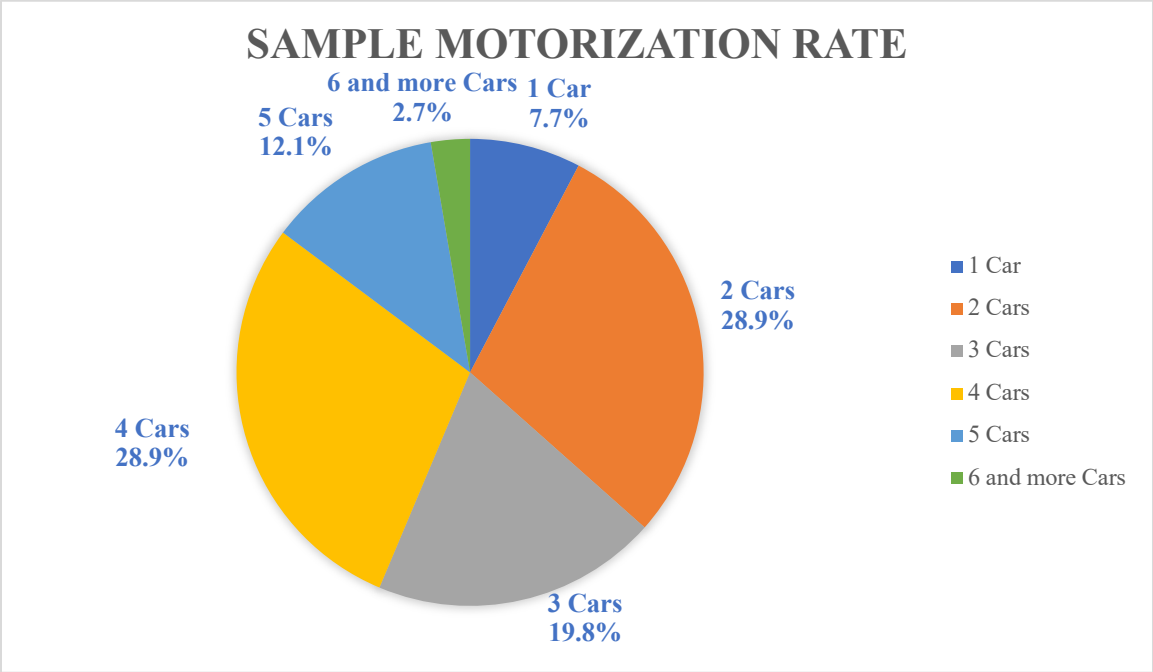


Figure 8. Number of cars within Household – (2.6% with 6 and more cars)

Furthermore, such captivity is also mirrored in the car ownership data obtained through the survey in which 64% of respondents report having three or more cars within their household (as per Figure 8) and has been mirrored in the few scientific papers that cover, or at least allude to, the state of public transportation in Bahrain. One such study has been produced by Pinelo Silva & Akleh (2018) whom explored the quadrangular relationship between the built environment, the climate, walkability and physical activity within the case-study context of Bahrain. Therein, the authors highlighted the implications of an unreliable, incohesive public transport network, deeply in need of an overhaul, on sustaining the private-vehicle dominant paradigm within the Kingdom. Although, the authors did also pragmatically elaborate on ecological factors, outside of the socio-technical sphere of influence, that render other forms of mobility – especially active and, to a lesser extent, micro mobility options – unattractive and impractical. Along with engendering higher dependence on private car usage, harsh weather conditions have been correlated with higher dependence on indoor environments and, as a result, endemic levels of physical inactivity. Logically, this brings to light much needed attention towards the potential utility of MaaS in not

only contributing towards the attainment of clearly spelled out, purely transport-related, and easily relatable Sustainable Development Goals such as Target 11.2 but also towards the attainment of other SDGs such as SDG3 "Ensure healthy lives and promote well-being for all at all ages" (Ferretto et al., 2021) through its potential for nudging users towards bundles and schemes where micro, and especially, active mobility options feature heavily.

In instituting and operationalizing countermeasures – even when up against issues (such as extreme weather in this case) that might seem intractable, irreversible, and in turn futile – to improve walkability and cycling; combating urban heat islands (O'Brien et al., 2019), adopting natural microclimate strategies (i.e., growing trees) (Fahmy et al., 2010), and offering some of the core antecedents needed for fostering an active mobility culture (i.e., provision of clearly demarcated and dedicated bicycle lanes and pedestrian walkways) (Pisoni et al., 2022) are some examples of how the seemingly insurmountable issue of 'harsh weather' might be meaningfully tackled within the context of Bahrain.

Table 9. Percentage of Respondents with and without a Driving License

Driving License	**Percentage**
Yes	95.6%
No	4.4%

Overall, using car ownership alone as a proxy to infer preferences towards MaaS remains, based on chequered results from various studies in the literature, of tenuous reliability. Findings in both Polydoropoulou et al. (2020) and Ho et al. (2020) illustrate reduced preference towards MaaS amongst frequent car users, and a heightened unwillingness to do away with cars amongst car-lovers, compared to frequent users of public transportation. Conversely, Ho et al. (2020) has also reported a higher proclivity within car-sufficient households (where each person/driver has their own car), vis-à-vis car-negotiating households (where there are more drivers than cars), to subscribe to MaaS packages. Lastly, findings from Zijlstra et al. (2020) demonstrated no relevant influence of private transport ownership on preferences towards MaaS. Irrespectively, the dependence on private cars in Bahrain, or at least within the surveyed sample, is unequivocally evidenced by the proportion of respondents with driving licenses (95.6%). And when viewed in light of younger generations such as Millennials (1981 – 1996) and Gen Z (1997 – 2012: Only

those that are 18 or above from this generation) that comprise approximately 76% of respondents surveyed in this study, not only reinforces the notion of overdependence on private cars in Bahrain but also runs counter to the 'Millennial Factor' movement, as outlined in Mulley (2017) and discussed earlier, which sees people from younger generation wean off of private car use and ownership – to reiterate, the 'Millennial Factor' has lent the impetus behind much of the positive traction that has been gained for the uptake of MaaS in the literature, yet it's visible inapplicability to Bahrain, and potentially the wider GCC, mirrors the perils of extrapolating and inferring patterns and findings deduced from studies rooted in predominantly Western countries in the Global North towards countries with starkly dissimilar socio-technical and ethnoreligious landscapes compared to Bahrain.

3.10.8 MaaS and Household Size

The role of household size and composition has often been at the forefront of variables influencing the uptake of, and perceptions towards, emergent mobility schemes. Moreover, the switching cost associated with transitioning away from the currently dominant personally-owned ICEV paradigm towards more environmentally friendly options such as Evs has often been seen as burdensome in larger, compared to smaller, households (Higueras-Castillo et al., 2022).

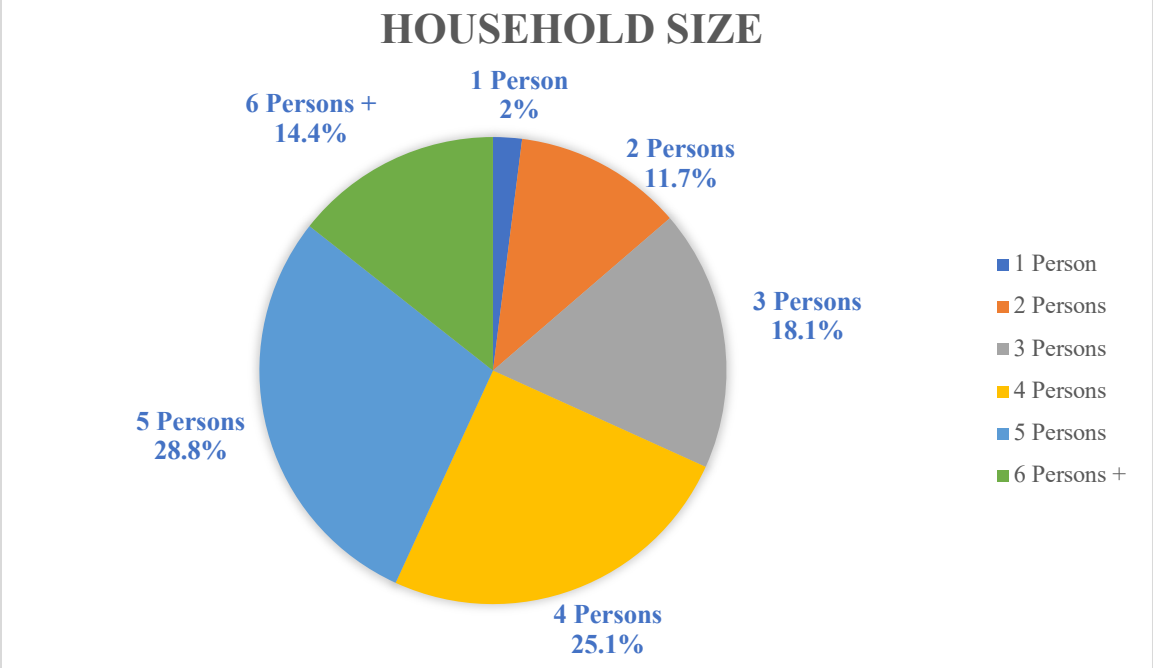


Figure 9. Household Size of Respondents

Still, it is imperative to examine some of the core tenets that underlay the notion of 'switching cost'. Namely, it has come to be seen as equally grounded in both 'psychological' as well as 'economic' motives (Sokolova & Prorok, 2022). Thus, and in specific reference to the former, switching cost can also be construed as an indicator that reflects the depth of inertia stifling the replacement of outdated, legacy technologies with contemporaneous innovation (Soto et al., 2021). To illustrate, Duan et al. (2022) have expounded on this – albeit under the guise of *transaction cost theory* – against the backdrop of MaaS in which users' are hypothesized to confront the option of incurring two types of transaction costs when deciding to adopt a suitable MaaS offering: one, the resources involved in searching, choosing, and using MaaS and, two, the resources required in troubleshooting and redressing any potential issues that might occur while using MaaS (the authors have equated resources with effort, time, and cost).

Reflected in one of the core theoretical models that focuses on clearly delineating and categorizing the antecedents undergirding users' intention to switch from one good or service to another is the 'Push-Pull-Mooring' (PPM) model (Wang et al., 2020) – although it is worth acknowledging the intended use-case for the model was to originally assess the factors that lead people to migrate from one place to another before the tool eventually gained traction in transport studies.

Analyzed through the lens of the PPM model, the categorization of large household size under the push category (used for factors that 'push' users from change) seems to be magnified the moderating role of inertia under the mooring category (Wang et al., 2020). Another push example, as reported in Ho et al. (2018) and pertains to household composition, that seemingly dissuades married couples – whom are already less likely to consider using MaaS (Duan et al., 2022) – from considering MaaS inversely correlates with the number of children they have; families with higher number of children, two or more, have been reported to be less interested in utilizing MaaS (although this specific variable has been reflected in the distributed questionnaire). Likewise, and with heightened relevance for the Bahraini context, the number of family members with a driving license has also been inversely correlated with families' willingness to adopt MaaS; families with more individuals with a driving license have been reported in (Hensher et al., 2021) to be more averse to the adoption of MaaS.

3.10.9 Delimitations of the 'Household' term and 'Self-definition'

Although the introduction of semantics might unnecessarily overcomplicate the study, the term 'household' deserves to be scrutinized more deeply. Towards that end, the commonalities and disparities in how the term is defined – and in the case of the distributed survey, implicitly understood – in research has received much needed attention in the work of Casimir & Tobi (2011). Defined loosely, the term can broadly encompass any group of people who share some, or all, of the following: networks, food, an address, and/or accommodation. By pursuing such an open-ended approach, the authors have cautioned of the ease with which researchers and respondents, equally alike, might conflate between the term 'household' and 'family'. Defined more stringently, the authors have to deduce the key criteria for how the term should be defined, based on a thorough synthesis of 58 papers from the extant literature, into 20 indictors (found in the study) with certain components, such as 'Civil Status', assuming much more emphasis (i.e., restrictions and prohibitions on cohabitation) when considered within the ethnoreligious context of this study in Bahrain. Collectively, what this issue demonstrates the lack of a unifying definition that exposes the 'household' term to the vagaries of self-definition – in simple terms, people grounding their definition, and understanding, of a specific word on their individualities i.e., emotions, interpretation, thoughts etc.

One of the manifest ways the aforementioned issue can creep into this piece of research would be in whether participants who might have been recently married but, due to economic reasons, still live with either spouse's parents have counted themselves along with their parents, and possibly other siblings, as one household when conversely, they might be argued to be two distinct households under one roof. Whereas, respondents who have been recently married but have the financial capacity to afford their own accommodation might counted and considered only themselves and spouses as comprising the household – reflecting a much smaller size in the questionnaire.

3.10.10 Employment and Enrollment Status of Respondents

In line with the credo adopted in this study, which aims to focus on the entire commuter base as opposed to only commuting workers or commuting students, the distribution reflected in Table 10 demonstrates an overwhelming representation of full-time-only workers (63.1%) in contrast with full-time-only students (8.1%). Yet, it also reaffirms and reflects the acknowledgement on which

this study is premised in that commuting workers and commuting students are by no means mutually exclusive – since certain individuals can be classified under both.

Table 10. Employment and Enrollment Status of Respondents

Employment / Enrollment Status	Percentage
Working Full Time	63.1%
Working Part Time	7.7%
Working FT and Studying FT	3%
Working FT and Studying PT	4%
Working PT and Studying FT	2.7%
Working PT and Studying PT	0.3%
Studying FT	8.1%
Studying PT	0.3%
None of the above	10.7%

As such, the sample base captured through the distributed survey offers a fitting reflection of the targeted population for this hybridized variant of MaaS. Hybridized because it offers a cross-over between MaaS variants that have already surfaced in the literature such as University as a Service (UaaS) (Le Pira et al., 2023) and of course the much more prominently and extensively covered Corporate Mobility as a Service (CMaaS) variant (Frank et al., 2024; Hesselgren et al., 2020; Vaddadi et al., 2020; Zhao et al., 2020) but with a more narrow focus on users' agentic role and commute trips from primarily residential locations to either a workplace or university as opposed to covering on-site transportation needs for large campuses and workplaces or in between multi-location campuses and workplaces as seems to be the common thrust of CMaaS. Although such a proposition has potential in testing grounds such as the University of Bahrain campus Sakhir that, due to its sheer size, necessitates the involvement of some form of motorized transportation.

3.10.11 Users on Both Sides of the Fence (Working Students)

A key consideration that has been built into the design of the survey has been the enabling of respondents whom would classify under both commuter categories outlined above (individuals whom are both working and studying) the freedom and flexibility to select whichever commute experience they prefer as the basis for responding to the survey questions. To illustrate, questions such as 'how would you describe traffic conditions during your daily commute?' and 'how often do you practice carpooling for your daily commute?' allows working student the scope to use

either commuting experience, to work or an educational institution (the term is used instead of university because determining the level of the educational institution respondents report being enrolled in has not been pursued in the survey), as the basis for answering the aforementioned questions.

The inclusion of working students, albeit a clear minority as in total they comprise only 10% of responses across all the Employment/Enrollment categories of different durations as shown in Table 10 offers an opening through which to conduct preliminary analysis on a subgroup that, to the best of the author's knowledge, has yet to receive attention within the extant MaaS literature. Yet, it is worthwhile mentioning that employment status has often been construed as a key indicator for the uptake of MaaS in studies such as Duan et al. (2022) which demonstrate a markedly lower interest in MaaS by retired and unemployed people. Additionally, the focus on this broadened conception of the 'commuting base' – except for the 10.7% of respondents that have selected the 'none of the above' option (explained in more detail below) – allows for the analysis of input from users deeply entrenched within a routinized type of behavior, in this case focusing on the practice of commuting with a clear overdependence on private car use, that is perpetuated and inertially strengthened when performed recurrently (Catulli et al., 2021). Alluding back to respondents that chose the 'none of the above' option (again, representing 10.7%), this subgroup remains also heterogeneous and fragmented as it can just as equally comprise of respondents who are either recent graduates, unemployed, or retired; one of the attendant risks associated with soliciting input from either recent graduates or retirees, as an example, is that it subjects such respondents to the risks of cognitive bias and memory bias as they try to recall their commuting experience while completing this survey. Furthermore, such biases lay the groundwork for another type of bias, that is of even more concern for this study, called *impact bias* which holds that respondents are more likely to only remember the given extremes of an event (best and worst of times) while often showing unawareness towards its atypicality (Grüner & Vollrath, 2021). Thus, when attempting to answer survey questions such as 'are you in favor of restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hours?' might invariably lead such respondents towards affective forecasting – and consequently, the risk of committing affective forecasting errors – since respondents might have overestimated or underestimated the magnitude of their past commuting experiences (part of the basis on which they are answering the aforementioned question) (Eastwick et al., 2008).

3.11 Examining Antecedents Towards MaaS Adoption and Sustainable Mobility

3.11.1 Smartphone Ownership and Use of Journey Planners

Although MaaS services can be accessed through other digital interfaces (i.e., websites), the conceptual foundation of this mobility scheme, as outline in the literature review, rests on the ubiquity of smartphones, applications, and telecommunication networks. Still, research on the role of smartphone applications on individuals' mobility remains far from exhaustive (Khan et al., 2020). Juxtaposed against one of the five indicators – *tech-savviness* – put forward by (Zijlstra et al., 2020) would be the obverse 'Non-tech savvy' category assumed in (Khan et al., 2020) to reflect individuals less attuned and accustomed to the use of technology in general and smartphones in particular. When contrasted against the opposing 'Tech-savvy' group, the authors have reported mixed findings on the role of tech-savviness on users' Vehicle Kilometers Travelled (VKT). In instances where smartphone dependency and application usage are highest, the authors have witnessed a sharp increase in VKT in the tech-savvy group vis-à-vis non-tech savvy users. Nevertheless, the lack of familiarity towards carpooling and car-sharing applications among the non-tech savvy group has also attributed to higher propensity to increase VKT within that group compared to the tech-savvy group.

In case of the surveyed sample pool, all but 1.3% of respondents report owning a smartphone. However, smartphone ownership does not necessarily correlate with level of tech-savviness as the latter often rests on the frequency, proficiency, and easy with which users can navigate through the different functionalities that are enabled through the use of smartphone technology. And those that have been deemed most pertinent to MaaS – which has been commensurately reflected in the extent of attention and focus such functionalities have received within the existing MaaS scholarship – were applications that facilitate journey planning and online transactions (note: the focus here is on proto-MaaS characteristics and not beyond-MaaS features, such as hotel and restaurant bookings, as discussed in the literature review section).

Table 11. Percentage of respondents owning smartphones

Smartphone Ownership	Percentage
Yes	98.7%
No	1.3%

With journey planning, a significant proportion of respondents' report using apps such as Google Maps either often (33.7%) or always (16.7%) as shown in Figure 10. Also, the perceived utility of such apps has been reported at an even higher rate amongst the sampled respondents with 55% agreeing and 27.9% strongly-agreeing to the usefulness of journey planners. Such positive perceptions and attitudes towards journey planners, apart from demonstrating their utility within the dominant automobile paradigm, has been theorized to play a central role in not only MaaS adoption but also in the uptake of PT services (one of the reasons underlying claims of sustainable mobility linked with the use of MaaS).

Moreover, journey planners have been posited to enhance the usability, accessibility, and uptake of PT services through meeting users' need for guidance, identifying transit options that meet users' preferences, and facilitating multimodality (Aditjandra, 2019).

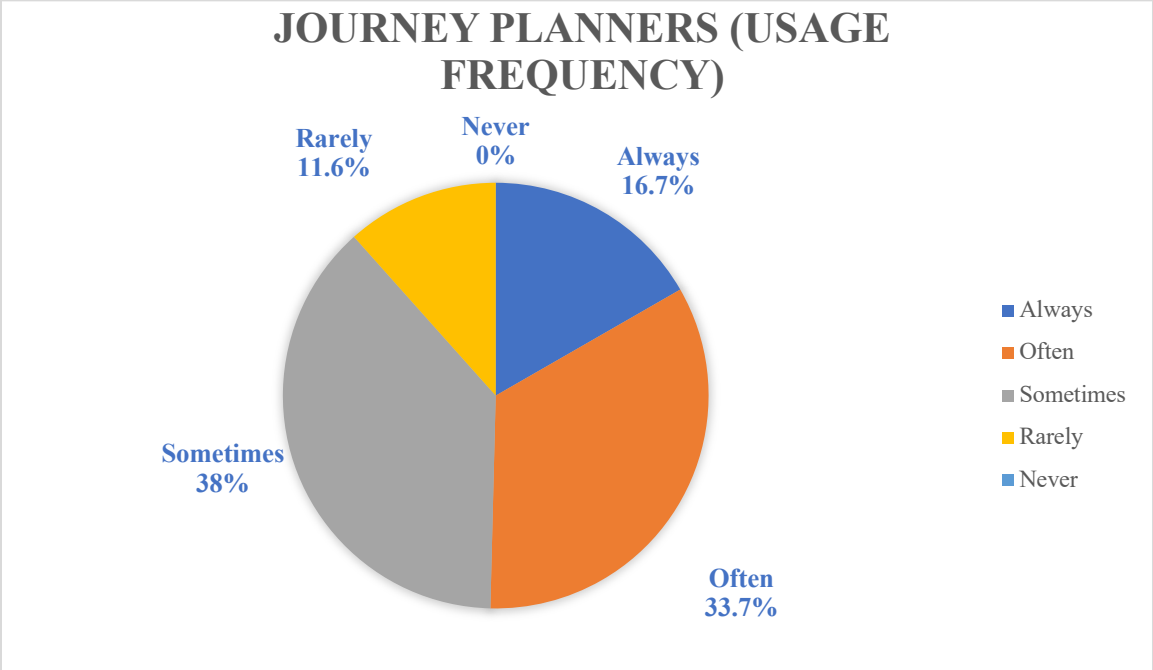


Figure 10. Frequency in use of Journey-Planners

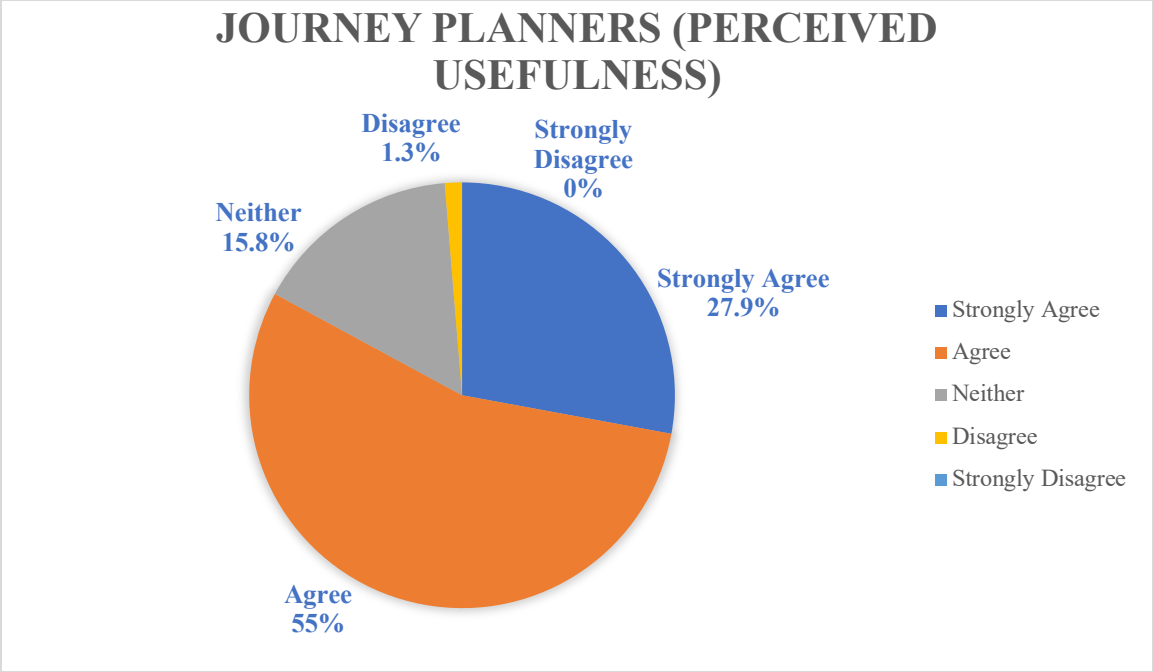


Figure 11. Percentage of respondents that find journey-planners useful

However, the traditional conception and deployment of journey planners within the context of, and sustainability expectations resting on, MaaS are currently being redefined to fully capture the unprecedented level of modal and service variety that commonly comprise MaaS ecosystems. Emblematic of such efforts has been the MaaS-centric prototype journey planner developed by Georgakis et al. (2020) which features an 'environmental friendliness' calculator, based on simple linear model, capable of ranking (in ascending order) different modal combinations for specific trips on the basis of CO_2 emissions (modal combinations and routes with the highest emissions are ranked last). Even though the authors ascribed the following kilometric emission coefficients for each mode (Subway—40 g/km; train—60 g/km; Bus—50 g/km; Car—100 g/km), it has been suggested within the study that providing end-users with exact or accurate emission details does not generate any additional value. Conversely, (Yatskiv et al., 2023) have underscored the need for populating MaaS-centric journey planners with sustainability features as a means of gradually nudging users towards altering their behavior and perceptions when choosing between 'comfort' and 'sustainability' within the realm of personal mobility – such initiatives are, in their totality, bound to be crucial for the realization, and embedding, of policies pursuant to the realization of societal goals within Level 4 MaaS as reflected in the MaaS integration topology conceived by Sochor et al. (2018).

Moreover, the concept of developing what has been dubbed a 'sustainable Transport Planner' capable of evaluating multimodal routes, meeting traveler preferences, and befitting the environmental aspirations associated with MaaS was originally conveyed in Dinko et al. (2021) and builds on the broader theme of Personalized Travel Planning (PTP) as means of nudging people towards pro-environmental travel behavior (Ahmed et al., 2020). Overall, redefining and broadening the scope of journey planners has been posited to play a catalyzing role in stimulating a shift from the currently dominant car-ownership paradigm towards a MaaS-centric model centered on car-usership.

3.11.2 Frequency and Preference for Online Transactions

Another core antecedent that not only underpins the fundamental setup of this mobility scheme but also acts as a barometer for user uptake that has emerged from the literature is the capacity and means for passengers to be able to carry out online transactions, most commonly, while on the move. Considering this has already been meaningfully covered in the literature review section it is still worth briefly revisiting and reiterating some of the controversial exclusionary elements that are generated by this antecedent and are contrary to the predominantly persuasive rhetoric that has surrounded MaaS (Pangbourne et al., 2020). Although by no means localized to MaaS and is rather endemic across the broader urban transit domain, positioning online payments as a prerequisite for accessing MaaS services raises the question of how subgroups such as the unbanked, underbanked, and those classified within the ultra-low-income bracket will be able to cope? This same antecedent, or prerequisite, is also just as equally pertinent to the preceding MaaS antecedent – smartphone ownership.

Alluding to the preceding question, the highly informative work produced by Owusu-Agyemang et al. (2023) illuminates on the role of banking status on travel outcomes. Therein, the authors have not only articulated on the limitations faced by the aforementioned subgroups as a direct consequence of their banking status but have also framed such an effect as part of a broader shift that is exacerbating the already dire situation of, the previously discussed, captive 'transit-dependent' riders.

When contrasted with survey input, the scope of the problem might be viewed as moot or inconsequential given the lack of respondents that would qualify as unbanked or underbanked – although such an omission might be argued to reflect the lack of representativeness of the selected

sample which can equally be addressed by the counterargument that the population sample targeted for this study are individuals engaged, or have engaged, in the practice of commuting which significantly diminishes the odds for identifying unbanked, or even underbanked, respondents. In response to the question "how often do you use your smartphone for online payments?", 35.4% of respondents claim to always rely on smartphones for carrying out transactions and 46.1% often relying on smartphones, as shown in Figure 12. The remainder of the figure, when viewed in light of figure that shows the stated frequency of use for different payment options, demonstrates the continuing prevalence of cash payments. Still, the utility of BenefitPay (linked to individuals' debit and/or credit card accounts) and, to a lesser extent, reliance on standard credit card payments, as shown in figure, illustrate – albeit indirectly – the predominance of respondents with access to mainstream banking services (Owusu-Agyemang et al., 2023) or those that can be qualified as full-banked (Golub et al., 2019) and, hence, the means to obtain the debit and/or credit cards that are needed for conducting online smartphone transactions.

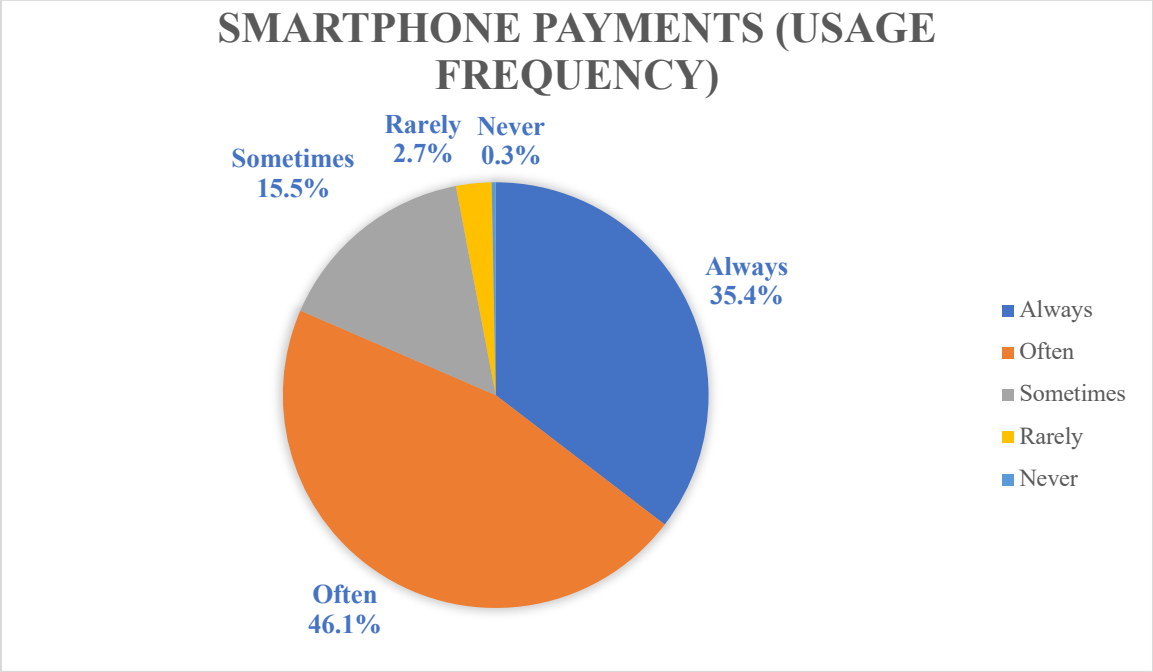


Figure 12. Percentage of respondents that use smartphone for online transactions

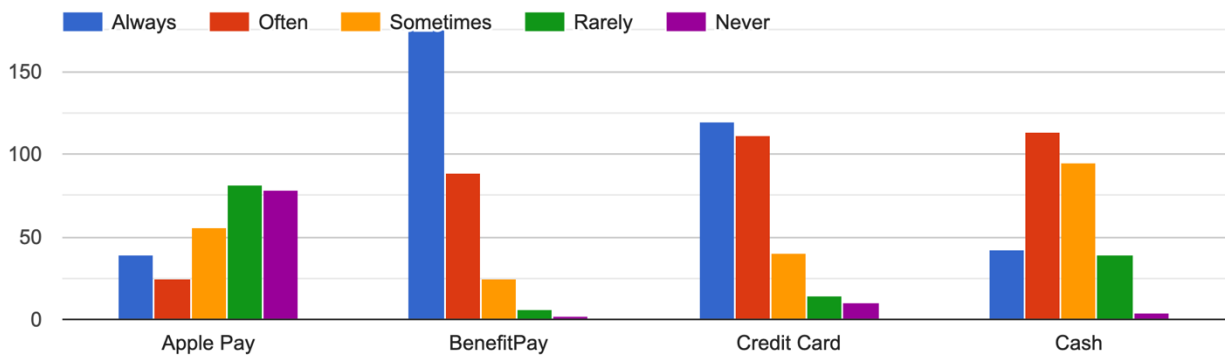


Figure 13. Payment method preference of respondents

Conclusively, the purported environmental benefits that have been ascribed to emergent smart mobility systems such as MaaS will continue to be viewed as tenuous so long as certain population subgroups are faced with, in this case, financial accessibility hurdles and the consequent risk of being marginalized and disenfranchised from using such systems (Golub et al., 2019).

Interestingly as well, the parallel roll-out of smart mobility systems and down-scaling of conventional government-supported transport systems (along with, where applicable, indigenized transport modes) poses a very real threat in potentially widening inequality, exacerbating entrenched systemic risks (Brown, 2022), and ultimately leading towards the reproduction of the earlier-discussed issue of transport poverty (Groth, 2019). In that sense, such mobility systems might simply act as conduits through which preexisting issues are perpetuated and counterproductive when viewed through the lens of SDG number 10 “reduce inequalities within and across countries”.

3.11.3 Multimodal Behavior and Perceptions

Arguably, one of the main indicators that offers a litmus test for gauging modal inertia is Multimodal mindset. Established as one of the key indictors for predicting uptake of MaaS by early adopters, Zijlstra et al. (2020) have theorized that having past experiences with alternative forms of transportation (other than private car use) increases the propensity, proclivity, and ease with which passengers consider adopting such modes as part of their ideal configuration of a MaaS bundle.

Such increased predisposition towards adopting alternative modes might, in part, also be explained through the premise of 'affective forecasting' (Eastwick et al., 2008) where individuals with previous positive experiences with alternative modes are more easily swayed and enticed in transitioning away from the existing automobile regime. Yet, the inverse can also be assumed to be just as equally valid, considering individuals that associate negative connotations with alternative modes, possibly because of negative prior experiences, are expected to be much more challenging to nudge in a transition away from the existing automobile regime. Therefore, respondents in this study were presented with a number of questions to help offer insight into the extent of their multimodal mindset – or whether they can simply be classified as those with an uncompromising 'monomodal' mindset grounded in the unwavering use of the private automobile. Nevertheless, it is paramount to reinvoke the idea of multioptionality which, as conceptualized by Groth (2019) and already discussed in the literature review section, holds the availability of alternative reliable and accessible transportation modes as one of key enablers needed for carrying out an objective analysis of the level of multimodal thinking and mindset within a selected population.

In Bahrain, the limitation of public urban mobility options to just bus services offered by BPTC and – although this might be a bit more controversial option within the sustainable transport discourse but remains a commonality within MaaS pilots and theorizations – taxi services provides the rationale and core basis behind the incorporation of mobility questions on respondents' experiences while travelling abroad. Again, the benefits of incorporating such questions are two-fold, one, they partly counteract the limitations associated with the adoption of purely SP questions by introducing questions that respondents answer based on actual experience (barring risks such as memory bias or fraudulent responses that might derail such benefits) and, two, it allows the study to solicit inputs that meet the tenets of multioptionality. Additionally, the geographical re-contextualization of the study towards questions relating to foreign countries also offers a glimpse into a common observation that has emerged in the urban mobility scholarship during, and immediately after, the onset of the COVID pandemic. Specifically, the destabilizing effects that have been inadvertently triggered by the sudden roll-out of social distancing, commuting, and other containment-measures towards the preeminence of the existing transportation paradigm (which, understandably, differs on a country-by-country basis) has led authors such as Schmidt et al. (2021) to view such rare events as windows of opportunity for passengers to reconsider deeply

ingrained and habitualized practices. Following the same line of reasoning, it has been suggested, in studies such as Holmes et al. (2019), that passengers might find it challenging to transpose their mobility habits and behavior when travelling to foreign countries often out of altruism, moral obligation, and the desire of not wanting to be seen as diverging from the behavior adopted by the locals. Irrespective of the extent of the challenge, a counterpoint can be gleaned from the extant literature on divergent spatial mobility styles where discord and lack of aspatiality between peoples' daily travel habits and holiday travel habits are very prominent and have presented researchers who seek to use segmentation as the basis for understanding and promoting behavioral change with immense challenges (Barr & Prillwitz, 2012).

Yet, inter-spatial segmentation might be inevitable for those seeking to obtain a more granular understanding of how individuals travel behavior, and proclivity towards using more sustainable travel options, differ when set against different geographical contexts. This derives from one of the core tenets of the Theory of Interpersonal Behavior (TIB) which posits a person's social factor, which centers on what "most others do" and is considered appropriate, as an antecedent for displaying a certain kind of behavior (Kang et al., 2020). In other words, individuals, by virtue of their social surroundings, might be inclined to briefly alter their mobility choices and habits out of a need to viewed as conforming with what is socially deemed to be appropriate behavior and it is such variability that has often been recognized as one of the reasons why past interventions used to incentivize drivers to switch towards PT systems have succeeded in altering drivers' intentions temporarily without any real action (Nordfjærn & Rundmo, 2019).

Furthermore, the increased likelihood of passengers adopting alternative public transport modes while on holiday abroad might not necessarily be limited to just the availability of reliable and comprehensive PT/alternative modal networks, the core tenet underscoring the concept of multioptionality, or pure altruism but might also be driven by what is referred to in behavioral economics as moral licensing beliefs (Xu et al., 2020) where, in order to compensate for previous bad/unsustainable behavior at home, passengers might be more pro-environmental in their modal choices when travelling abroad.

Likewise, (Gatersleben et al., 2014) have elucidated on this notion of quasi-'peer pressure' by invoking one of the core tenets underlying the Theory of Planned Behavior (TPB) which posits that people are more likely to demonstrate Pro-Environmental Behavior (PEB) when agglomerated

with other people that are believed to have positive attitudes towards such behavior (perceived descriptive social norm). By extension, moral licensing beliefs bring to focus the wider discourse and scholarship on 'negative footprint illusion' that might debunk any meaningful linear correlation between temporary sustainable practices (i.e., modal choice when abroad or recycling) and PEB. A simplistic example of 'negative footprint illusion' is when people who recycle, as an example, use that type of sustainable practice as a justification for adopting other less or unsustainable practices, such as driving to work in one's personal car (Holmgren et al., 2019).

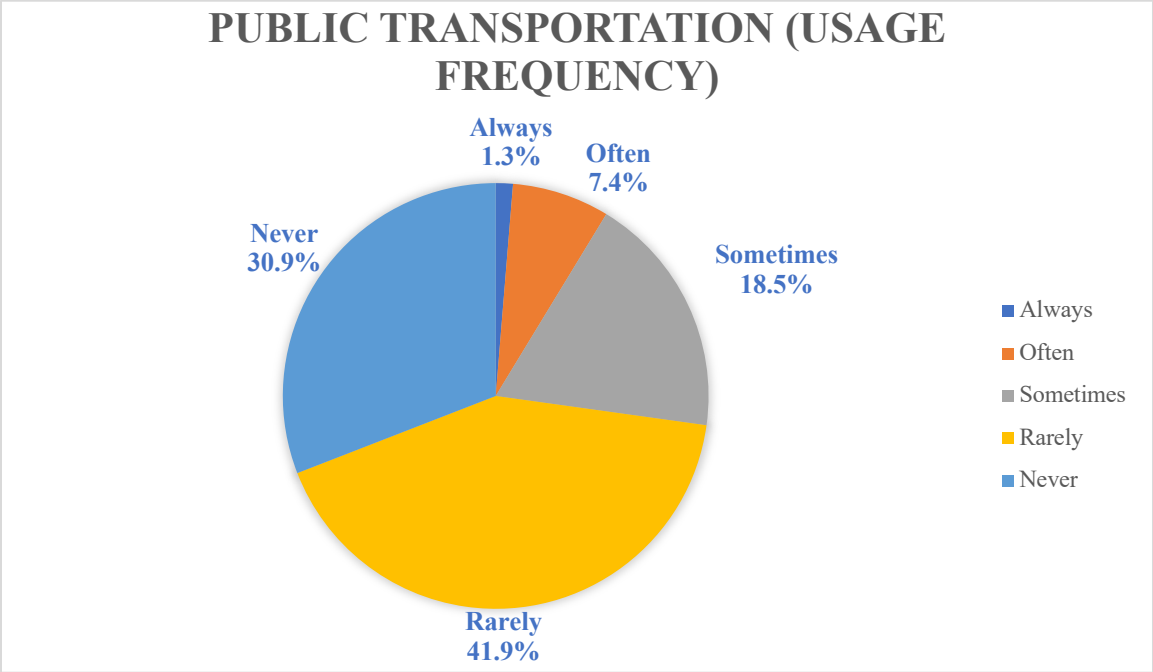


Figure 14. Percentage of respondents that use public transport

In reference to current adoption of public transport in Bahrain, Figure 14 illustrates the severity of car-dominance – especially as reflected by the 'never' (41.9%) and 'rarely' (30.9%) response categories – within the country and also some of the descriptive input obtained from respondents on what they consider to be drawbacks of public transport, pending a more in-depth thematic analysis in subsequent sections, corroborates some of the findings that have emerged in the literature on perceptions of public transport in general within the GCC. Therein, respondents have premised their reported perceived drawbacks of public transport on ethnoreligious (i.e., considering it unbefitting for locals and women) and socioeconomic grounds.

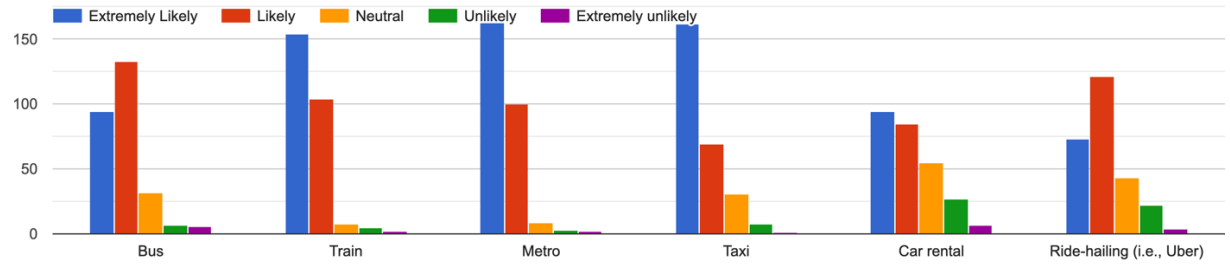


Figure 15. Modal preference of respondents when abroad

Yet, a number of responses have seemed to emphasize factors such as 'lack of security' which, again when viewed through the lens of 'affirmative forecasting', seem to be derived from a more generic perception of public transportation – or potentially stemming from a negative experience respondents' might have faced while using a PT system abroad – which is then unobjectively extrapolated towards PT systems in Bahrain where, as an example, security incidents are extremely rare.

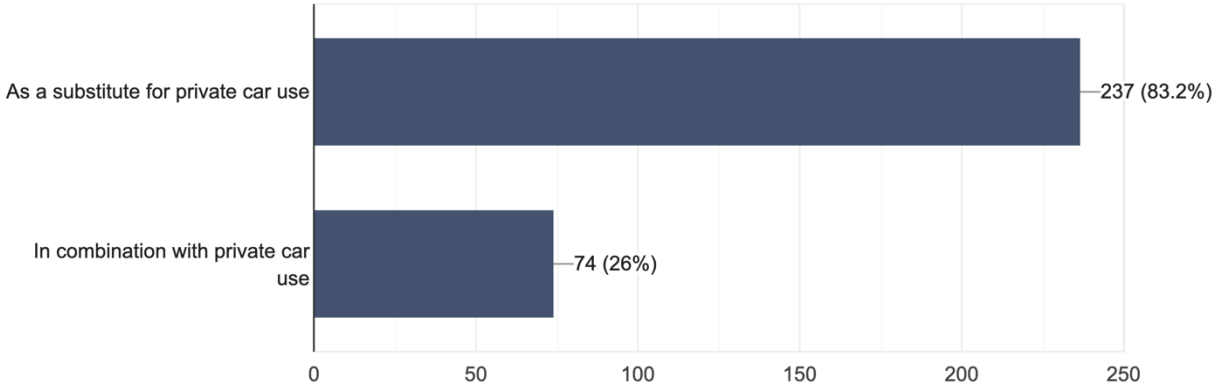


Figure 16. Percentage of respondents adopting additional transport modes in conjunction with, or in place of, private cars

Table 12. Percentage of respondents in considering alternative transport options before using private cars

Respondents considering alternative transport options before using private cars	**Percentage**
Yes	63.8%
No	36.2%

3.12 Primers and Indicators of Environmental Consciousness and Pro-Environmental Behavior (PEB)

To further augment the survey questions that aimed to explore the level of multimodal mindset within the surveyed sample, and correlations with PEB, additional questions derived from other domains relating to sustainable behavior have been incorporated into the survey. Specifically, a question asking respondents to ascribe a level of importance to fuel economy, when in a hypothetical scenario of purchasing a car, was embedded (to further aid the respondents in understanding the question, a cutout image of car energy efficiency label, that has been developed by the Gulf Standardization Organization (GSO) and enforced across many GCC countries, has also been included). Next, respondents were presented with a question on how frequently they recycle that was also accompanied by an image of one of the most common collection (recycling) bins available across Bahrain. Lastly, a third question was presented to respondents asking them, similar to the first question, to ascribe importance towards CO_2 Emission details that accompany different airline trips with a cutout image from Google Flights included.

Yet, it is important to also factor in the reliability of incorporating such questions and using them as markers for the presence of a sustainable multimodal mindset and, by extension, overall PEB. As thoroughly considered in the work of Gatersleben et al. (2014), the adoption of PEB in one domain (say recycling) does not necessarily translate to the same people having positive attitudes towards sustainable practices in other domains – which the authors, in this case, referred to using the 'cycling to work' example. Also, the authors observed a higher probability in spillover effects in PEB when less dissimilarity exists between two domains (i.e., going from recycling plastic to paper). In light of this, the three aforementioned survey questions present varying degrees of dissimilarity in their relevance to the topic at hand, adoption of sustainable commuting/mobility practices under MaaS, with the question on the importance of car energy efficiency being the least dissimilar. In regards to the chosen domains, the adopted questions on air travel and fuel efficiency have also been used in other studies, such as Isetti et al. (2020), to measure current mobility behaviors and revealed behavior towards sustainability by respondents (same research mechanism has also been incorporated; administered survey albeit, in the aforementioned study, incorporating a 7-point instead of a 5-point Likert scale).

Conversely, it is important to also shed light on parts of the literature that counter any presupposed correlation between people's familiarity with fuel standards and the often touted expectation of emission reductions – with the work of Hasan et al. (2020) being a point in case. Still, this matter goes into the heart of the utilitarian and economic foundations on which people base their relationship with fuel and, in turn, private car use: the cost of fuel and the concomitant impact on modal choice which have been found to be positively correlated (Walnum et al., 2014). Although the authors have cautioned that such a relationship might be more ambiguous in some countries compared to others by virtue of market distortions engendered by country-specific governmental policies with the widespread provision of government-sponsored fuel subsidies in Bahrain and other GCC countries, even with the recent adoption of WTO recommended policies on Energy Pricing Reforms, being a prime example of policies with a highly distortive effect. Similarly, in examining the relationship of passengers with public transport systems, the inclusion of even more extensive governmental subsidies for public transit networks should also be acknowledged and matched up against the previously discussed issue of fuel subsidies for private car usage since, similar to the latter, the former just as equally includes an element of market distortion that blurs the utilitarian and economic relationship between passengers and PT networks. But, governments, if ever caught up in this debate, are much more likely to defend such subsidies as being paramount for the pursuance of economic, environmental, and equity objectives (Henseler & Maisonnave, 2018).

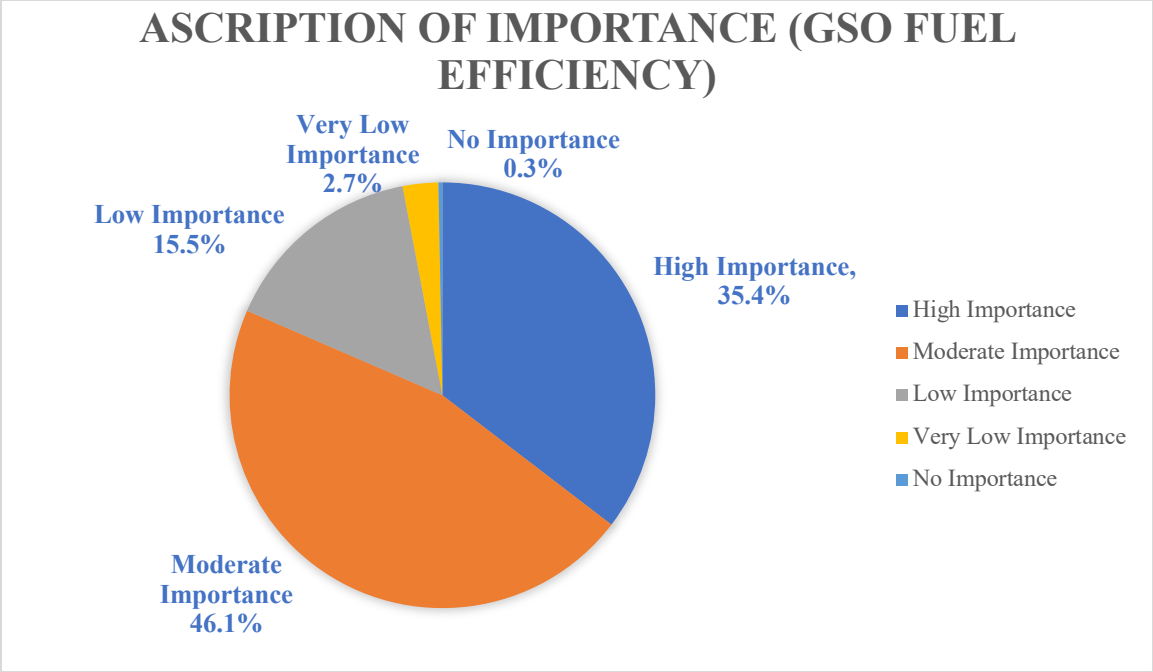


Figure 17. Importance ascribed by respondents towards 'fuel economy' performance

Transitioning towards the third question on the importance of CO_2 emissions (as estimated and populated on the Google Flights platform) that was presented to respondents, a similar caveat by Kroesen (2013) has also been raised in that the relationship between air travel behavior and general environmental awareness remains a rather tenuous and debatable one. In addition to making cross-contextual (i.e., between urban and air travel) inferences challenging and fraught, perceptions towards the acknowledgement of risks externalizing from the aviation section have also been found to be inconsistent across heterogeneous geographies with the work of Brouwer et al. (2008), and lack of awareness being considered the main attribute, demonstrating how European nationals are more cognizant of aviation-related environmental risks compared to their Asian and American counterparts. Nevertheless, a number of transatlantic studies conducted on the impact of point-of-sale eco-labelling information adopted in the aviation sector towards flight choices have concluded with marked shifts in consumer preferences, and willingness to pay (often upwards of €77 more for every tonne of CO_2 reduced), towards less polluting flights (Carroll et al., 2022). Additionally, the study also incorporated additional labelling examples (such as those for appliances, properties, and cars) broadly used for establishing correlations with environmental

concern and PEB that have not been adopted (except for cars) in this study. In slight deviation from the aforementioned claim put forward by Brouwer et al. (2008) the authors also in their findings underscored the need for long-term claim education policy, within both the European and American contexts, as a means to counteract the issue imperfect information that seems to be gripping the aviation industry when it comes to the dissemination of eco-labelling information between different airlines across the globe.

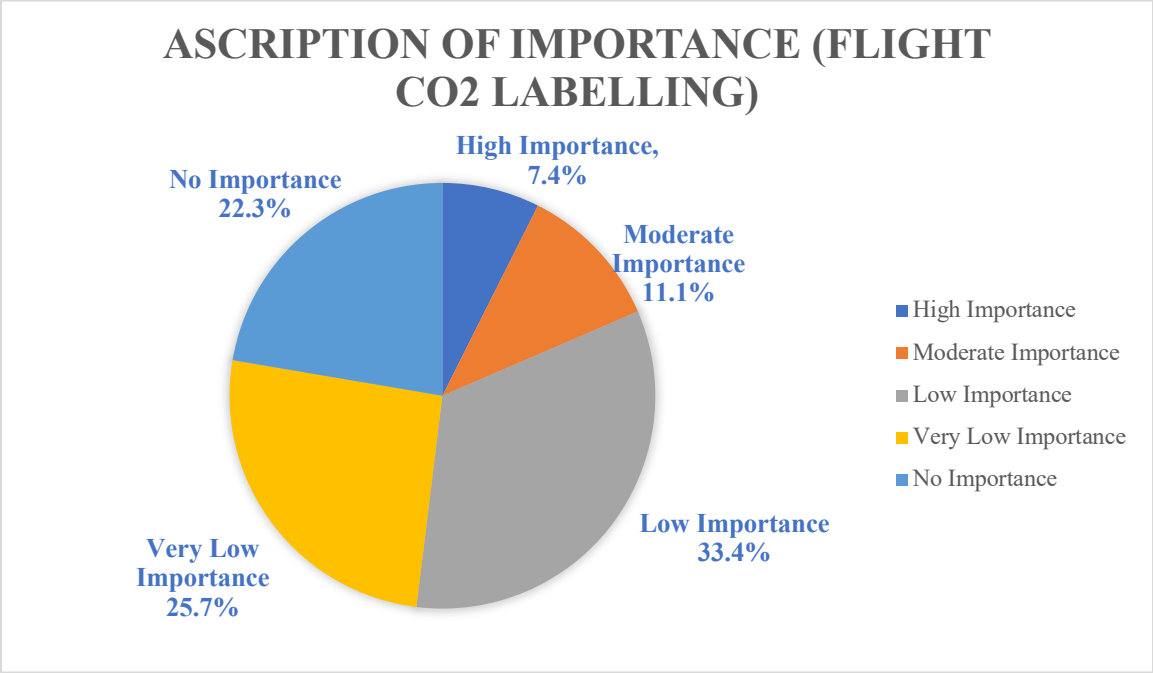


Figure 18. Importance ascribed by respondents towards Airfare CO_2 emission labels

Just to offer brief commentary on the preliminary findings from the PEB proxy questions, for now focusing on just contrasting between Figures 17 and 18, it is clear that a number of respondents ascribe more importance towards vehicle fuel efficiency in contrast to less polluting flights. With vehicle fuel efficiency being categorized as highly important by 26.1% of respondents and as moderately important by 34.4% of respondents, whereas only 7.4% of respondents categorized flight CO_2 emissions as highly important and 11.1% as moderately important.

Now, a multitude of factors might be attributable for such a gap in perceptions. One core element would be an asymmetry between the questions presented to respondents in which the importance of vehicular fuel efficiency directly correlates to an object that the respondents own (or is owned by one of their first-degree family connections), maintain, and are directly

accountable and responsible for. Whereas, the latter question on the importance of eco-labelling for flights relates to a service in which respondents are only, temporarily, granted access to and in which a lump-sum (fare price) is paid covering a plethora of charges and taxes imposed by an airline (in which respondents rarely have full knowledge of). Nonetheless, hastily attributing respondents heightened concern towards vehicle fuel efficiency, in contrast to air travel emissions, to components such as proximity and ownership (since respondents are directly responsible for refueling their vehicles – unlike aircrafts – and, in doing so, bear direct exposure to fluctuations in energy/fuel markets) could prove to be an erroneous assumption as suggested by the work of Turrentine & Kurani (2007). The authors have cast light on the complexity, and multifaceted nature, of the relationship between consumer households and automotive fuel economy where they were able to pinpoint the lack of basic knowledge in rational economic decision-making as the underlying factor behind consumers' often symbolic understanding of, and relationship with, fuel economy. As such, preferences highlighted in the survey towards fuel efficiency should not automatically be construed as markers for PEB, a multifactorial construct in and of itself (Pellegrini & Tagliabue, 2024), that would translate towards the adoption of sustainable options – such as shared mobility, micro-mobility, active mobility, and public transportation – under MaaS.

Additionally, another mismatch might also exist between both questions in that vehicle fuel efficiency and flight eco-labelling fundamentally communicate two distinct messages; the former is centered on an economic-utilitarian foundation intended to persuade consumers to lean towards a more cost-saving option while the latter seeks to bolster environmental awareness and expose consumers to the environmental impact of a service they wish to access along with options on how such an impact can be minimized. In both cases, respondents' choices also inadvertently reflect the level of persuasiveness behind, that is also the cornerstone of, both fuel-efficiency and flight-emission labelling. In regards to carbon labels in general, the study by Gössling & Buckley (2016) highlights how incoherency (stemming from heterogeneous calculation and labelling/coloring standards) in the development of carbon labels – across different tourism-related sectors such as aviation, automotives, restaurants, hospitality, and more – has rendered most labels ineffective and as suffering from a lack of persuasive communication. Similarly, and with great implications towards distinguishing between both survey questions, the authors have also elaborated on the notion of effectiveness of knowledge where, in examples such as fuel-economy labels, consumers are more easily able to relate and understand the impact of savings (i.e., more fuel efficiency results

in ‘X amount’ specific monetary savings in return) unlike examples relating to simply displaying lower carbon emission footprint (not possible to accurately quantify extent of impact on climate change).

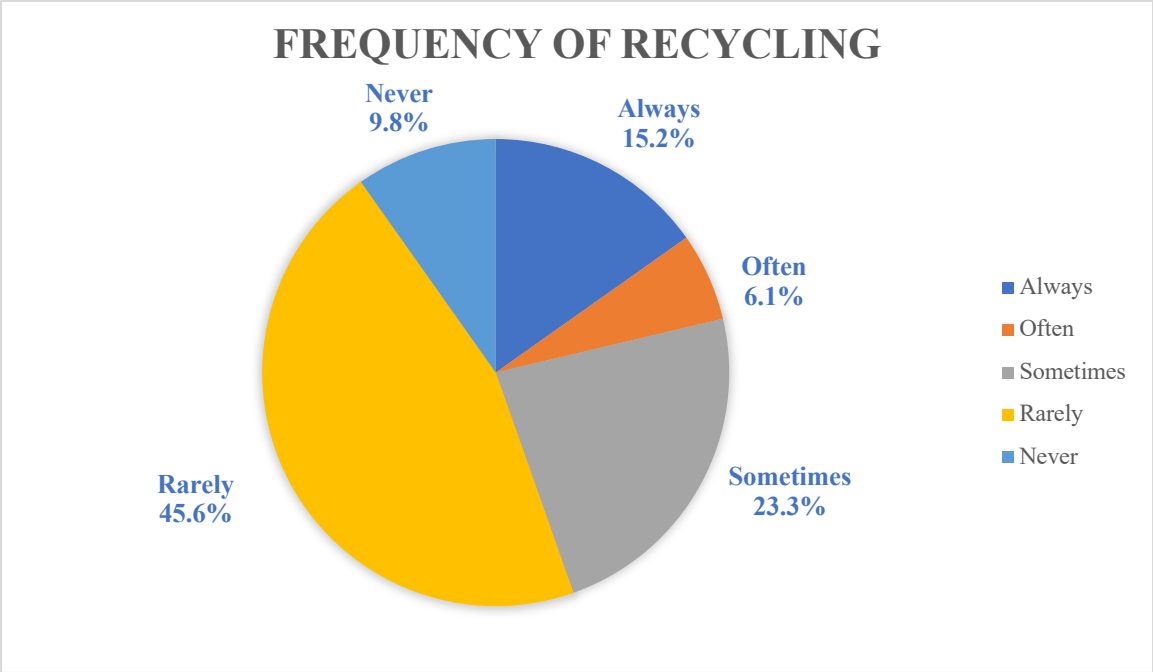


Figure 19. Frequency of Recycling

Lastly, the third PEB proxy question adopted in the survey focuses on the frequency of sorting and recycling to which an astounding 45.6%, almost half, of respondents have admitted to rarely considering – coupled with another 9.8% that claim to have never considered recycling. And with PEB acknowledged as a complex multifactorial construct (Pellegrini & Tagliabue, 2024), trying to definitively answer the question of why this is the case inevitably breaches beyond the scope of this research.

Yet, the situation in Bahrain can be viewed as symptomatic of the lack of attention (Alagha et al., 2022); rules, standards, processes, and regulations (Alghazo et al., 2019); and a rampant ‘throw-away’ culture (Alghazo et al., 2018) that are derailing countries across the GCC when it comes to recycling initiatives. All in all, the inclusion of a question on recycling frequency was predominantly aimed at corroborating findings from the extant literature, and confirming their generalizability towards the Bahraini context, suggesting a positive correlation between recycling,

and PEB in general along with the other two questions, and the adoption of a multimodal mindset which forms the lynchpin of sustainability claims propagated by MaaS advocates.

3.12.1 Questions on Hypothetical Policies Countering Automobility

It is unquestionable that the discontinuation of the current ICE-dominant automobility regime, along with the ensuant convergence towards alternative mobility regimes more in line with decarbonization objectives, will heavily rest on the ability, and willingness, of governments to revisit policy and infrastructure dimensions that have long been considered to play a catalytic role in perpetuating the privileged status and stability enjoyed by the automobile (Hoffmann et al., 2017) – such stability has been considered instrumental in quelling efforts to foster a societal renaissance towards better acceptance and uptake of alternative mobility options seeing as it solidifies the already-entrenched and habitualized behavior of unconscious driving which greatly nullifies deliberative processes aimed at instilling positive intentions towards change (Kang et al., 2020). Towards that end, two additional questions have been incorporated into the survey; one that centers on a slight curtailment of the unbridled usability of the automobile in Bahrain and a second that centers on the reallocation of national infrastructural resources towards, a centerpiece of the alternative mobility regime, public transportation. Namely, the former floated the idea of introducing restrictions on private Single Occupancy Vehicles (SOVs) in highly congested areas during peak hours and whether the respondents would agree with such an unprecedented national policy move. As for the latter, respondents were presented with another SP question in whether they will be more likely to use public transport in Bahrain following a hypothetical roll-out of bus prioritization policies (bus-only access areas, bus lanes, etc.) throughout the Kingdom.

Starting off with restrictions on SOV usage, a number of dis-incentivization techniques exist in the toolkit of policymakers and transport planners which range from options such as increasing the price of fuel (which has already taken place in Bahrain twice between 2016 and 2018 through partial roll-back of governmental subsidies that were part of the broader GCC Energy Reform plans), introduction/increase of road tolls, restriction of private car use within cities and city centers (incorporated into the survey but with a focus on the more generic term ‘heavy congestion areas’ instead of ‘cities’), curbing of road development and maintenance projects, introduction/increase of environmental taxation, and introduction/increase of parking fees (Kresnanto, 2024; Nordfjærn & Rundmo, 2019).

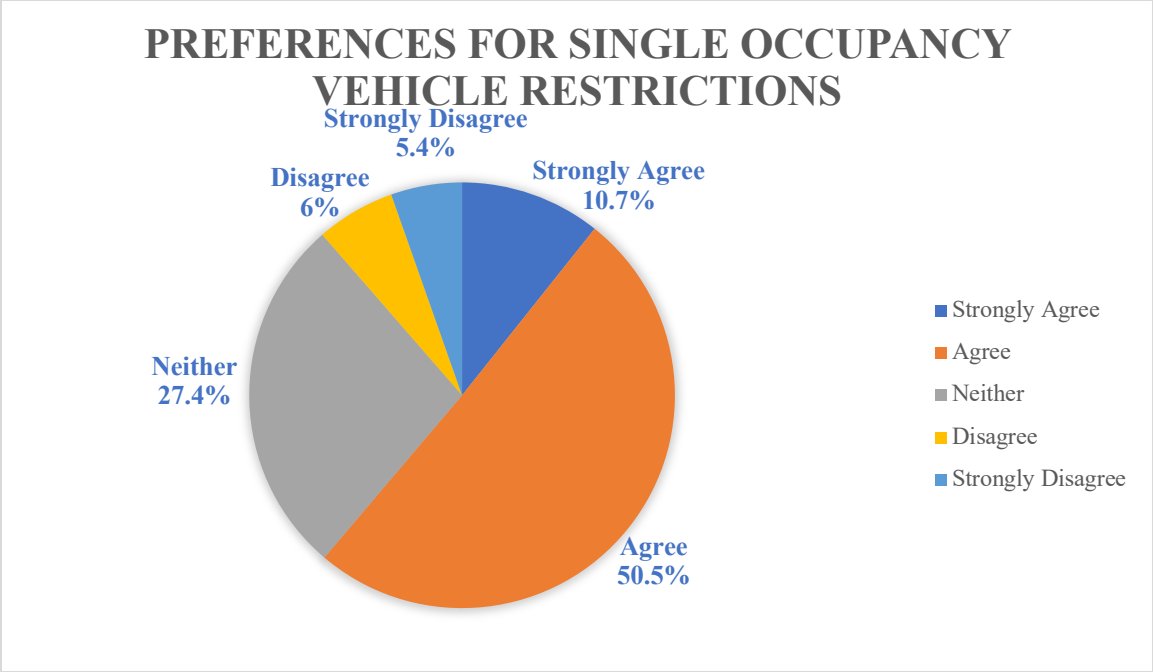


Figure 20. Acceptance of hypothetical SOV restrictions by respondents

As can be deduced from Figure 20, a clear majority of respondents demonstrate acceptability towards the introduction of targeted restrictions on SOVs with 50.5% agreeing and 10.7% strongly agreeing to curbing measures against SOVs in heavily congested areas and during peak hours. Important to note here is that even when dissecting the phraseology in which the question[10] has been presented to respondents and the evident lack of language that would potentially classify this as a leading question (intended to influence and elicit a specific biased response from respondents), the inclusion of such a question along with another question such as "How would you describe traffic conditions during your daily commute?" (which, again in accordance with the tenets of affective forecasting, invokes negative connotations, and one of the core externalities, of private SOV usage) might potentially skew respondents' towards choosing a firmer response than what they would be willing to accept in a real-life scenario.

[10] Are you in favor of restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hours?

Another important caveat to also discuss relates to the significant percentage of respondents (27.4%) that, so-called, remained on the fence and adopted a neutral stance in answering this question by choosing the 'neither agree or disagree' option. Now, for such people, the lack of knowledge and firsthand experience in using alternative options might explain the reason behind their undecidedness. Whereas, for the more apprehensive group of respondents that opted for the disagree (6%) and strongly disagree (5.4%) options, a lingering sense of anxiety might be underpinned by a perceived lack of modal choices and reliable substitutable options which might collectively form the basis for their ex-ante apprehension and renunciation of proposals for restrictions on the SOV usage. Fundamentally, this highlights some of perils of gauging policy acceptability through stated-preference methods, as they ultimately solicit input from respondents that is oftentimes grounded in a priori reasoning (based on a prospective judgment towards a measure or policy that will be introduced in the future which respondents have no experience of) (Andriolli & Silva, 2024).

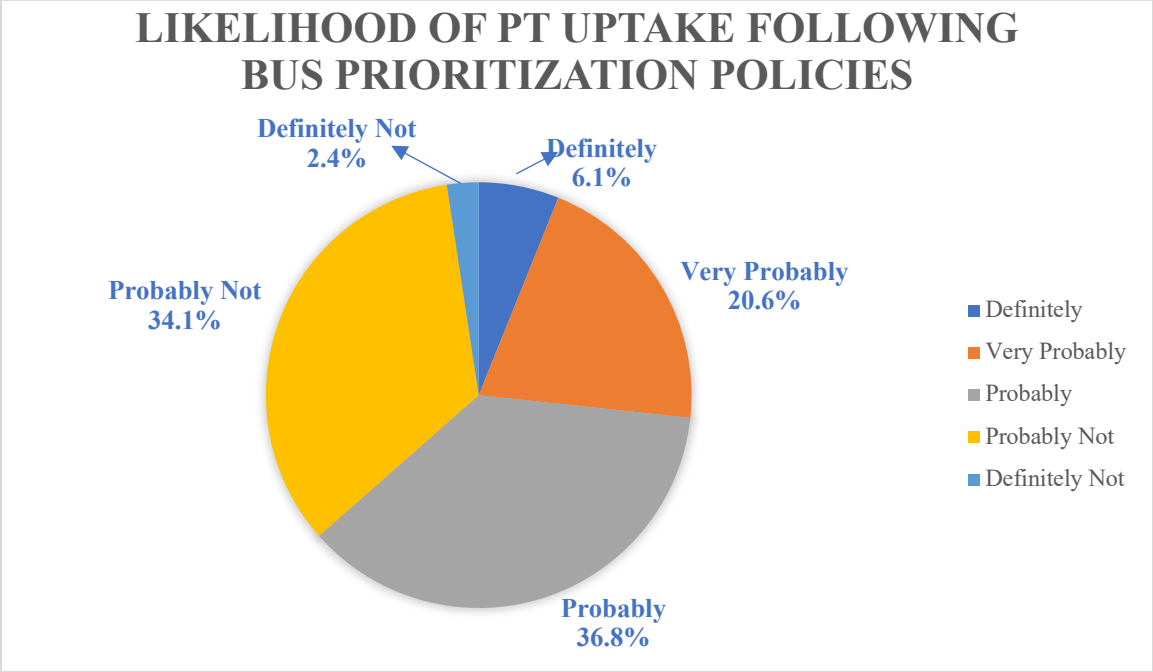


Figure 21. Likelihood of PT uptake in the event of bus-prioritization policies

As for the other Transport Demand Management (TDM)-based question on the adoption of public transportation prioritization policies in Bahrain, the results indicate a balanced response when contrasting the score percentages for the 'probably' (36.8%) and 'probably not' (34.1%)

options. Now, it has to be acknowledged that, unlike the preceding question, this question is twofold. One, it implicitly assesses the level of public acceptance for TDM policies and, two, it explicitly questions respondents on whether they are willing to increase their uptake of PT in Bahrain following a hypothetical roll-out of TDM policies such as bus-only access areas and dedicated bus lanes. Therefore, it is important to understand the potential risk of conflating between, and inaccurately extrapolating based on, both sides of this question, for example, some respondents might be in favor of pull (making PT more attractive to users) TDM policies but not necessarily sufficiently inclined to use public transportation following the introduction of such policies and under the absence of push strategies that make private car use less attractive. As such, this might be due to other qualms (such as privacy, security, and level of hygiene) prospective passengers might hold that are preventing them from opting for public transport. And, in many cases, such qualms might originate from secondhand information based on negatively-appraised experiences provided by referents (people within prospective passengers' social circles) (Kang et al., 2020). Regardless, the implementation of TDM policies often elicits skepticism amongst the populace and will, for the most part, boil down to the level of pro-environmental attitudes ingrained in each individual (Kresnanto, 2024).

3.13 Theoretical Frameworks

3.13.1 Multilevel Perspective Theory

Transportation studies, not least of which emerging substrands such as *Mobility-as-a-Service*, have often been viewed and scrutinized through interdisciplinary approaches, such as *Complex Network Theory*, owing to their inherent level of complexity (Lin & Ban, 2013).

This has been necessitated by the level heterogeneity involved in user (passengers) socio-economic and socio-cultural characteristics which, as an example, has formed the basis for the deployment of the 'Social Milieus' theory by authors such as Groth et al. (2021) in determining how various millennial subgroups (Cosmopolitans, Middle-Class, Precariat) are driven towards hegemonic automobility and alternative, more sustainable forms of, multimodality.

Likewise, 'Critical Perspectives' have been adopted in analyzing transportation issues considering the field has come to be viewed by authors such as (Kębłowski et al., 2022) as 'a playground of political and economic interests' borne out by divergent agendas. Furthermore, the

"*multi-actor, multi-disciplinary, and co-evolutionary nature of transportation sector*", as described in Sharmeen & Meurs (2019), further necessitates the deployment of additional tools to clearly delineate existing interdependencies, self-reinforcing relationships, lock-in effects, and the interplay between key actors within the regime level. In doing so, some of the key 'drivers' and 'inhibitors' influencing a potential transition away from the current transportation paradigm (symbolized by the dominant role of the personal ICEV) and towards an alternative, what is hoped to be, more multimodal transportation model become visible.

Chapter 4. Findings and Results

4.1 Thematic Analysis

As already discussed under section 3 (methodology section) NVivo 14 has been adopted for open-ended questions embedded in the MaaS survey. Namely, the following questions were analyzed for emerging themes and codes.

1. What do you consider beneficial about travelling by public transport when making your travel decisions?
2. Are there any public transport drawbacks you consider when making your travel decisions?
3. What are the benefits and drawbacks of ride-hailing services (i.e., taxi/Uber), in your opinion?
4. Do you feel responsible for the above [Car-related externalities]? If so, what actions are you taking to change that?

Before discussing the key thematic findings stemming from the four questions presented above, it is worth acknowledging a core assumption that might have been unwittingly engendered by the very nature of the survey (and the portfolio of questions embedded therein) and how it was designed. Namely, respondents might have offered responses to the above questions on the basis of experiences they might have had in, or have heard of from, other contexts (i.e., when travelling abroad). Some were even explicit in offering this as the rationale on which they based the response they have provided within an indicative example being the three references that have been made to the United Kingdom for both questions one and two above.

4.1.1 Public Transportation Benefits

Focusing on the benefits respondents are expected to realize from the use of public transportation, the majority of respondents have alluded to the financial incentives represented by the often low-cost (which received 76 references) nature of PT as the most beneficial feature. Given the increased frequency of the ‘cost’ and ‘cheaper’ terms (both incorporated under the ‘Low Cost’ code) in the word cloud illustration shown below, which has been generated by NVivo to demonstrate frequently used and occurring terms, further reinforces the need for adopting tailored and multipart

pricing schemes, systems, and structures (Caiati et al., 2020) to not only fulfil one of MaaS' most prominently purported environmental claims, helping passengers move away entirely from private car ownership, but also in nudging passengers towards the use of PT services in this case and potentially other forms of environmentally sound mobility alternatives. Additionally, some cost saving opportunities have been cited in some of the references, such as, the elimination of the need for making refueling and parking payments (reference 63 and reference 75, respectively, as shown in Appendix A).

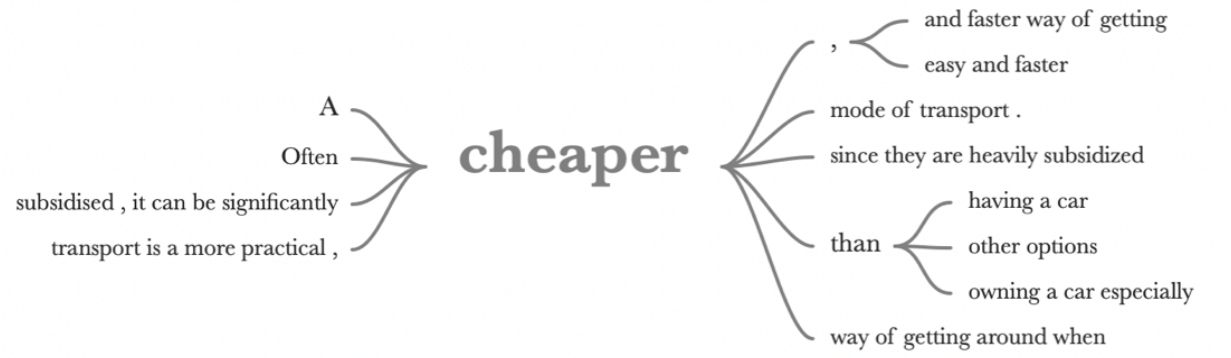


Figure 22. NVivo Word coding for PT benefits (Cheaper)

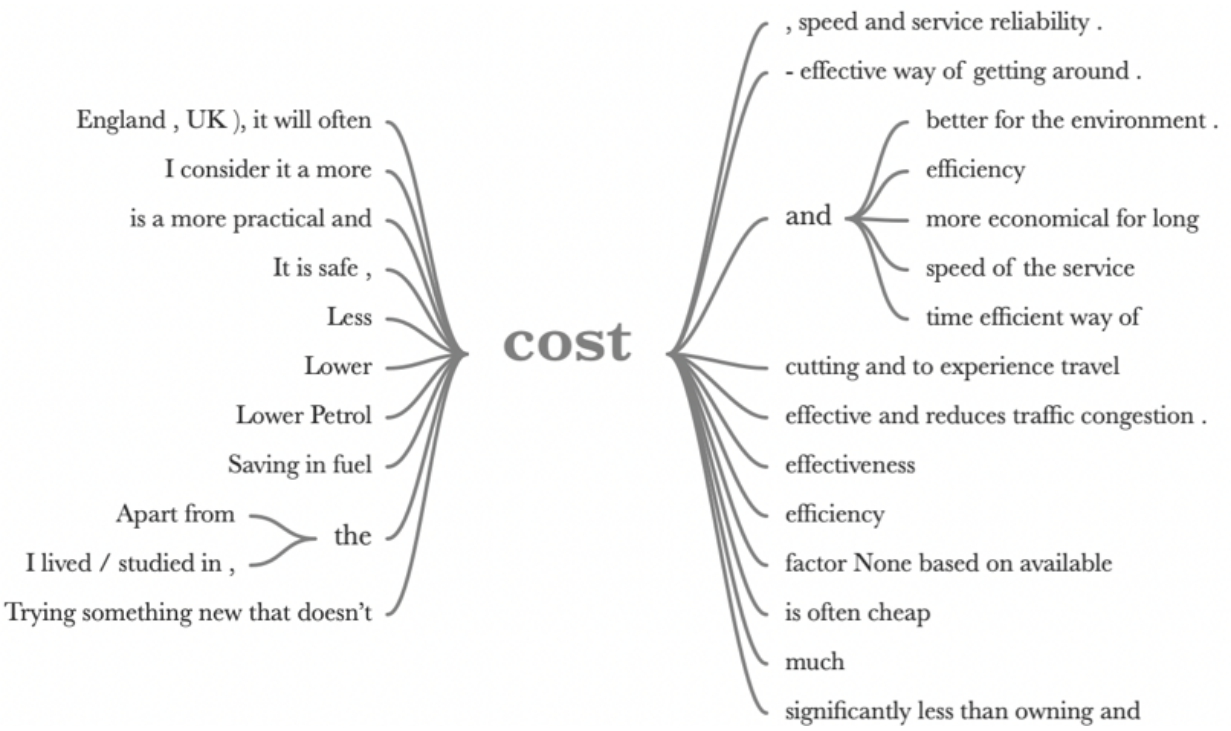


Figure 23. NVivo word coding for PT benefits (Cost)

Also, the ‘convenience’ code has received the second highest number of references (55) demonstrating its resonance amongst the surveyed respondents – although this code was created to capture responses that contained the word ‘convenience’ or ‘convenient’ in verbatim but could also be argued to include other prevalent codes as subthemes such as ‘no need for parking’ (which received 24 references) which has also been commonly cited as a benefit of using PT. Similarly, references to the negation of driving, insuring, refueling, repairing, and maintaining a private car have also been one of the emergent themes classified under the ‘convenience’ code – as shown under Appendix A. Although a less prominent code, that would correlate with convenience, a few respondents cited the ability to focus on other tasks (coded as “Allows for Other Tasks” with three references) and opportunities for socialization (coded as “Socializing” with two references) – as a result of the time that is freed up from not having to drive – as an additional benefit of using PT. Collectively, the established codes discussed thus far suggest, especially the cost-related codes, are firm focus of respondents on convenience, opportunity costs, and trade-offs in considering to transition towards the use PT.

On a cognitive level, a number of respondents (i.e., references 3, 5, 15, 22, 44, 55 etc. as Appendix A) have alluded to the reduction of mental issues relating to stress, worry, and burden as one of the prime benefits, under the ‘Convenience’ code, for using PT. However, the responses also, as mentioned earlier, incorporate an element of skewness since some have based convenience on the need of covering long distances and travelling abroad (where unfamiliarity becomes an issue when considering driving); features that are less pertinent to the Bahraini context. Likewise, references made to the use of PT in other geographical contexts has also necessitated the creation of another of code labelled “Exploration” (which contains 10 references) in which respondents touched on opportunities for sightseeing and other recreational gains as some of the benefits of using PT when navigating through a foreign country.

Moving on to environmental perceptions and Pro-Environmental Behavior (PEB), two dedicated codes were established to capture responses that cited lower emissions, pollution, and environmental impact (code labelled ‘More Sustainable’ with 16 references) and reduction of congestion, travel time, and motorization rates (code labelled ‘Traffic Reduction’ with 15 references) as benefits stemming from the use of PT. Focusing on the former, a majority of respondents referenced under this code demonstrate, at least implicit and superficial, knowledge

on the ecological externalities that are engendered through the overuse, and predominance, of private vehicles evidenced by the more explicit acknowledgement that increase uptake and usage of PT would lead to the benefits identified in the preceding section related and, inversely, the curbing of externalities associated with the overdependence on privately-owned ICEVs. However, another emergent theme has been captured in the code labelled "Provides Back-up" (with 7 references) might slightly counteract some of the aforementioned responses that are indicative of PEB since respondents viewed the availability of PT as a reassurance in the event of emergencies or when a private car is temporarily not available (i.e., due to service maintenance etc.). Such responses that ascribe and connote a secondary, "back-up", role to PT services remain emblematic of how deeply rooted private cars are within the currently existing mobility landscape in Bahrain.

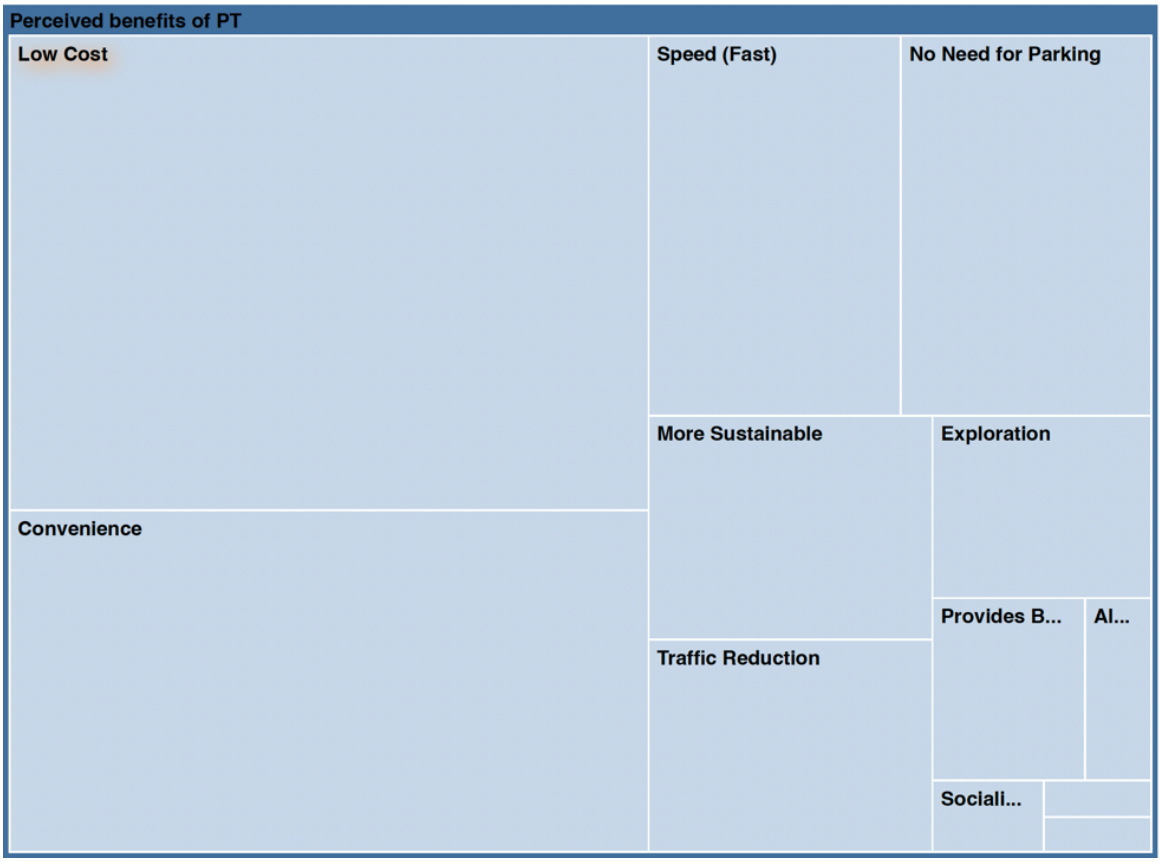


Figure 24. NVivo Word Matrix (PT Benefits)



Figure 25. NVivo Word Cloud (PT Benefits)

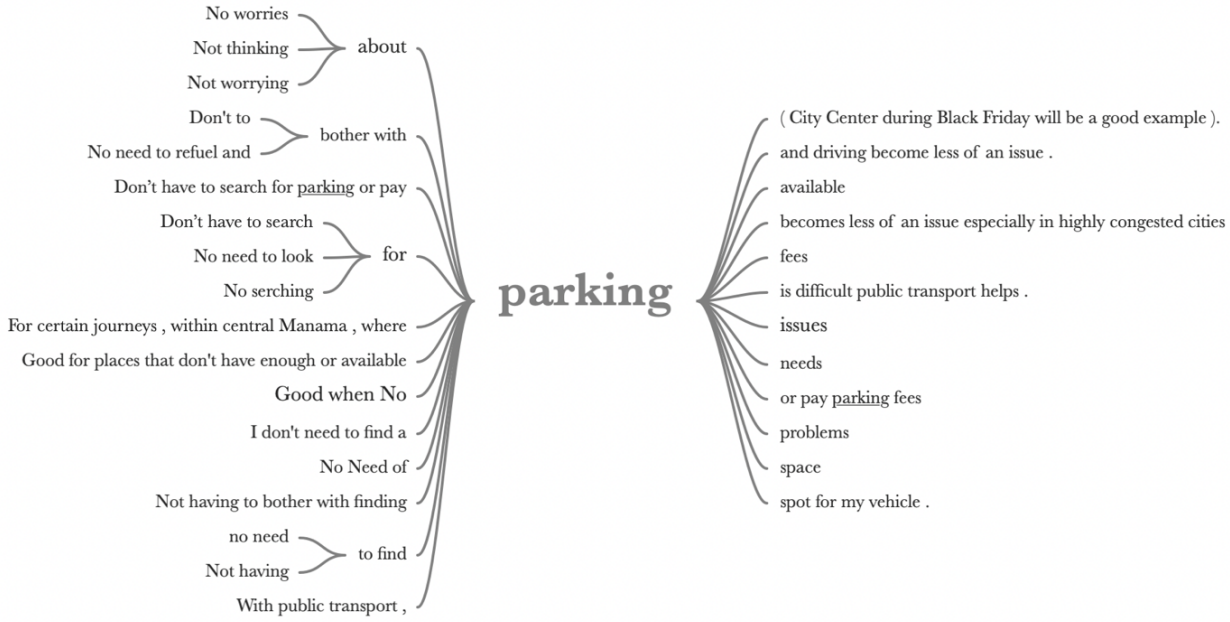


Figure 26. NVivo Word coding for PT benefits (Parking)

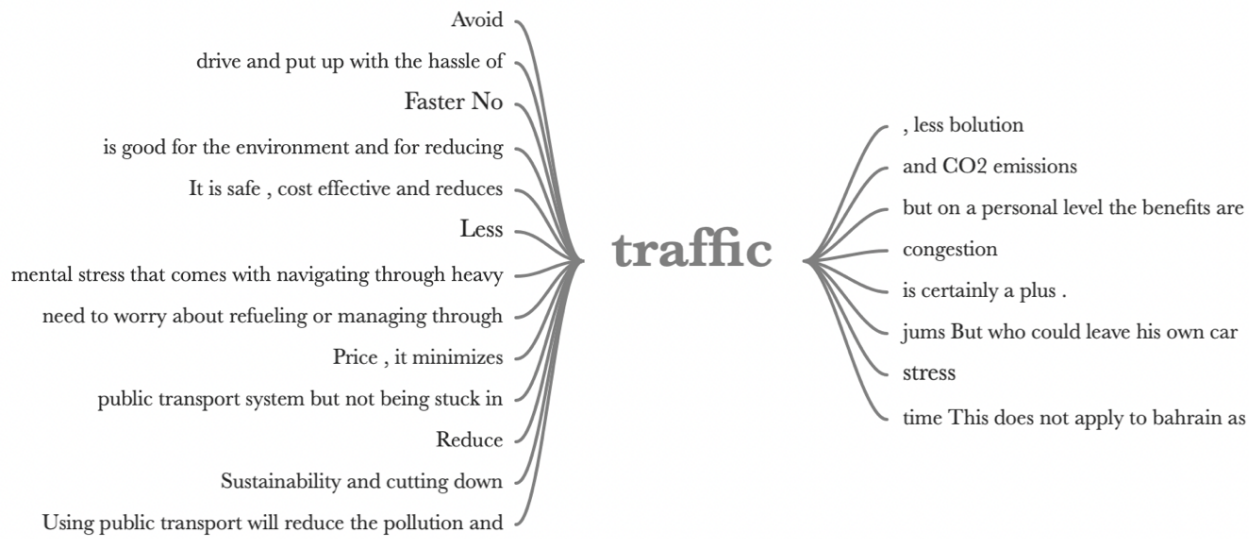


Figure 27. NVivo Word coding for PT benefits (traffic)



Figure 28. NVivo word coding for PT benefits (environment)

4.1.2 Public Transport Drawbacks

Starting off with the most prominent code relating to respondents' perceptions of the core drawbacks and deterrents of PT, the speed element of transportation (coded as 'Speed (Slow)' with 54 references), or rather the lack thereof, has emerged as one of the main areas of concern among respondents. The scope of the code was expanded to include operational elements and risks relating to the following:

- Delays due to maintenance work and/or strikes
- Long headway (waiting time at stations between different arriving buses)
- Excessive stops

- Time needed to walk/cover FMLM distances between O/D points

The second, more dominant, code has been the issue of safety (coded as 'Unsafe' with 60 references) within PT networks where an emergent subtheme is strongly suggestive of heightened disproportionate risk and concern towards female passengers some of which might have been conflated with, and/or exacerbated by, privacy concerns and issues of over-crowdedness (covered in more detail below). To a lesser extent, references have been made to time-based scenarios in which PT networks might be perceived more of risk – i.e., during late hours of the day or at night. Nevertheless, the low-uptake of PT – as shown in Figure 14 – along with some of the references that have been made to the use of PT systems abroad (i.e., Reference 21 under the 'Unsafe' code for PT networks) would, again, reflect the extent to which respondents are basing their answers on experience from being abroad. Concerns of pickpocketing, raised by (Reference 57) would also indicate practices that are incongruent and extremely rare within the Bahraini context but also happen to be issues, potentially reinvigorated in the post-pandemic setting, plaguing public areas in Western countries. Similarly, another code which has received a relatively high number of references (labelled 'Overcrowded') might as well have incorporated responses that implicitly reflect respondents' perceptions and/or experiences from countries where reliance on PT is much more pronounced and, thus, spikes in ridership number during peak, or rush hour, periods are consequently more visible.

Conversely, another prominent code that has received around 40 references relates to the issue of hygiene (coded as 'unclean') and level of cleanliness, or at least perceptions thereof, where terms such as "smelly", "unhygienic", are "unclean" were commonly invoked to describe PT. This in turn would highlight a significant concern relating to one of the core elements used to define successful urban mobility systems: cleanliness (Susilo & Cats, 2014). Furthermore, the responses also point towards concern regarding the cleanliness of the broader PT network (including facilities) and not only on-board transportation vehicles (buses, metro/train car etc.) thus, from a MaaS ecosystem perspective, the inclusion of clean stations, stops, interchange points, and auxiliary facilities with core amenities present a viable pull strategy in luring passengers towards shared mobility options where emissions per passenger are potentially lower or, at a minimum, present areas where more focus should be dedicated. Altogether, this has been starkly captured in references matched under the 'Lack of Support' code which clearly impart the perception

respondents have of national authorities – whom, as most references would suggest, seem to be underperforming – in supporting PT networks to ensure infrastructural and sanitary issues to arise and cripple the service.

Moreover, the limited accessibility, convenience, and user-friendliness offered PT networks have also been matched with dedicated codes (albeit with less references compared to the aforementioned issues) – the 'Inaccessible' code received 26 references, 'Inconvenient' code with 40 references, and 'Not user-friendly' code with 23 references. Under the 'Inaccessible' code, the majority of referenced responses center on issues stemming from extensive FMLM discontinuities; where in simpler terms, respondents articulated the difficulties inherent in covering the distance between the nearest stop/station and their point of origin and, vice versa, from the nearest stop/station to their destination. Less substantively, fewer references have also pointed towards the lack of network scope where few stops/stations, which some respondents have alluded to as being disproportionately distributed, render the PT service impractical and from being a coveted door-to-door offering which many references seem to have alluded to in rationalizing their response. In similar fashion, the 'Not user-friendly' code contains references that further expound on this issue.

Namely, the lack of clarity – and, in some cases, total absence – of PT information might to a certain extent explains the difficulties passenger face in locating the optimal (nearest) stop/station, and by extension FMLM means, based on their O-D points. Under the 'Inconvenient' code, a number of issues and limitations were grouped ranging from excessive weather conditions that are inconducive for walking to stops/stations (again, a factor with a potentially compounding effect on the major issues outlined under the 'Inaccessible' code), lack of amenities (such as air conditioning on-board transport vehicles and/or stations/stops) and support for family travel (large groups with children), and, in this case, temporal factors (i.e., inflexible schedules, long headway (time gaps) between vehicles servicing certain stations, unavailability during certain times of the day etc.) have also been commonly referenced under this code. Lastly, it is important to articulate the rationale behind the decoupling of spatial and temporal, often invoked and discussed collectively as spatiotemporal in the mobility literature, factors that emerged from the reviewed survey responses which were categorized under the 'inaccessibility' and 'inconvenient' codes, respectively.

The aforementioned spatial elements (FMLM gaps and disproportionately distributed stops/stations), especially when considered in light of the harsh weather conditions Bahrain is normally under during most of the year, offer a clearer and argument towards being an accessibility limitation. Whereas, the aforementioned temporal elements would, for the most part, highlight an incongruency between passengers' (respondents') daily routines/preferences and the operating schedules and headways (trip frequency and amount of time between each trip) determined by PT Operators, thus, presenting an issue that is more innocuous and, relatively, easier to address hence the classification of references highlighting temporal limitations under the 'Inconvenient' code. (To ensure consistency, temporal advantages inherent in the use of RH services have been, likewise, placed under the 'Convenient' code – more in the following subsection).

Before moving on to the next subsection, it is worth also covering some of the least referenced codes. Starting off with the 'Does not accommodate locals' code, six references were recorded evidencing – as is indicative by the naming of the code – the sociocultural, ethnocentric, and even classist divide, as discussed in further detail in the literature review, that seem to underscore how both the PT network and other passengers are viewed. Continuing on more or less the same reasoning, a dedicated code, albeit with low references (3 and labelled as 'Lack of Gender Segregation'), was created for responses that explicitly highlighted cultural incompatibilities and/or vulnerabilities female passengers might potentially be exposed to that would necessitate segregation measures.

Coding Matrix 2 (PT ONLY)

	A : Perceived benefits of PT	B : Perceived drawbacks of PT
1 : MaaS Survey Data:Age = 35-39	20	41
2 : MaaS Survey Data:Age = 45-50	29	31
3 : MaaS Survey Data:Age = 40-44	23	30
4 : MaaS Survey Data:Age = 30-34	47	69
5 : MaaS Survey Data:Age = 18-24	31	52
6 : MaaS Survey Data:Age = 25-29	37	57
7 : MaaS Survey Data:Age = 50 and above	34	43
8 : MaaS Survey Data:Gender = Male	120	167
9 : MaaS Survey Data:Gender = Female	100	155
10 : MaaS Survey Data:Household number = 1	3	5
11 : MaaS Survey Data:Household number = 4	62	86
12 : MaaS Survey Data:Household number = 3	51	54
13 : MaaS Survey Data:Household number = 2	19	34
14 : MaaS Survey Data:Household number = 5	56	96
15 : MaaS Survey Data:Household number = 6 and more	29	47
16 : MaaS Survey Data:Nationality = Non-GCC Country	30	37
17 : MaaS Survey Data:Nationality = Bahraini	177	267
18 : MaaS Survey Data:Nationality = Other GCC Country	10	15
19 : MaaS Survey Data:Work-Study Status = Working Full-Time	132	211
20 : MaaS Survey Data:Work-Study Status = Working Full-Time and Studying Part-Time	11	14
21 : MaaS Survey Data:Work-Study Status = Working Full-Time and Studying Full-Time	6	10
22 : MaaS Survey Data:Work-Study Status = Working Part-Time	21	23
23 : MaaS Survey Data:Work-Study Status = None of the above	28	33
24 : MaaS Survey Data:Work-Study Status = Studying Full-Time	13	22
25 : MaaS Survey Data:Work-Study Status = Working Part-Time and Studying Full-Time	5	8
26 : MaaS Survey Data:Work-Study Status = Studying Part-Time	0	0
27 : MaaS Survey Data:Work-Study Status = Working Part-Time and Studying Part-Time	3	0

Figure 29. Coding Matrix for PT Benefits and Drawbacks

4.1.3 Ride-hailing Benefits

Considering the focus on modal options available in Bahrain (hence options respondents attempting the survey are likely to be familiar with), and in accordance with the premise underpinning the refined MaaS variant *MaaS-Lite*, respondents were questioned on their perceptions of the benefits and drawbacks of ride-hailing services (traditional taxis services along with more contemporary services such as Uber and Lyft were all considered as ride-hailing services). This subsection focuses on the former. The key theme, and by some margin (with 36 more references than the second most-referenced code), was coded and labelled as ‘Convenient’ (with 75 references).

In addition to incorporating responses that explicitly contain the terms ‘convenient’ and/or ‘convenience’, emphasis on the temporal characteristics of RH services (the spontaneous and on-demand nature of the service for example) has been an emergent subtheme under this code. In addition, one of the key value propositions, and temporal characteristic, of ride-hailing services has been coded separately as ‘24/7 Availability’ with 15 references. Similarly, somespatial advantages (highlighting the door-to-door nature of the service), albeit less pronounced, have also emerged under the ‘Convenience’ code.

However, the majority of responses explicitly alluding to spatiotemporal benefits (no FMLM issues or constrictive timetables) have been coded under the ‘Accessible’ code (containing a total of 23 references). As a consequence of the unimodal nature of RH services (no modal interchanges), the speed of the service has been highlighted as one of the key benefits (coded as ‘Fast Service’ with 39 references). Lastly, although this is potentially mostly localized to the use of contemporary RH services such as Uber and Lyft, accessing the service, and utilizing the functionalities, through smartphone apps has been captured in the ‘User-friendly’ code (with 18 references) reaffirm the role of user cognitive effort, as originally discussed in the literature review citing the work of (Lyons et al., 2019), in facilitating acceptance of emergent technologically-driven mobility schemes such as MaaS. Moreover, the terms ‘ease to use’ and ‘app’ can be visibly gleaned from the referenced embedded under this code in addition to, albeit less common, responses that extoll the benefit of likeness or standardization of using and accessing the same service (app) regardless of geographical context (implicitly denoting the omission of issues such as language barriers, divergent requirements and interfaces etc.) and features such as geo-tracking that allow users full visibility and trackability of drivers, routes, and travel conditions – coded separately under ‘Trackability’ with 4 references. However, similar to the secondary role respondents ascribed to PT in the preceding subsection, a dedicated theme coded ‘Offers Back-up’ has received 30 references highlighting the utility of RH services during situations of emergencies, fatigue/inability to drive, and unavailability of private car to name a some of the scenarios.

Of course, this can be viewed through two distinct prisms; one, more pessimistic, view is that this further reaffirms the entrenched dominance of private car ownership and usage, and the second, more optimistic, view is that the availability of alternative modes offers the type of reassurance enabled by the presence of, as originally invoked by (Groth, 2019), multioptionality

(a fundamental antecedent of MaaS). Lastly, the relative seclusion offered by RH services, although this will be starkly juxtaposed with some of the main drawback themes covered in the following section, allows for a perception of privacy and safety both of which have been separately coded as 'Offers Privacy' (with 19 references) and 'Offers Safety' (with 6 references), respectively.

4.1.4 Ride-hailing Drawbacks

Counteracting the 'Offers Privacy' code discussed in the latter stages of the preceding section, one of the most commonly referenced codes under this theme has been labelled as 'Untrustworthy Drivers' with 31 references. Therein, respondents expound on safety concerns inherent in riding in a car with a stranger with some of the responses being heavily influenced, and even contain explicit references to, companies such as Uber where globally documented and broadcasted cases of driver misconduct and misbehavior issues are extensively publicized. Altogether, this also lent the impetus for some of the respondents to critically call into question the recruitment and vetting practices adopted by RH companies to ensure that such behavioral issues are mitigated.

Similarly, it also important to acknowledge that a majority of the responses coded under the 'Lack of Safety' code (with 19 references) are underpinned by security concerns, although in implicit references to drivers – hence the creation of dedicated standalone code.

Still, the level of mistrust respondents seem to demonstrate towards drivers in RH services extends beyond safety concerns as, potentially more common in traditional taxi services, certain responses have pointed towards deceptiveness and transparency in how drivers employ often manual charging methods with little to no transparency on price ranges and structures which takes us to following, most referenced, code under this theme – labelled as "Fluctuating Prices and High Cost" with 127 references. Here, respondents seem to clear correlate the convenience offered by RH services with a pricing strategy that is considered not only premium but also murky, and to quote a term from Reference 12, "predatory". In general, high, volatile, and unpredictable prices seem to emerge as the dominant leitmotif under this code. Although some respondents have demonstrated familiarity with, and skepticism of, pricing techniques such as 'surge pricing' adopted by RH services such as Uber. Also referred to as 'surge multiplier', surge pricing is adopted during times of high demand and factors in variables such as area of operation, time/length of ride, and other factors based on which prices are adjusted in real-time (Jiao, 2018).

The study by Battifarano & Qian (2019) not only reaffirms the opaqueness of operational metrics, including surge multipliers, adopted by RH companies as perceived by the passengers and highlighted in the references (responses) categorized under this code but also sheds light on the mistrust placed on pricing strategies by the riders enlisted under such Transport Network Companies (TNCs) such as Lyft where cases of riders routinely ignoring surge multiplier signals and, as a result, avoiding certain geographical areas entirely out of widespread mistrust. Moreover, avoidance of certain geographical areas by RH operators due to distrust in market signals and surge multipliers might, at least partly, also explain the perceptions respondents hold towards such services as 'Unavailable' (coded as such with 7 references) during periods of peak demand. Lastly, additional issues, albeit containing a marginal number of references, range from 'Slow Service' (8 references), 'Lack of Privacy' (2 references), and 'Increases Traffic' (5 references).

	A : Perceived Benefits of RH Services	B : Perceived Drawbacks of RH services
How many cars are in your household = 1	15	10
How many cars are in your household = 2	73	67
How many cars are in your household = 3	51	39
How many cars are in your household = 4	81	56
How many cars are in your household = 5	31	31
How many cars are in your household = 6 and more	3	2
How many family members are in your household = 1	2	1
How many family members are in your household = 4	58	48
How many family members are in your household = 3	47	49
y:How many family members are in your household = 2	27	21
y:How many family members are in your household = 5	85	61
y:How many family members are in your household = 6 and more	34	26
y:What is your employmentenrollment status = Working Full-Time	166	129
y:What is your employmentenrollment status = Working Full-Time and Studying Part-Tim	11	8
y:What is your employmentenrollment status = Working Full-Time and Studying Full-Tim	7	7
y:What is your employmentenrollment status = Working Part-Time	20	20
y:What is your employmentenrollment status = None of the above	22	18
y:What is your employmentenrollment status = Studying Full-Time	16	17
y:What is your employmentenrollment status = Working Part-Time and Studying Full-Tim	10	5
y:What is your employmentenrollment status = Studying Part-Time	0	0
y:What is your employmentenrollment status = Working Part-Time and Studying Part-Tim	0	0
y:What is your gender = Male	137	109
y:What is your gender = Female	117	96
y:What is your nationality = Non-GCC Country	23	19
y:What is your nationality = Bahraini	213	179
y:What is your nationality = Other GCC Country	13	6
y:Which category below includes your age = 35-39	26	24
y:Which category below includes your age = 45-50	28	23
y:Which category below includes your age = 40-44	19	21
y:Which category below includes your age = 30-34	56	43
y:Which category below includes your age = 18-24	45	36
y:Which category below includes your age = 25-29	55	37
y:Which category below includes your age = 50 and above	25	22

Figure 30. Coding Matrix for RH Benefits and Drawbacks

4.1.5 Externalities (Inaction)

Under this theme, three main codes were established: the first, "Denial of Responsibility and Downplaying of Impact" which received 24 references; secondly, "Lack of Alternatives" with 16 references; and lastly, "Lack of National Policy and Support" with 6 references. Beginning with the most referenced code under this theme that can be considered as both two-pronged ("Denial of Responsibility" and "Downplaying of Impact") and intersecting, respondents here can be evidently seen to invoke, albeit implicitly, some of the tenets of Multi-Level Perspective (MLP) theory in articulating the reasons that would absolve them from responsibility towards transportation-related externalities, justifying inaction and shifting the focus – and, as a consequence, the blame – towards key players within the socio-technical regime (industry and policy) (Geels, 2012). Moreover, a consistently cited reason for inaction emerging from this code, again, echoes the importance of multipotentiality (Groth, 2019) with a multitude of respondents underscoring the limited availability of reliable and comprehensive transport options here in Bahrain and positing such limitedness as the core motive for private car use, in particular, and the wider car dependence culture evident across the country, in general.



Figure 31. Word Cloud – Externalities (Inaction)

Namely, and as can be gleaned from the word cloud shown in Figure 31, references made to those central to the shaping of national mobility policy, infrastructure and urban planning, and broader market dynamics have been encapsulated in terms such as 'country', 'government', 'authorities', and 'public'. Such terms have been invoked by respondents that offered reasons consistent with the first prong this code "denial of responsibility" by diverting and ascribing total responsibility for car-related externalities to national authorities and policymakers. Shifting towards the second prong under this code "downplaying of impact", the emerging theme seems to heavily rest on disaggregation.

As such, acknowledgment of one's own emissions contributions and, the much broader, ecological footprint as being too miniscule and inconsequential – especially when contrasted with what some respondents perceived to be widescale impacts driven by commercial interests – to instigate or drive anthropogenic global warming prevails among the responses collated under this theme. Likewise, the practice of operating and using private, mostly single occupancy, vehicles and the corollary environmental impact has been cast, by some of the respondents, against the impact generated by other sectors and factors with externalities contributing towards anthropogenic environmental degradation.

Tying in with some of the responses discussed in the aforementioned code, responses under the "Lack of Alternatives" code not only capture the importance of multioptionality but also demonstrate how a lack thereof is often attributed with perpetuating car dependency within the Kingdom. Lastly, it is important to note that certain respondents offered mixed responses for the question on which this theme is based: Do you feel responsible for the above [*Many people think that cars and their excessive use generate problems for society, the environment and even the economy]? If so, what actions are you taking to change that?* In other words, certain respondents acknowledged a certain degree of responsibility although have claimed to have taken no action considering the reasons categorized under the codes discussed throughout this subsection.

4.1.6 Externalities (Action)

Conversely, respondents that acknowledge both responsibility and the adoption of counterbalancing initiatives, emblematic of Pro-Environmental Behavior, have offered insightful responses that are coded under this theme. The most referenced (total 16) example has been coded as 'Recycling' followed by 'Carpooling' with 15 references, and modifications to consumerist

behavior and purchasing decision – coded as 'Curbing of Consumerist Behavior' with 12 references. Other examples, albeit with fewer references, have also been coded.

	A : Irresponsibility (Inaction)	B : Responsibility (Action)
How many cars are in your household = 1	2	10
How many cars are in your household = 2	7	23
How many cars are in your household = 3	8	12
How many cars are in your household = 4	14	13
How many cars are in your household = 5	11	5
How many cars are in your household = 6 and more	0	1
How many family members are in your household = 1	0	3
How many family members are in your household = 4	3	16
How many family members are in your household = 3	7	15
y:How many family members are in your household = 2	4	13
y:How many family members are in your household = 5	19	9
y:How many family members are in your household = 6 and more	9	11
y:What is your employmentenrollment status = Working Full-Time	26	40
y:What is your employmentenrollment status = Working Full-Time and Studying Part-Time	0	1
y:What is your employmentenrollment status = Working Full-Time and Studying Full-Time	2	2
y:What is your employmentenrollment status = Working Part-Time	0	4
y:What is your employmentenrollment status = None of the above	6	8
y:What is your employmentenrollment status = Studying Full-Time	4	6
y:What is your employmentenrollment status = Working Part-Time and Studying Full-Time	3	3
y:What is your employmentenrollment status = Studying Part-Time	0	0
y:What is your employmentenrollment status = Working Part-Time and Studying Part-Time	0	2
y:What is your gender = Male	21	36
y:What is your gender = Female	21	31
y:What is your nationality = Non-GCC Country	4	18
y:What is your nationality = Bahraini	34	42
y:What is your nationality = Other GCC Country	3	6
y:Which category below includes your age = 35-39	4	7
y:Which category below includes your age = 45-50	3	13
y:Which category below includes your age = 40-44	2	4
y:Which category below includes your age = 30-34	10	6
y:Which category below includes your age = 18-24	12	16
y:Which category below includes your age = 25-29	9	9
y:Which category below includes your age = 50 and above	2	12

Figure 32. Coding Matrix for Externalities (Inaction/Action)

Generally, such practices evidence the extent to which passengers, cognizant of the environmental impact (and overall environmental footprint) wrought by their dependence and use of SOV vehicles and other practices, are willing to counteract their actions based on the options at their disposal. With recycling and modifications to consumerist behavior, respondents have disclosed their proclivity towards practices such as recycling, reducing usage of highly polluting materials and products (namely, plastic and vehicles with poor fuel-efficiency), and reduction of purchases. Likewise, when similar practices have also been documented when it comes to direct usage, or involvement, of private cars. The aforementioned practice of carpooling and the reduction of unnecessary car trips (coded as 'Reduce Car Usage' with 12 references) and,

consequently, overall VKT in SOVs have been some of the staple approaches favored and adopted by respondents in countering their heavy dependence on harmful ICEVs.

4.2 Statistical Analysis

4.2.1 Gender and Consideration of further uptake of Public Transportation

The Chi-Square Test of Independence was used to determine whether there is an association between gender and consideration of increasing PT usage. The null hypothesis states that there is no association between gender and consideration of increasing PT usage while the alternative hypothesis states there is an association between gender and consideration of increasing PT usage. Result on Table 13 showed that there is a statistically significant association between gender and consideration of increasing PT usage, $\chi 2 = 35.757, p < .001$.

Table 13. Chi-square Test on the association between gender and consideration of increasing PT usage

		Male	**Female**	**Total**	***χ2***	***p***
Would you consider using, or increasing your use of, the public bus service in Bahrain if national bus prioritization policies (bus-only access areas, bus lanes, etc.) were instituted?	Definitely Not	2	5	7	35.757	.000
	Probably Not	31	69	100		
	Probably	75	38	113		
	Definitely	13	5	18		
	Very Probably	40	21	61		
Total		161	138	299		

Note. df = 4

This result implies that the frequencies of considering increasing PT usage vary notably between different genders. This could be construed as gender variable playing a role in how people view the use of public transportation, potentially reflecting different needs, preferences, or experiences related to public transport that vary by gender. The contingency table in Table 13, showed that males were more likely to consider increasing public transport usage.

4.2.2 Gender and acceptance of SOV Restrictions

Furthermore, the Chi-Square test of independence was also nused to determine whether there is an association between gender and SOV restrictions. The null hypothesis states that there is no

association between gender and SOV restrictions while the alternative hypothesis states there is an association between gender and SOV restrictions. Result on Table 14 showed that there is a statistically significant association between gender and SOV restrictions, $\chi 2 = 10.887, p < .05$. This result implies that the frequencies of SOV restrictions vary notably between different genders. This could be interpreted as gender playing a role in people's opinion of restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hour. Likewise, males agree more than females on SOV restrictions.

Table 14. Chi-square Test on the association between gender and SOV restrictions

		Male	**Female**	**Total**	**χ2**	**p**
Are you in favor of restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hours?	Strongly Disagree	10	6	16	10.877	.028
	Disgaree	8	10	18		
	Neither Agree or Disagree	33	49	82		
	Agree	93	58	151		
	Strongly Agree	17	15	32		
Total		161	138	299		

Note. df = 4

4.2.3 Gender and Fuel-Efficiency Preferences

The Chi-Square test of independence was used to determine whether there is an association between gender and Fuel-efficiency preference. The null hypothesis states that there is no association between gender and Fuel-efficiency preference while the alternative hypothesis states there is an association between gender and Fuel-efficiency preference. Result on Table 15 showed that there is a statistically significant association between gender and Fuel-efficiency preference, $\chi 2 = 20.662, p < .001$. This result implies that the frequencies of Fuel-efficiency preference vary notably between different genders. This could be interpreted as gender playing a role on how people ascribe importance to a vehicle's 'fuel economy' performance. Likewise, Table 15 showed that females attached high importance than males while more males compared to females attached moderate importance.

Table 15. Chi-square Test on the association between gender and importance of vehicle's fuel economy

		Male	Female	Total	χ2	p
When considering buying a vehicle, how much importance would you ascribe to a vehicle's 'fuel economy' performance?	No Importance	8	25	33	20.662	.000
	Very low importance	24	8	32		
	Low importance	29	23	52		
	Moderate Importance	63	41	104		
	High importance	37	41	78		
Total		161	138	299		

Note. df = 4

4.2.4 Gender and Flight Emission Labelling

Furthermore, the Chi-Square test of independence was used to determine whether there is an association between gender and flight emissions. The null hypothesis states that there is no association between gender and flight emissions while the alternative hypothesis states there is an association between gender and flight emissions. Result on Table 16 showed that there is a statistically significant association between gender and flight emissions, $\chi 2 = 15.265, p < .05$. The result shown here implies that the frequencies of importance of CO_2 flight emissions preference vary notably between different genders. This could be interpreted as gender playing a role on how people ascribe importance to CO_2 flight emissions. More females ascribe moderate of high importance to CO_2 flight emissions than males.

Table 16. Chi-square Test on the association between gender and importance of CO_2 flight emissions

		Male	Female	Total	χ2	p
When deciding between different flights (airfare options), how much importance would you ascribe to flights' estimated 'CO2 emissions'?	No Importance	24	41	65	15.265	.004
	Very low importance	51	25	76		
	Low importance	58	41	99		
	Moderate Importance	19	17	36		

	High importance	9	13	22
Total		161	137	298

Note. df = 4

4.2.5 Gender and Frequency of Recycling

The Chi-Square test of independence was used to determine whether there is an association between gender and considerations on recycling. The null hypothesis states that there is no association between gender and considerations on recycling while the alternative hypothesis states there is an association between gender and considerations on recycling. Result on Table 17 showed that there is no significant association between gender and considerations on recycling, $\chi 2 = 6.061$, $p = .195$ which implies that the frequencies of considerations on recycling do not vary notably between different genders. This could be interpreted as gender not playing a role on how people consider sorting and recycling waste before disposal. Similarly, more females compared to males consider sorting and recycling waste before disposal.

Table 17. Chi-square Test on the association between gender and consideration of recycling

		Male	**Female**	**Total**	***χ2***	***p***
How often do you consider sorting and recycling waste before disposal?	Never	15	15		6.061	.195
	Rarely	82	52			
	Sometimes	35	35			
	Often	7	11			
	Always	21	24			
Total		160	137	297		

Note. df = 4

4.2.6 Age Range and Consideration of further uptake of Public Transportation

The Chi-Square Test of Independence was used to determine whether there is an association between age range and consideration of increasing PT usage. The null hypothesis states that there is no association between age range and consideration of increasing PT usage while the alternative hypothesis states there is an association between age range and consideration of increasing PT

usage. Result on Table 18 showed that there is a no association between age range and consideration of increasing PT usage, $\chi 2 = 28.154, p = .254$. This result implies that the frequencies of considering increasing PT usage does not vary notably between different age range. This could be construed as age range playing no role in how people view the use of public transportation.

Table 18. Chi-square Test on the association between age range and consideration of increasing PT usage

		18 - 24	**25 - 29**	**30 - 34**	**35 - 39**	**40 - 44**	**45 - 49**	**50 and above**	χ^2	*p*
Would you consider using, or increasing your use of, the public bus service in Bahrain if national bus prioritization policies (bus-only access areas, bus lanes, etc.) were instituted?	Definitely Not	1	0	4	1	0	0	1	28.154	.254
	Probably Not	19	22	17	19	6	7	11		
	Probably	17	19	22	15	10	13	17		
	Definitely	3	2	2	1	2	4	4		
	Very Probably	12	9	16	2	8	6	8		
Total		52	52	61	38	26	30	41		

4.2.7 Age Range and acceptance of SOV restrictions

Furthermore, the Chi-Square test of independence was used to determine whether there is an association between age range and SOV restrictions. The null hypothesis states that there is no association between gender and SOV restrictions while the alternative hypothesis states there is an association between age range and SOV restrictions. Result on Table 19 showed that there is a statistically significant association between age range and SOV restrictions, $\chi 2 = 38.763, p < .05$. This result implies that the frequencies of SOV restrictions vary notably between different age range.

Table 19. Chi-square Test on the association between age range and SOV restrictions

		18 - 24	**25 - 29**	**30 - 34**	**35 - 39**	**40 - 44**	**45 - 49**	**50 and above**	χ^2	p
Are you in favour of restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hours?	Strongly Disagree	0	2	2	5	1	0	6	38.763	.029
	Disagree	4	2	4	2	1	2	3		
	Neither Agree or Disagree	19	18	15	12	4	10	4		
	Agree	25	26	34	19	15	12	21		
	Strongly Agree	4	4	6	0	5	6	7		
Total		52	52	61	38	26	30	41		

This could be interpreted as age range playing a role in people's opinion of restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hour. Table 19 further showed that older participants, 45 years and above, gave more moderate and high importance to SOV restrictions. Participants within the 25 years to 34 years age range gave more 'no importance' to SOV restrictions than other age ranges while older age groups 45 years and above gave high importance than other age ranges.

4.2.8 Age-Range and Fuel Efficiency Preferences

The Chi-Square test of independence was used to determine whether there is an association between age range and Fuel-efficiency preference. The null hypothesis states that there is no association between age range and Fuel-efficiency preference while the alternative hypothesis states there is an association between age range and Fuel-efficiency preference. Result on Table 20 showed that there is a statistically significant association between age range and Fuel-efficiency preference, $\chi 2 = 38.225, p < .05$ which can be potentially imply that the frequencies of Fuel-efficiency preference vary notably between different age range.

Table 20. Chi-square Test on the association between age range and importance of vehicle's fuel economy

		18 - 24	**25 - 29**	**30 - 34**	**35 - 39**	**40 - 44**	**45 - 49**	**50 and above**	χ^2	p
When considering buying a vehicle, how much importance would you ascribe to a vehicle's 'fuel economy' performance?	No Importance	4	3	8	4	4	5	6	38.225	.033
	Very low importance	9	3	5	1	5	2	7		
	Low importance	9	14	14	8	2	3	2		
	Moderate Importance	19	24	22	14	8	8	9		
	High importance	11	8	12	11	7	12	17		
Total		52	52	61	38	26	30	41		

This could be interpreted as age range playing a role on how people ascribe importance to a vehicle's 'fuel economy' performance. Participants aged 25 years to 34 years gave more no importance to vehicle's 'fuel economy' performance than other age ranges while older age groups 45 years and above gave high importance than other age ranges (Table 20).

4.2.9 Age-Range and Flight Emission Labelling

Furthermore, the Chi-Square test of independence was used to determine whether there is an association between age range and flight emissions. The null hypothesis states that there is no association between age range and flight emissions while the alternative hypothesis states there is an association between age range and flight emissions. Result on Table 21 showed that there is a statistically significant association between age range and flight emissions, $\chi 2 = 39.956, p < .05$. This result implies that the frequencies of importance of CO_2 flight emissions preference vary notably between different age range.

Table 21. Chi-square Test on the association between age range and importance of CO_2 flight emissions

		18 - 24	**25 - 29**	**30 - 34**	**35 - 39**	**40 - 44**	**45 - 49**	**50 and above**	$\chi 2$	p
When deciding between different flights (airfare options), how much importance would you ascribe to flights' estimated 'CO_2 emissions'?	No Importance	5	14	15	8	4	8	12	39.956	.022
	Very low importance	19	13	19	8	7	4	6		
	Low importance	18	18	22	15	8	7	11		
	Moderate Importance	6	4	5	2	7	5	7		
	High importance	4	3	0	5	0	6	4		
Total		52	52	61	38	26	30	41		

This could be interpreted as age range playing a role on how people ascribe importance to CO_2 flight emissions. Participants aged 25 years to 34 years gave more no importance to CO_2 flight emissions than other age ranges while older age groups 45 years and above gave high importance than other age ranges (Table 21).

4.2.10 Age-Range and Frequency of Recycling

The Chi-Square test of independence was used to determine whether there is an association between age range and considerations on recycling. The null hypothesis states that there is no association between age range and considerations on recycling while the alternative hypothesis states there is an association between age range and considerations on recycling. Result on Table 22 showed that there is a significant association between age range and considerations on recycling, $\chi 2 = 47.268, p < .05$. This result implies that the frequencies of considerations on recycling vary notably between different age range. This could be interpreted as age range playing a role on how people consider sorting and recycling waste before disposal. All age ranges consider sorting and recycling waste before disposal.

Table 22. Chi-square Test on the association between age range and consideration of recycling

		18 - 24	25 - 29	30 - 34	35 - 39	40 - 44	45 - 49	50 and above	$\chi 2$	p
How often do you consider sorting and recycling waste before disposal?	Never	3	11	5	4	2	1	4	47.268	.003
	Rarely	26	26	30	19	13	11	10		
	Sometimes	9	7	21	7	8	5	13		
	Often	4	3	2	4	1	2	2		
	Always	10	5	2	4	2	10	12		
Total		52	52	61	38	26	30	41		

4.2.11 Household Car Ownership levels and Consideration of further uptake of Public Transportation

The Chi-Square Test of Independence was used to determine whether there is an association between number of Cars in household and consideration of increasing PT usage. The null hypothesis states that there is no association between number of Cars in household and consideration of increasing PT usage while the alternative hypothesis states there is an association between number of Cars in household and consideration of increasing PT usage. Result on Table 23 showed that there is a statistically significant association between number of Cars in household and consideration of increasing PT usage, $\chi 2 = 45.405$, $p < .001$.

Table 23. Chi-square Test on the association between number of Cars in household and consideration of increasing PT usage

		1	2	3	4	5	6 or more	Total	$\chi 2$	p
Would you consider using, or increasing your use of, the public bus service in Bahrain if national bus	Definitely Not	0	4	0	2	1	0	7	45.405	.001
	Probably Not	4	27	18	34	16	2	101		
	Probably	8	41	24	26	10	4	113		

prioritization policies (bus-only access areas, bus lanes, etc.) were instituted?	Definitely	7	4	2	3	1	1	18		
	Very Probably	4	10	16	22	8	1	61		
Total		23	86	60	87	36	8	300		

This result implies that the frequencies of considering increasing PT usage vary notably between the number of Cars in household. This could be interpreted as the number of Cars in household playing significant role in how people view the use of public transportation. Table 23 showed that **t**hose will lesser cars (1 or 2) will consider PT usage more than those with more cars.

4.2.12 Household Car Ownership levels and Acceptance of SOV Restrictions

Furthermore, the Chi-Square test of independence was used to determine whether there is an association between number of Cars in household and SOV restrictions. The null hypothesis states that there is no association between number of Cars in household and SOV restrictions while the alternative hypothesis states there is an association between number of Cars in household and SOV restrictions. Result on Table 24 showed that there is a statistically significant association between number of Cars in household and SOV restrictions, $\chi 2 = 53.563, p < .001$. This result implies that the frequencies of SOV restrictions vary notably between the number of Cars in household.

This could be interpreted as number of Cars in household playing a role in people's opinion of restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hour. Table 24 showed that **t**hose will lesser cars (1 or 2) will strongly agree to SOV restrictions than those with more cars.

Table 24. Chi-square Test on the association between number of Cars in household and SOV restrictions

		1	**2**	**3**	**4**	**5**	**6 or more**	**Total**	***χ2***	***p***
Are you in favor of	Strongly Disagree	2	6	1	2	2	3	16	53.563	.000

restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hours?	Disgaree	3	4	6	3	1	1	18		
	Neither Agree or Disagree	2	19	21	30	10	0	82		
	Agree	8	45	29	46	21	3	152		
	Strongly Agree	8	12	3	6	2	1	32		
Total		23	86	60	87	36	8	300		

4.2.13 Household Car Ownership levels and Fuel-efficiency Preferences

The Chi-Square test of independence was used to determine whether there is an association between number of Cars in household and Fuel-efficiency preference. The null hypothesis states that there is no association between number of Cars in household and Fuel-efficiency preference while the alternative hypothesis states there is an association between number of Cars in household and Fuel-efficiency preference. Result on Table 25 showed that there is a statistically significant association between number of Cars in household and Fuel-efficiency preference, $\chi 2 = 75.703$, $p < .001$.

Table 25. Chi-square Test on the association between number of Cars in household and importance of vehicle's fuel economy

		1	**2**	**3**	**4**	**5**	**6 or more**	**Total**	χ^2	p
When considering buying a vehicle, how much importance would you ascribe to a vehicle's 'fuel	No Importance	0	10	11	6	5	2	34	75.703	.000
	Very low importance	0	6	7	16	3	0	32		
	Low importance	2	15	10	19	6	0	52		
	Moderate Importance	1	27	21	33	19	3	104		

economy' performance?	High importance	20	28	11	13	3	3	78		
Total		23	86	60	87	36	8	300		

This result implies that the frequencies of Fuel-efficiency preference vary notably between the number of Cars in household. This could be interpreted as number of Cars in household playing a role on how people ascribe importance to a vehicle's 'fuel economy' performance. Table 25 showed that those will lesser cars (1 or 2) will give high importance to fuel economy more than those with more cars.

4.2.14 Household Car Ownership levels and Flight Emission Labelling

Furthermore, the Chi-Square test of independence was used to determine whether there is an association between number of Cars in household and flight emissions. The null hypothesis states that there is no association between number of Cars in household and flight emissions while the alternative hypothesis states there is an association between number of Cars in household and flight emissions. Result on Table 26 showed that there is a statistically significant association between number of Cars in household and flight emissions, $\chi 2 = 89.036, p < .001$. This result implies that the frequencies of importance of CO_2 flight emissions preference vary notably between the number of Cars in household. This could be interpreted as number of Cars in household playing a role on how people ascribe importance to CO_2 flight emissions. Table 26 showed that those will lesser cars (1 or 2) will give high importance to CO_2 flight emissions.

Table 26. Chi-square Test on the association between number of Cars in household and importance of CO_2 flight emissions

		1	**2**	**3**	**4**	**5**	**6 or more**	**Total**	***χ2***	***p***
When deciding between different flights (airfare options), how much importance	No Importance	1	20	18	14	10	3	66	89.036	.000
	Very low importance	1	18	18	32	7	0	76		
	Low importance	5	34	15	30	14	1	99		
	Moderate Importance	5	9	6	8	5	3	36		

would you ascribe to flights' estimated 'CO_2 emissions'?	High importance	11	4	3	3	0	1	22		
Total		23	85	60	87	36	8	299		

This result implies that the frequencies of importance of CO_2 flight emissions preference vary notably between the number of Cars in household. This could be interpreted as number of Cars in household playing a role on how people ascribe importance to CO_2 flight emissions. Table 26 showed that those will lesser cars (1 or 2) will give high importance to CO_2 flight emissions.

4.2.15 Household Car Ownership levels and Frequency of Recycling

The Chi-Square test of independence was used to determine whether there is an association between number of Cars in household and considerations on recycling. The null hypothesis states that there is no association between number of Cars in household and considerations on recycling while the alternative hypothesis states there is an association between number of Cars in household and considerations on recycling. Result on Table 27 showed that there is a significant association between number of Cars in household and considerations on recycling, $\chi 2 = 53.418, p < .001$.

Table 27. Chi-square Test on the association between number of Cars in household and consideration of recycling

		1	**2**	**3**	**4**	**5**	**6 or more**	**Total**	***χ2***	***p***
How often do you consider sorting and recycling waste before disposal?	Never	1	5	10	11	2	1	30	53.418	.000
	Rarely	3	40	27	48	15	2	135		
	Sometimes	3	25	15	14	9	4	70		
	Often	5	4	1	4	4	0	18		
	Always	11	11	7	9	6	1	45		
Total		23	85	60	86	36	8	298		

This result implies that the frequencies of considerations on recycling vary notably between the number of Cars in household. This could be interpreted as number of Cars in household playing a role on how people consider sorting and recycling waste before disposal. Participants with lesser cars (1 or 2) consider sorting and recycling waste before disposal than those with more cars.

4.2.16 Frequency of Public Transportation use and Likelihood of Increasing Public Transportation use

The Chi-Square Test of Independence was used to determine whether there is an association between frequency of using public transport and consideration of increasing PT usage. The null hypothesis states that there is no association between frequency of using public transport and consideration of increasing PT usage while the alternative hypothesis states there is an association between frequency of using public transport and consideration of increasing PT usage. Result on Table 28 showed that there is a statistically significant association between frequency of using public transport and consideration of increasing PT usage, $\chi 2 = 58.306$, $p < .001$. This result implies that the frequencies of considering increasing PT usage vary notably between the frequency of using public transport. The results further showed that participants who never or rarely use PT will more likely consider increasing PT usage than those who often or always use it.

Table 28. Chi-square Test on the association between frequency of using public transport and consideration of increasing PT usage

		Never	**Rarely**	**Sometimes**	**Often**	**Always**	**Total**	χ^2	p
Would you consider using, or increasing your use of, the public bus service in Bahrain if national bus prioritization policies (bus-only access areas, bus	Definitely Not	7	0	0	0	0	7	58.306	.000
	Probably Not	38	47	12	4	0	101		
	Probably	29	54	24	5	1	113		
	Definitely	5	3	5	3	2	18		
	Very Probably	13	21	15	11	1	61		

lanes, etc.) were instituted									
Total		92	125	56	23	4	300		

4.2.17 Frequency of Public Transportation use and acceptance of SOV Restrictions

Furthermore, the Chi-Square test of independence was used to determine whether there is an association between frequency of using public transport and SOV restrictions. The null hypothesis states that there is no association between number of frequency of using public transport and SOV restrictions while the alternative hypothesis states there is an association between frequency of using public transport and SOV restrictions.

Table 29. Chi-square Test on the association between frequency of using public transport and SOV restrictions

		Never	**Rarely**	**Sometimes**	**Often**	**Always**	**Total**	χ^2	*p*
Are you in favor of restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hours?	Strongly Disagree	15	1	0	0	0	16	64.572	.000
	Disgare	11	4	1	1	1	18		
	Neither Agree or Disagree	31	29	14	6	2	82		
	Agree	25	81	33	13	0	152		
	Strongly Agree	10	10	8	3	1	32		
Total		92	125	56	23	4	300		

Result on Table 29 showed that there is a statistically significant association between frequency of using public transport and SOV restrictions, $\chi 2 = 64.572, p < .001$. This result implies that the frequencies of SOV restrictions vary notably between the frequency of using public transport. This could be interpreted as frequency of using public transport playing a role in people's opinion of restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hour. Table 29 further showed that participants who never or rarely use PT will more likely agree or strongly agree to SOV restrictions than those who often or always use PT.

4.2.18 Frequency of Public Transportation use and Vehicular Fuel-Efficiency Preferences

The Chi-Square test of independence was used to determine whether there is an association between frequency of using public transport and Fuel-efficiency preference. The null hypothesis states that there is no association between frequency of using public transport and Fuel-efficiency preference while the alternative hypothesis states there is an association between frequency of using public transport and Fuel-efficiency preference. Result on Table 30 showed that there is a statistically significant association between frequency of using public transport and Fuel-efficiency preference, $\chi 2 = 67.039, p < .001$. This result implies that the frequencies of Fuel-efficiency preference vary notably between the frequency of using public transport. This could be interpreted as frequency of using public transport playing a role on how people ascribe importance to a vehicle's 'fuel economy' performance. Table 30 further showed that participants who never or rarely use PT attach moderate and high importance to fuel economy than those who often or always use PT.

Table 30. Chi-square Test on the association between frequency of using public transport and importance of vehicle's fuel economy

		Never	**Rarely**	**Sometimes**	**Often**	**Always**	**Total**	χ^2	p
When considering buying a vehicle, how much importance	No Importance	9	20	5	0	0	34	67.039	.000
	Very low importance	4	7	18	3	0	32		

would you ascribe to a vehicle's 'fuel economy' performance ?	Low importance	12	21	13	5	1	52		
	Moderate Importance	29	58	9	7	1	104		
	High importance	38	19	11	8	2	78		
Total		92	125	56	23	4	300		

4.2.19 Frequency of Public Transportation use and Importance ascribed to Air Fare Emission Labels

Furthermore, the Chi-Square test of independence was used to determine whether there is an association between frequency of using public transport and flight emissions. The null hypothesis states that there is no association between frequency of using public transport and flight emissions while the alternative hypothesis states there is an association between frequency of using public transport and flight emissions. Result on Table 31 showed that there is a statistically significant association between frequency of using public transport and flight emissions, $\chi 2 = 35.643$, $p < .05$. This result implies that the frequencies of importance of CO_2 flight emissions preference vary notably between the frequency of using public transport. This could be interpreted as frequency of using public transport playing a role on how people ascribe importance to CO_2 flight emissions. Table 31 further showed that participants who never or rarely use PT will attach moderate and high importance to CO_2 flight emissions than those who often or always use PT.

Table 31. Chi-square Test on the association between frequency of using public transport and importance of CO_2 flight emissions

		Never	**Rarely**	**Sometimes**	**Often**	**Always**	**Total**	χ^2	p
When deciding between different flights (airfare	No Importance	28	24	11	3	0	66	35.643	.003
	Very low importance	16	33	20	7	0	76		

options), how much importance would you ascribe to flights' estimated 'CO_2 emissions'?	Low importance	21	54	16	6	2	99		
	Moderate Importance	14	10	6	4	2	36		
	High importance	12	4	3	3	0	22		
Total		91	125	56	23	4	299		

4.2.20 Frequency of Public Transportation use and Consideration of Recycling

The Chi-Square test of independence was used to determine whether there is an association between frequency of using public transport and considerations on recycling. The null hypothesis states that there is no association between frequency of using public transport and considerations on recycling while the alternative hypothesis states there is an association between frequency of using public transport and considerations on recycling. Result on Table 32 showed that there is a significant association between frequency of using public transport and considerations on recycling, $\chi 2 = 82.055, p < .001$. This result implies that the frequencies of considerations on recycling vary notably between the frequency of using public transport. This could be interpreted as frequency of using public transport playing a role on how people consider sorting and recycling waste before disposal. Table 32 further showed that participants who never or rarely use PT will often or always consider sorting and recycling waste before disposal than those who often or always use PT.

Table 32. Chi-square Test on the association between frequency of using public transport and consideration of recycling

		Never	**Rarely**	**Sometimes**	**Often**	**Always**	**Total**	**χ^2**	**p**
How often do	Never	9	4	15	2	0	30	82.055	.000

you consider sorting and recycling waste before disposal?	Rarely	20	80	23	11	1	135		
	Sometimes	25	27	11	6	1	70		
	Often	8	5	2	3	0	18		
	Always	30	7	5	1	2	45		
Total		92	123	56	23	4	298		

4.2.21 Frequency of Smartphone Payments and Consideration of further uptake of Public Transportation

The Chi-Square Test of Independence was used to determine whether there is an association between frequency of Smartphone payments and consideration of increasing PT usage. The null hypothesis states that there is no association between frequency of Smartphone payments and consideration of increasing PT usage while the alternative hypothesis states there is an association between frequency of Smartphone payments and consideration of increasing PT usage. Result on Table 33 showed that there is no significant association between frequency of Smartphone payments and consideration of increasing PT usage, $\chi 2 = 18.947, p = .271$. This result implies that the frequencies of considering increasing PT usage do not vary notably between the frequency of Smartphone payments. The results further showed that participants who often or always use smartphone for online payments will more likely consider increasing PT usage than those who never or rarely use it.

Table 33. Chi-square Test on the association between frequency of using Smartphone payments and consideration of increasing PT usage

		Never	**Rarely**	**Sometimes**	**Often**	**Always**	**Total**	χ^2	p
Would you consider using, or increasing your use of, the public	Definitely Not	0	0	1	2	4	7	18.947	.271
	Probably Not	0	2	10	47	42	101		

bus service in Bahrain if national bus prioritization policies (bus-only access areas, bus lanes, etc.) were instituted?	Probably	1	4	18	57	33	113		
	Definitely	0	1	2	5	10	18		
	Very Probably	0	1	16	28	16	61		
Total		1	8	47	139	105	300		

4.2.22 Frequency of Smartphone Payments and acceptance of SOV Restrictions

Furthermore, the Chi-Square test of independence was used to determine whether there is an association between frequency of Smartphone payments and SOV restrictions. The null hypothesis states that there is no association between number of frequency of using Smartphone payments and SOV restrictions while the alternative hypothesis states there is an association between frequency of using Smartphone payments and SOV restrictions. Result on Table 34 showed that there is a statistically significant association between frequency of using Smartphone payments and SOV restrictions, $\chi 2 = 52.282,\ p < .001$. This result implies that the frequencies of SOV restrictions vary notably between the frequency of using Smartphone payments. This could be interpreted as frequency of using Smartphone payments playing a role in people's opinion of restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hour. Table 34 further showed that participants who often or always use smartphone for online payments will more likely agree or strongly agree to SOV restrictions than those who never or rarely use it.

Table 34. Chi-square Test on the association between frequency of using Smartphone payments and SOV restrictions

		Never	**Rarely**	**Sometimes**	**Often**	**Always**	**Total**	χ^2	p

Are you in favor of restrictions on the use of Single Occupancy Vehicles (vehicles with only one passenger) in heavy congestion areas during peak hours?	Strongly Disagree	1	0	2	3	10	16	52.282	.000
	Disgaree	0	2	0	6	10	18		
	Neither Agree or Disagree	0	0	9	36	37	82		
	Agree	0	5	28	83	36	152		
	Strongly Agree	0	1	8	11	12	32		
Total		1	8	47	139	105	300		

4.2.23 Frequency of Smartphone Payments and Vehicular Fuel-Efficiency Preferences

The Chi-Square test of independence was used to determine whether there is an association between frequency of using Smartphone payments and Fuel-efficiency preference. The null hypothesis states that there is no association between frequency of using Smartphone payments and Fuel-efficiency preference while the alternative hypothesis states there is an association between frequency of using Smartphone payments and Fuel-efficiency preference.

Table 35. Chi-square Test on the association between frequency of using Smartphone payments and importance of vehicle's fuel economy

		Never	**Rarely**	**Sometimes**	**Often**	**Always**	**Total**	χ^2	p
When considering buying a vehicle, how much importance	No Importance	0	0	2	12	20	34	37.384	.002
	Very low importance	0	0	3	12	17	32		

would you ascribe to a vehicle's 'fuel economy' performance ?	Low importance	0	1	7	25	19	52		
	Moderate Importance	0	2	23	60	19	104		
	High importance	1	5	12	30	30	78		
Total		1	8	47	139	105	300		

Result on Table 35 showed that there is a statistically significant association between frequency of using Smartphone payments and Fuel-efficiency preference, $\chi 2 = 37.384, p < .05$. This result implies that the frequencies of Fuel-efficiency preference vary notably between the frequency of using Smartphone payments. This could be interpreted as frequency of using Smartphone payments playing a role on how people ascribe importance to a vehicle's 'fuel economy' performance. Table 35 further showed that participants who often or always use smartphone for online payments attach moderate and high importance to fuel economy than those who never or rarely use it.

4.2.24 Frequency of Smartphone Payments and Importance ascribed to Air Fare Emission Labels

Furthermore, the Chi-Square test of independence was used to determine whether there is an association between frequency of using Smartphone payments and flight emissions. The null hypothesis states that there is no association between frequency of using Smartphone payments and flight emissions while the alternative hypothesis states there is an association between frequency of using Smartphone payments and flight emissions. Result on Table 36 showed that there is a statistically significant association between frequency of using Smartphone payments and flight emissions, $\chi 2 = 35.370, p < .05$.

Table 36. Chi-square Test on the association between frequency of using Smartphone payments and importance of CO_2 flight emissions

		Never	Rarely	Sometimes	Often	Always	Total	χ^2	p
When deciding between different flights (airfare options), how much importance would you ascribe to flights' estimated 'CO_2 emissions'?	No Importance	0	1	5	26	34	66	35.370	.004
	Very low importance	0	4	10	39	23	76		
	Low importance	0	1	25	50	23	99		
	Moderate Importance	1	2	4	13	16	36		
	High importance	0	0	2	11	9	22		
Total		1	8	46	139	105	299		

This result implies that the frequencies of importance of CO_2 flight emissions preference vary notably between the frequency of using Smartphone payments. This could be interpreted as frequency of using Smartphone payments playing a role on how people ascribe importance to CO_2 flight emissions. Table 36 further showed that participants who often or always use smartphone for online payments attach moderate and high importance to CO_2 flight emissions than those who never or rarely use it.

4.2.25 Frequency of Smartphone Payments and Frequency of Recycling

The Chi-Square test of independence was used to determine whether there is an association between frequency of using Smartphone payments and considerations on recycling. The null hypothesis states that there is no association between frequency of using Smartphone payments and considerations on recycling while the alternative hypothesis states there is an association between frequency of using Smartphone payments and considerations on recycling. Result on Table 37 showed that there is a significant association between frequency of using Smartphone payments and considerations on recycling, $\chi 2 = 38.738, p < .001$.

Table 37. Chi-square Test on the association between frequency of using Smartphone payments and considerations on recycling

		Never	**Rarely**	**Sometimes**	**Often**	**Always**	**Total**	χ^2	p
How often do you consider sorting and recycling waste before disposal?	Never	0	0	3	13	14	30	38.738	.001
	Rarely	0	1	21	75	38	135		
	Sometimes	1	2	15	27	25	70		
	Often	0	3	0	10	5	18		
	Always	0	2	8	12	23	45		
Total		1	8	46	139	105	299		

This result implies that the frequencies of considerations on recycling vary notably between the frequency of using Smartphone payments. This could be interpreted as frequency of using Smartphone payments playing a role on how people consider sorting and recycling waste before disposal. Table 37 further showed that participants who often or always use smartphone for online payments will often or always consider sorting and recycling waste before disposal than those who never or rarely use it.

Chapter 5. Discussion and Recommendations

5.1 Exploring barriers and drivers of CMaaS and bottom-up mobility planning in Bahrain

5.1.1 Accessibility for Women

Starting with one of the core accessibility tenets of SDG Target 11.2, underscored in the text box below, the focus on the peculiarities of female passengers, within the ethnocultural context of Bahrain, merits a readjustment of how mobility planning is undertaken. Namely, and as covered in the thematic analysis findings in the previous section, the exposure of women towards the vagaries of potential transport offerings that might be incorporated into a MaaS journey, such as using a RH service run by a male operator, has in this study been shown to elicit an evident level of apprehension and mistrust. On similar grounds, the operating of mixed-gender public transport open to a diverse set of ethnic backgrounds, has also elicited responses that concur with contemporary literature (on uptake of PT by female passengers) emerging from neighboring countries in the Gulf accentuating the argument for long-standing appeals for gender-segregation in public transportation.

From a MLP perspective, the appeasing of such concerns through tailored female-centric urban and transport planning initiatives might prove crucial in undermining one of the key 'lock-in' and 'inertial' barriers that have long inhibited a transition of female passengers, potentially the most difficult to persuade, towards the use PT. Also, some of the gender-specific statistical correlations carried out in the preceding chapter, would confirm the embeddedness of female passengers within the current automobility dominant paradigm. An example of which can be gleaned from subsection 4.2.2 where female respondents have less acceptable towards the idea of introducing prohibitory policies on the unbridled use of SOVs which is also consistent with findings from the statistical analysis conducted under subsection 4.2.3, which highlights the inverse; namely, that female respondents ascribe higher importance towards fuel-efficiency standards of personally owned and operated vehicles which implicitly highlights a utilitarian rationale, and a certain degree of self-interest, in their sough-after desire of covering the most distance using a personally-owned vehicle while being able to keep refueling costs at a minimum. Altogether, both of the aforementioned statistical analyses remain consistent with the correlation

between ‘gender’ and ‘increased use of PT’ highlighting a higher proclivity and willingness amongst male, in contrast to female, passengers to increase their use of public transportation following the introduction of public transit prioritization schemes.

5.1.2 Technological Proficiency and Requisites

Centering the focus on the role of technology in not just emerging mobility schemes but also existing – what have often been regarded as – conventional transport modes helps illuminate on an evident gap and shortcoming in how SDG Target 11.2 has been framed and, more importantly, how it is currently being construed. A stark example of this lays in one of the key themes established as part of the thematic analysis that captures one of the essential ‘drivers’ behind why respondents often opt for RH services as opposed to traditional PT systems (notwithstanding the clear spatiotemporal advantage and convenience offered by RH services); namely, having full accessibility to, and navigability of, a transportation service via a smartphone app. Altogether, this along with the statistical correlations drawn in subsections 4.2.21, 4.2.22, and 4.2.23 draw a clear pattern of technological access and proficiency (in this case, frequency of smartphone transactions has been used as a proxy) positively correlating with respondents’ willingness to use PT, acceptance of SOV restrictions, and the level of importance respondents ascribe to fuel-efficiency standards, respectively.

Also, in aiming to nudge passengers towards multimodal thinking, possessing the required technological antecedents (smartphone, internet access, and required technological proficiency) is central to the notion of multioptionality considering that a lack in any of the aforementioned antecedents can simply render certain mobility options as inaccessible (and thus of no utility for certain passengers). Conversely, and with much greater implication for bottom-up mobility planning, the operating of outdated and archaically managed PT networks (those without an official online presence) can often, in and of itself, be enough to deter passengers from transitioning towards certain modes. Therefore, ensuring that demand-side transport offerings reflect the type of technologically-driven accessibility passengers are becoming more and more expecting of (as a consequence of rapid digitization and proliferation in smartphone ownership) is of paramount importance – especially considering newer generations (i.e., millennials) are more prone towards purchasing services, and equally goods, through electronic channels (Electronic Point of Sale) (Melović et al., 2021).

Although, more outdated channels need not be rendered as obsolete considering that any move towards a singular online channel might disenfranchise a host of subgroups within the population (i.e., those without the financial and/or technical capacity to obtain and use smartphones, tablets, laptops etc.).

5.1.3 Public Transportation: The Case for Soft Pull Measures

Findings from codes that have been established as part of the thematic analysis conducted in this study point towards gaps addressable through the formulation of soft intervention measures. Firstly, addressing the applicable nomenclature here is vital to the thrust of this analysis.

The adoption of, and contradistinction between, 'Soft' and 'Hard' measures can be through the adoption and categorization of different 'Pull' and 'Push' that aim to modulate and incentivize the uptake of specific transport modes. In this case, 'Soft' measures can range from running awareness campaigns on the perils of unsustainable mobility practices (Piras et al., 2022) to travel feedback programs (Richter et al., 2011) which, in essence, aim at the targeting key socio-psychological variables that are responsible for driving certain mobility behaviors.

Additionally, 'Soft' measures are also considered to be less costly vis-à-vis 'Hard' measures. As for 'Hard' measures, these constitute a package of interventions and policies that have been traditionally adopted in addressing transportation issues. Examples of 'Hard' measures range from transport pricing, prohibitions, and the establishment of infrastructural improvements (Richter et al., 2011).

Now, given the overwhelming reliance on 'Hard' policies in tackling limitations stemming from the current transport network – namely, expansion of road space through the building of additional parking spaces, road lanes, and flyovers – within Bahrain which, again, according to *Braess's Paradox* ends up on only having a counterproductive effect by making SOV usage within the country more lucrative, the extent of the unintended consequences of such unliteral actions remains an area that needs to be more vigorously scrutinized within the Kingdom.

Still, even if potential complementarities and interdependence between both 'Hard' and 'Soft' transportation policies remains an area that is also still in need of robust and rigorous scientific scrutiny (Bamberg et al., 2011); positive synergies between both sets of policies, when enrolled simultaneously, have been documented (Richter et al., 2011). As such, the coding of the

following in themes as part of thematic analysis offers, at the very least, preliminary impetus on why a shift towards a combination of both 'Hard' and 'Soft' policies are needed within the Kingdom if there was ever to be a meaningful drive towards nudging the populace towards a transition away from SOVs and to more sustainable transport offerings.

- PT > Drawbacks > *Unsafe* (60 References)
- PT > Drawbacks > *Inconvenient* (40 References)
- PT > Drawbacks > *Unclean* (40 References)
- PT > Drawbacks > *Overcrowded* (30 References)
- PT > Drawbacks > *Unaccessible* (26 References)
- PT > Drawbacks > *Not User-Friendly* (23 References)

Alluding back to the potential for respondents that might cited safety concerns on the basis of experiences from foreign countries which remain far from reflective of the realities of the available transport network here in Bahrain, the need for the adoption of 'Soft' measures – such as awareness campaigns – to appease and debunk such concerns becomes of paramount importance to ensure that negative connotations based on outlier cases (potentially also cases reported through the media from far-flung countries) are not generalized towards all PT systems.

One such approach can be gleaned from an initiative that has been rolled out in 2017 and publicized through various news outlets – the introduction of air condition bus stops.

Clearly targeting some of the responses coded under the 'Inconvenient' concerning weather conditions within the Kingdom, such a Hard-Pull measure (considering this as an infrastructural improvement intend to *pull* passengers towards using PT) can, at least in this case, be seen as being support with a Soft-Pull measure (where updates and information regarding such improvements have been broadcasted and disseminated through a variety of channels in order to keep both current and prospective PT users abreast of all the improvements being implemented).

5.1.4 Externalities: Acceptance or Rejection of Responsibility and Polluter Pays Principle (PPP)

Perceptions towards externalities stemming from private single-occupancy car use seem to be highly polarized as indications of Pro-Environmental Behavior seem pronounced in respondents that claim full, or some, responsibility for such externalities. Thus, acts such as recycling and cessation of unnecessary car trips, as already discussed, have been commonly referenced – and coded in the thematic analysis section – as ways in which respondents try to counterbalance the environmental footprint generated from overdependence on private car use. Additionally, the role of 'Multimodal Mindset – as originally articulated in the literature review section by Zijlstra et al. (2020) – seems to have been augmented, or rather supplanted, by exemplars of PEB since alternative transport modes (again, so-called 'Multioptionality') in Bahrain remain a constrictive limitation. This also seems to be reflected in the statistical analysis conducted on the 'association between Frequency of Public Transportation use and Consideration of Recycling' conducted under section 4.2.20, where those that reported using PT the least have been determined to be those most likely to recycle.

Conversely, a second-camp within the respondent base seems to starkly contrast with input provided from respondents whom acknowledged a certain degree of responsibility for car-related externalities – hence the term 'polarization'. Therein, a majority of responses visibly aim at deflecting responsibility towards other practices that, from the respondents' perspective, seem to be normalized by the notion that other people within Bahraini society are just as complicit in fostering such behavior. This type of acculturation, perceived lack of 'Hard' (i.e., car-competitive PT options) and 'Soft' (bottom-up involvement of commuters) strategies, and lack of empowerment seem to offer the bedrock, at least according to the findings from thematic analysis, on which rejection of responsibility for car-related externalities, on a societal scale, seems to be warranted and merited.

5.2 Exploring the sustainability implications for CMaaS from bottom-up bundle design

Under this subsection, a slight departure from the common leitmotif of this chapter – a focus on a variety of domains through which potential soft or hard nudging approaches can be adopted to push passengers towards the use of more sustainable transport modes – towards a more laissez-

faire approach in mobility planning is assumed. The rationale here is that bottom-up CMaaS bundling is to be assumed with minimal, to no intervention, from policymakers – irrespective of environmental consequences.

This hands-off, non-interventionist approach (Muto, 2017) more accurately mirrors the core ethos of the laissez-faire approach which has also been adopted within mobility studies to offer a sort of diagnostic on why certain sustainable mobility schemes fall short of achieving their intended objectives. One such study has been produced by Medeiros & Duarte (2013) that starkly illustrates how the adoption of a 'Soft-Pull' strategy, in the form of top-governmental officials (Presidents, Prime Ministers, Governors, and so on) publicly using and promoting cycling, has created a positive trend that was simply short-lived and overridden by a historical lack of systematic and structural strategies aimed at making bicycling a reliable transportation mode.

Focusing back on Bahrain, the fourth strategy enumerated under the '*Bahrain National Detail Land Use Plan*', although slightly lacking in substantive detail, underscores the need for diversification and integration of transportation modes. However, the progress that has been made towards that end, as evidenced by details on SDG Target 11.2 provided in the second Voluntary National Review (VNR) report prepared and submitted by Ministry of Sustainable Development in 2023, demonstrates the lingering preponderance of automobility within the country with 146KM of roads being either improved or developed. This starkly contrasted with other examples, pertaining to sustainable mobility options, that have been cited where the dedicated bike and e-bike lanes along with the highly-anticipated Metro project receiving plan announcements.

Therefore, the unfettered mobility planning approach, enshrined in the current laissez faire paradigm, especially when coupled with theme emerging from the Thematic analysis such as 'Denial of Responsibility and Downplaying of Impact' and the lack of reliable and alternative sustainable transport modes (so called 'Multioptionality') , threatens to fuel the specter of current SOV passengers simply transposing their unsustainable and car-centric mobility habits towards CMaaS bundling – this, in turn, will be manifest in the form of a disproportionate preference and dependence on car centered mobility options available within a CMaaS offering.

Collectively, this echoes cautionary calls made by authors such as Pritchard (2022) warning of the perils that might ensue from offering MaaS services in countries or regions with high levels of unsustainable car-centricity and without the implementation of support policies and initiatives.

Testament to such a risk can be gleaned from the responses gathered from survey towards the following question “Which of the following modes have you used in all the countries you have visited? (You can choose more than one)”.

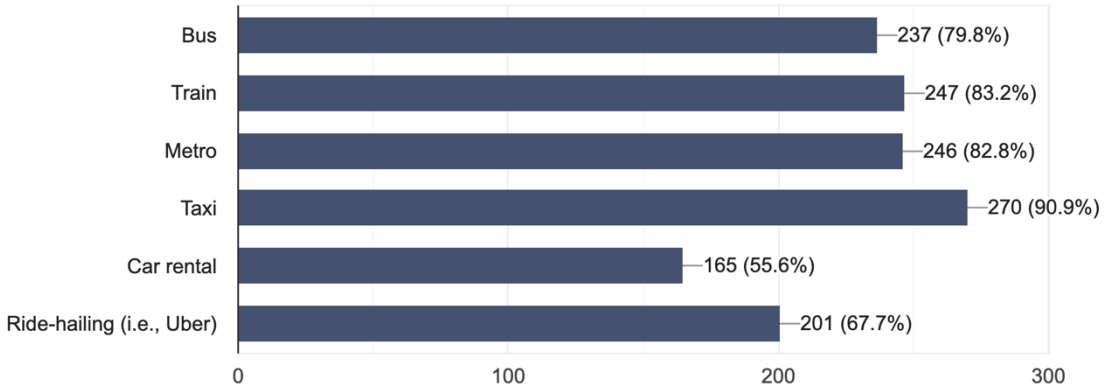


Figure 33. Modes of transport used by respondents when travelling abroad

Likewise, such an evident preference towards car-centric services such as traditional taxi services is also mirrored in the ‘extreme likeliness’ of adoption vis-à-vis other modes of urban transport when in a foreign country.

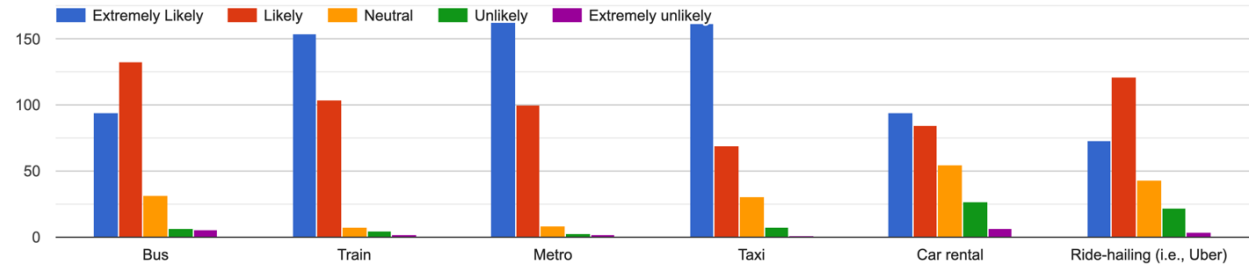


Figure 34. Modes of transport likely to adopted by passengers when travelling abroad

Even when viewed from a broader urban – systems dynamic – level, the current transportation updates provided under SDG 11 in the latest 2023 VNR report indicate a slight dominance of road-based feedback loops (in the form of continuous development and/or improvement carried out) that accentuate the attractiveness of private SOV usage and, as a consequence, car dependence (Pokharel et al., 2023). However, such an assessment is highly susceptible to change given that the report has also covered the ongoing Bahrain Metro project, expansion of the currently dominant public ‘Red’ bus services, along with the planned roll out of

dedicated lanes for cycling and e-bikes as alternative forms of more sustainable mobility currently in the pipeline; altogether, the totality of these ongoing initiatives would lend credence to the possibility of attaining sustainability objectives through the adoption of CMaaS schemes and a concomitant shift towards a transit-oriented society, as opposed to a car-dependent one, through such transit and active infrastructure-based feedback loops (Pokharel et al., 2023).

5.3 Determine the potential impact of CMaaS customization decisions on commuters' mode choice and uptake of PT

This study has demonstrated, and in many ways echoed, the variability in factors – those considered stemming from MaaS, socioeconomic, and attitudinal/behavioral factors (Cisterna et al., 2023) – involved in mediating and influence the potential modes of transportation chosen and prioritized by passengers in an unfettered, *laissez-faire*, transport environment. As discussed in the preceding subsection, without a meaningful and structural package of soft and hard transport strategies to push (or nudge) passengers away from the current status quo reflected by the dominant private automobile regime, the prophesied and transitional uptake of PT options as a result of MaaS schemes (irrespective of variant) would be met with a slim chance at best.

Of course, this assessment has been holistically determined through a review of a number of societal and policy problems. To recap, ethnoreligious qualms have emerged from the thematic, potentially explaining findings from subsequent statistical analyses, demonstrating a higher apprehension level amongst females compared to males towards the tackling of unfettered automobile use (SOV restrictions). Moreover, the same foundation is used as a departure point for criticisms levelled at existing PT systems (namely, red bus services in Bahrain) in that they do not offer gender segregation or any form of gender-specific protection towards female passengers. Secondly, socioeconomic factors, mainly perceptions of social order standing, have also emerged from the thematic findings the affirm preconceived notions towards PT systems in that they are offered as mode of transport for predominantly captive riders that excludes Bahrainis (which was further reaffirmed by most responses that view PT as a good second-option to have in the event an automobile is unavailable, even then use of rider-hailing services has also been cited as a viable alternative for such situations).

Thirdly, the lack of – or what might be argued to be a perceived lack of – reliable transportation options (from a temporal, spatial, and infrastructural viewpoint) emerged as another

factor undergirding the dominance of the private automobility within the Kingdom. All of which seem to be supported by the aforementioned responses showing an extreme likelihood of respondents using high-capacity transit options such as metro and rail services when travelling abroad – which can be predominately correlated to European countries considering that this is where a majority seem to have travelled to over the last 10 years (as shown in Figure 35). On the same note, the adoption of walking as form of both active mobility and, potentially FMLM solution, has been shown to be a more likely option for respondents, again, when travelling abroad. In essence, what this shows is that there is a contrast in PT and active mobility uptake when passengers are provided with reliable and diverse options – notwithstanding, exogenous factors such as harsh weather conditions that might also largely explain why active mobility options such as walking are not conducive within the climatic conditions within the GCC (Atef Elhamy Kamel, 2013).

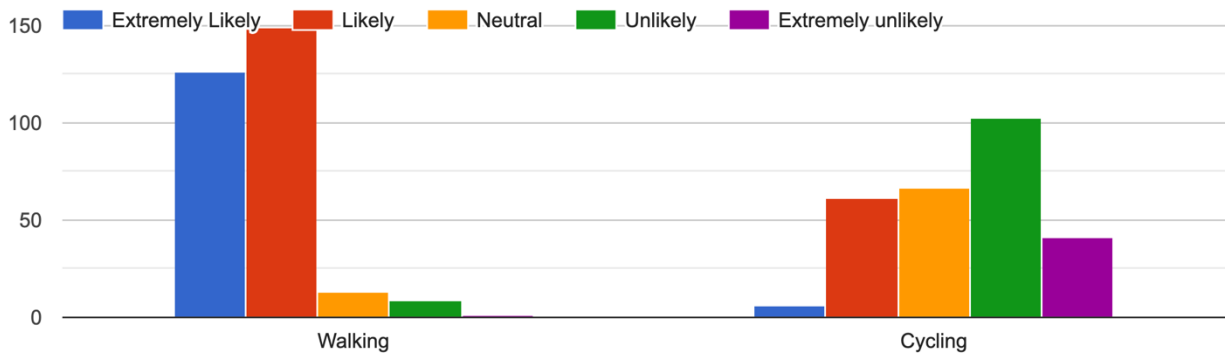


Figure 35. Active Mobility and likelihood of adoption by respondents when travelling abroad

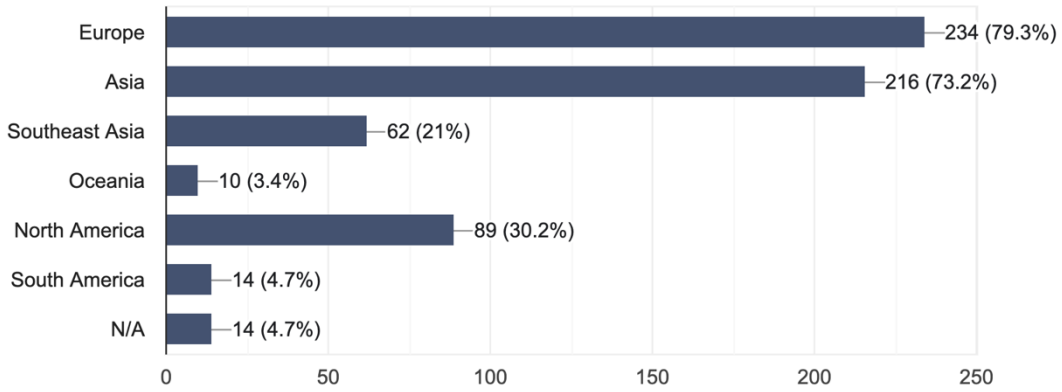


Figure 36. Regions visited by respondents over the last 10 years

Nevertheless, as mentioned in the results section, a key mediating factor that needs to also be acknowledge in the pursuit of an effective socio-technical transition towards more environmentally friendly mobility options lies in mooring or lock-in factors such as ‘culture’ and, by extension, ‘market user preference’ (Geels, 2011). Thus, a core limiting factor that might undermine the accurate extrapolation of potential passenger mobility preference based on travel behavior and preference from other countries – namely, European cities where approximately 80% of respondents seem to have visited and experienced non-ICEV urban mobility in – is that respondents in those particular cases might have been compelled on basis of not wanting to stand out from the masses (or majority) by adopting mobility habits that might be viewed as divergent from those of the local culture. What this engenders is a form of short-term acculturation towards different, potentially more sustainable, transport modes on the basis of community-based peer pressure (all of which might not necessarily mirror how respondents will accept, and use, similar PT options once they are introduced in their home country – i.e., the Bahrain Metro or GCC Railway Network).

Chapter 6. Conclusion

6.1.1 Practical contributions of the study

First and foremost, the reconciliation of the MaaS concept, in its most fundamental and overarching form, with key socio-technical peculiarities found within the Kingdom of Bahrain has shed light on areas of both incongruency and potential through which a likely shift towards sustainable urban mobility practices, through the conduit MaaS, can possibly be achieved within the Kingdom. To recap, the nexus between ethnoreligious/sociocultural variables, transport policies, and modal/service offerings under MaaS remains an area prime for further exploration – and as such, still remains a visible chasm within the existing MaaS scholarship – and rigorous analysis as can be deduced from preliminary findings originating from this study. Again, from a policy-centered perspective, the collection of stated preference data through a bottom-up participatory approach also helps in establishing the rationale and mechanism for utilizing 'Collaborative Backcasting' as an alternative pathway in transportation planning within Bahrain. The utility of adopting such a participative policy approach is that it allows for the calibration and tailoring of policies towards sustainable transport modes that are most accepted by passengers, based on the aforementioned variables, and that would aid towards the attainment of national and, in the case of UN SDG Target 11.2, supranational sustainable mobility objectives.

Chapter 7. Recommendations

7.1.1 Theoretical contributions of the study

Considering that the entirety of the study centered on an emergent concept (Mobility-as-a-Service) that, as the study was progressing, was constantly morphing and extending towards divergent conceptualizations, allowed for the capturing of distinct MaaS-like variants and concepts (as identified and discussed in the literature review). As such, this paved the way towards addressing one of the fundamental critiques levelled at this topic during the proposal external review process in that such schemes are inconducive for analysis within a Bahrain-centered focused given the lack of alternative urban transport modes and an overdependence on private car use. Still, the emergence of the refined MaaS conceptualization, in form of MaaS-Lite by Pickford & Chung (2019), provided the initial impetus for a reframing of the MaaS concept towards country-specific modal offerings and characteristics. Likewise, further research into the literature, revealed that multiple re-conceptualizations have already been scope to reflect country-specific or industrial-specific peculiarities which further broadened the conceptual remit of MaaS from a concept with potentially positive ramifications for the environment towards a concept that might also be able to, through secondary effects, stimulate sustainable behavior and practices in other industries such as tourism and freight.

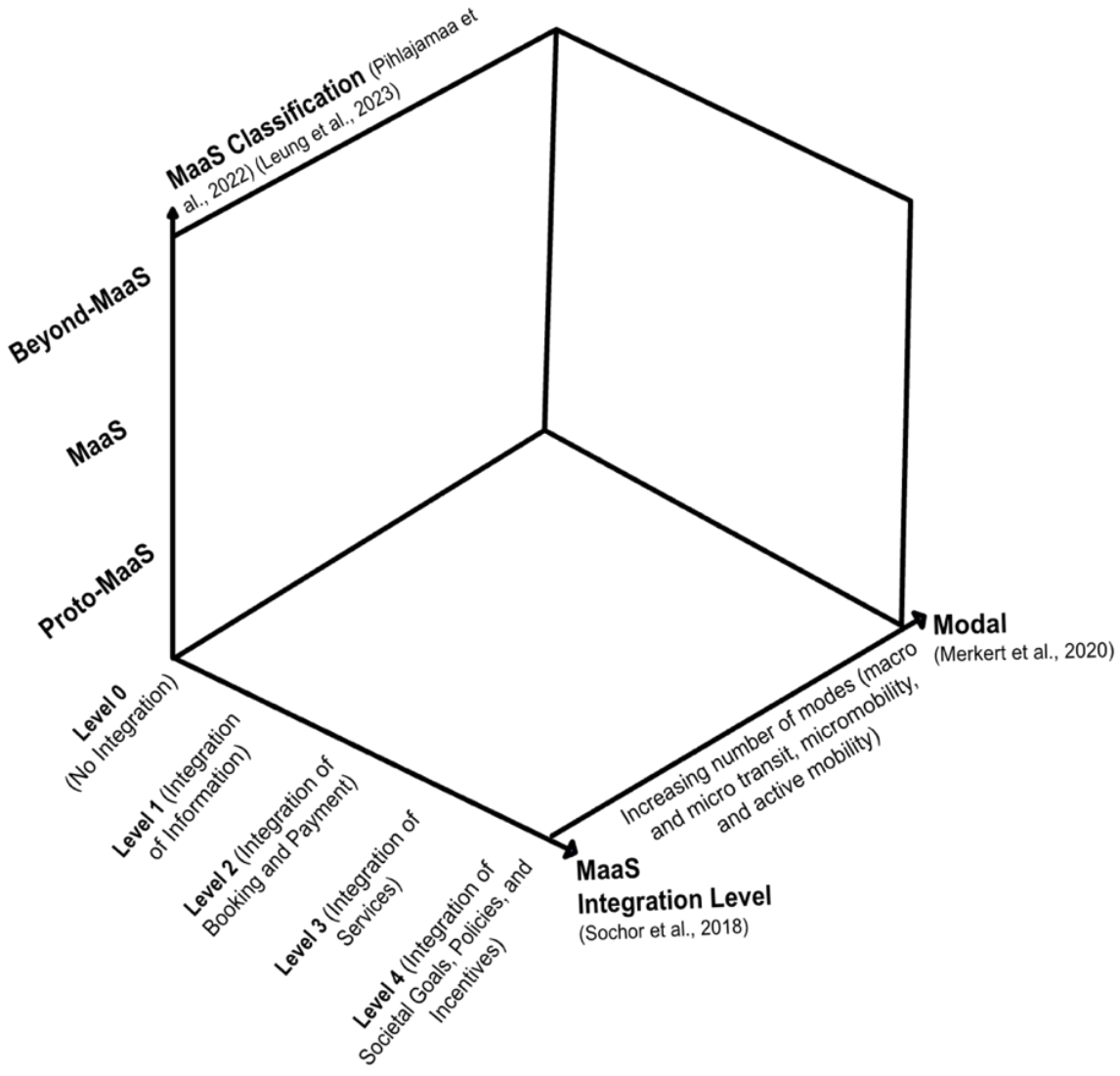


Figure 37. Proposed 3D model for capturing MaaS heterogeneity

Inspired by the framework developed by Merkert et al. (2020), originally intended to illustrate the institutional dimensions of public transport collaboration, a modified three-dimensional model which incorporates the commonly adopted MaaS integration levels developed by Sochor et al. (2018) and MaaS classes – Proto-MaaS (Pihlajamaa et al., 2022) and Beyond-MaaS (Leung et al., 2023) – is proposed (shown in Figure 38) as a more inclusive tool covering the wide spectrum of MaaS variants demonstrated in this study.

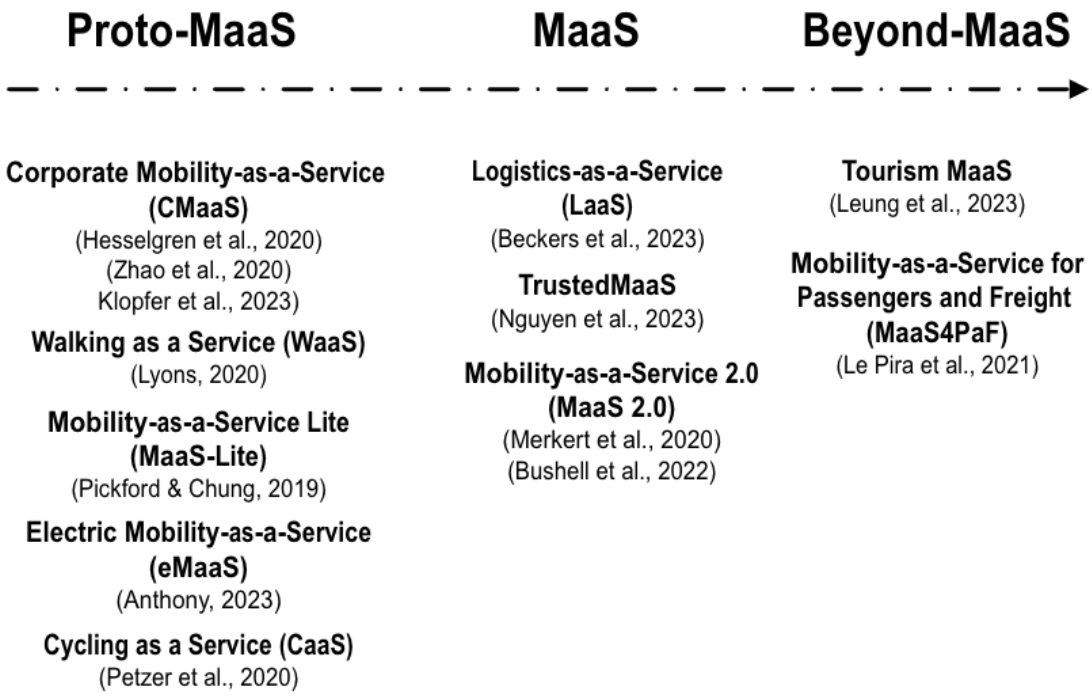


Figure 38. MaaS Classification

Although, some overlap in the proposed dimensions (i.e., Proto-MaaS schemes would commonly be correlated with limited modal options) is acknowledged, the inclusion of Beyond-MaaS to account for cross-sectoral MaaS schemes intertwined with other industries such as tourism (Tourism MaaS) and logistics (MaaS4PaF) is one of the key elements not captured by the topology proposed by (Sochor et al., 2018). Thus, to illustrate the utility of this 3-D model, a level 4 Tourism MaaS scheme (irrespective of modal variety) can be expected to aid in the fulfilment of societal goals across both the mobility realm (i.e., SDG Target 11.2) and the realm of tourism (i.e., SDG Target 12.b or EU Strategy for Sustainable Tourism).

7.1.2 Corporate Mobility as a Service (CMaaS) + University Mobility as a Service: The Emergence of Commute Mobility as a Service (C-MaaS)

Even though the initial focus and scope of this study centered on a refined conception of MaaS, at least from a modal perspective – hence the incorporation of the *MaaS Lite* term in the study title. The focus on a single journey type – namely, commuting – has also been adopted later on in the

study as a way to further refine this study. Although this is by no means bespoke as this has been established as the central tenet behind the Corporate Mobility as a Service (CMaaS) variant, this study actually broadens the scope of this conception to encompass not only workplace employees but higher education students who are above 18 years old and hence are eligible to drive based on Bahrain's traffic law. As such, the term Commute Mobility as a Service (C-MaaS) emerges as a crossover between Corporate Mobility as a Service (CMaaS) and, the less renowned, University as a Service (UaaS) MaaS variants.

7.2 Future Work and Limitations

The focus on a certain population subgroup – namely, commuters within this study – does not offer findings that are generalizable and cross-sectional towards the wider, and more diverse demographics within the, population. Thus, the extension of data collection beyond 3rd and 4th degree connections and towards a more randomized approach could possibly yield findings that are more reflective of the overall population. Similarly, the incorporation of questionnaire components that assess respondents' preference based on mobility offerings in other countries does not necessarily offer implications that immediately translate back to the Bahraini context. Conversely, offering a questionnaire that overlaps between questions relating to PT usage and perceptions here in Bahrain and from foreign countries might unnecessarily cloud the analysis as respondents might, explicitly or implicitly, offer inputs/responses that conflate between the two. Additionally, the exclusion of sensitive personal data such as income level prevented the analysis of income levels on potential user uptake and/or acceptance of PT, active mobility, SOV policies – a key variable in a number of seminal publications. Lastly, the current expansion of cycling networks, bus services, and introduction of the Bahrain Metro should offer more ample ground for conducting MaaS studies with, the more reliable, revealed preference data as opposed to stated preference data.

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Appendices

Appendix A: PT Benefits

Accessibility

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 1 reference coded [0.17% Coverage]

Reference 1 - 0.17% Coverage

Access for everyone

Allows for Other Tasks

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 3 references coded [0.50% Coverage]

Reference 1 - 0.17% Coverage

Having time to focus on other things.

Reference 2 - 0.17% Coverage

It frees up time for me to do other things.

Reference 3 - 0.17% Coverage

For family trips, it can actually be quite nice since it offers more time for us to chat with one another.

Convenience

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 55 references coded [8.43% Coverage]

Reference 1 - 0.06% Coverage

It is convenient

Reference 2 - 0.03% Coverage

I only do it abroad because it’s convenient, well-connected

Reference 3 - 0.17% Coverage

Less worrying about the road and more comfortable

Reference 4 - 0.08% Coverage

comfort

Reference 5 - 0.17% Coverage

Especially in unfamiliar locations, this removes the burden of having to drive or navigate in unknown areas.

Reference 6 - 0.03% Coverage

easy

Reference 7 - 0.17% Coverage

Not having to drive.

Reference 8 - 0.17% Coverage

Depending on the type of public transport. Abroad, using public transport is a more practical, cheaper, and faster way of getting around.

Reference 9 - 0.17% Coverage

Although not the case here in Bahrain. The time element and the hassle of not having to drive.

Reference 10 - 0.17% Coverage

From my experience travelling abroad, I feel that it is a more practical and cost-effective way of getting around.

Reference 11 - 0.17% Coverage

Not having to drive.

Reference 12 - 0.05% Coverage

Comfort

Reference 13 - 0.17% Coverage

Easy to find

Reference 14 - 0.06% Coverage

Abroad, I find it more convenient.

Reference 15 - 0.17% Coverage

It takes away the burden of having to drive.

Reference 16 - 0.17% Coverage

Travelling long distances can be a lot more convenient using public transport

Reference 17 - 0.17% Coverage

Good option when in areas that are not suited for driving.

Reference 18 - 0.17% Coverage

not bearing the responsibility of knowing the directions

Reference 19 - 0.17% Coverage

Good in places where driving and navigation are challenging

Reference 20 - 0.17% Coverage

No tension

Reference 21 - 0.17% Coverage

Good for place I don’t want to drive to.

Reference 22 - 0.17% Coverage

Not having to put up with the mental stress that comes with navigating through heavy traffic.

Reference 23 - 0.17% Coverage

There isn’t anything I would consider as a benefit in contrast to using my own car. maybe only not having to put up with refueling, repairs, insurance, etc.

Reference 24 - 0.17% Coverage

Sightseeing opportunities.

Reference 25 - 0.17% Coverage

Not having to drive myself.

Reference 26 - 0.17% Coverage

Easy to find

Reference 27 - 0.17% Coverage

Not having to drive and put up with the hassle of traffic.

Reference 28 - 0.11% Coverage

In certain circumstances, such as when being in a foreign country, it can be the most practical option in terms of price and distance.

Reference 29 - 0.17% Coverage

Good for covering long distances in an efficient manner.

Reference 30 - 0.17% Coverage

Airport transfers

Reference 31 - 0.17% Coverage

Mostly use it places or countries where I feel uncomfortable driving in.

Reference 32 - 0.17% Coverage

Good for limited access or car free zones.

Reference 33 - 0.17% Coverage

No need to worry about refueling or managing through traffic.

Reference 34 - 0.17% Coverage

Good for places I am visiting for the first time.

Reference 35 - 0.17% Coverage

Better option when travelling to restricted areas - car free zones or places with congestion tax.

Reference 36 - 0.17% Coverage

It’s good if I don’t know the directions

Reference 37 - 0.17% Coverage

Door to door service

Reference 38 - 0.17% Coverage

Use instead of my car to go airport

Reference 39 - 0.17% Coverage

Easy reach airport

Reference 40 - 0.17% Coverage

Good for going to airport

Reference 41 - 0.17% Coverage

For reliable services, it can help eliminate the need and requirements involved in owning a car which, over time, can accumulate and become costly.

Reference 42 - 0.17% Coverage

It takes away the need of having to navigate through unfamiliar territory.

Reference 43 - 0.17% Coverage

No need to rent car

Reference 44 - 0.17% Coverage

No traffic stress

Reference 45 - 0.17% Coverage

Avoid traffic

Reference 46 - 0.17% Coverage

Good when traveling

Reference 47 - 0.17% Coverage

No need for personal car

Reference 48 - 0.17% Coverage

No need to refuel and bother with parking.

Reference 49 - 0.17% Coverage

Faster and more convenient for long journeys .

Reference 50 - 0.17% Coverage

Good when traveling

Reference 51 - 0.17% Coverage

Drop you door to door

Reference 52 - 0.17% Coverage

Easy to reach crowded places

Reference 53 - 0.17% Coverage

No need for personal car

Reference 54 - 0.17% Coverage

Most convenient way of travelling when travelling between many countries.

Reference 55 - 0.17% Coverage

No traffic stress

Exploration

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 10 references coded [1.46% Coverage]

Reference 1 - 0.08% Coverage

Trying something new

Reference 2 - 0.11% Coverage

experience travel public transport

Reference 3 - 0.17% Coverage

I find this beneficial in situations where I want to explore places I haven’t been to before.

Reference 4 - 0.10% Coverage

change of scenery

Reference 5 - 0.17% Coverage

Useful when in a new country or place.

Reference 6 - 0.17% Coverage

Good when trying to explore new routes/locations.

Reference 7 - 0.17% Coverage

Really good when in a foreign country for a short period of time.

Reference 8 - 0.17% Coverage

Good for exploring new areas and sightseeing.

Reference 9 - 0.17% Coverage

Good for places I am visiting for the first time.

Reference 10 - 0.17% Coverage

It helps me familirise myself with different parts of the country.

Low Cost

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 76 references coded [10.81% Coverage]

Reference 1 - 0.17% Coverage

Cheap

Reference 2 - 0.01% Coverage

inexpensive

Reference 3 - 0.07% Coverage

doesn’t cost much

Reference 4 - 0.17% Coverage

cheaper

Reference 5 - 0.04% Coverage

Cost cutting

Reference 6 - 0.17% Coverage

Cheap

Reference 7 - 0.17% Coverage

Cheaper

Reference 8 - 0.08% Coverage

- Spending less on fuel on my personal car

Reference 9 - 0.16% Coverage

A cheaper mode of transport

Reference 10 - 0.04% Coverage

Saving money

Reference 11 - 0.17% Coverage

Less costly

Reference 12 - 0.17% Coverage

Cheap

Reference 13 - 0.17% Coverage

Cheaper

Reference 14 - 0.17% Coverage

reasonable prices

Reference 15 - 0.17% Coverage

Less cost

Reference 16 - 0.17% Coverage

cheap

Reference 17 - 0.17% Coverage

Less cost

Reference 18 - 0.17% Coverage

Cost efficiency

Reference 19 - 0.05% Coverage

Price

Reference 20 - 0.17% Coverage

Cheaper than having a car

Reference 21 - 0.17% Coverage

Cost

Reference 22 - 0.17% Coverage

Cost

Reference 23 - 0.17% Coverage

Saving petrol

Reference 24 - 0.17% Coverage

Cost

Reference 25 - 0.17% Coverage

Cheap

Reference 26 - 0.17% Coverage

Cost

Reference 27 - 0.17% Coverage

Cheaper.

Reference 28 - 0.04% Coverage

Lower cost

Reference 29 - 0.04% Coverage

cost effective

Reference 30 - 0.17% Coverage

Price is good.

Reference 31 - 0.17% Coverage

Low price

Reference 32 - 0.17% Coverage

Saving fuel.

Reference 33 - 0.17% Coverage

Helps save fuel

Reference 34 - 0.06% Coverage

Cheaper

Reference 35 - 0.02% Coverage

Price

Reference 36 - 0.17% Coverage

The low prices.

Reference 37 - 0.17% Coverage

cheaper than other options

Reference 38 - 0.17% Coverage

Depending on the type of public transport. Abroad, using public transport is a more practical, cheaper, and faster way of getting around.

Reference 39 - 0.04% Coverage

the cost factor.

Reference 40 - 0.17% Coverage

From my experience travelling abroad, I feel that it is a more practical and cost-effective way of getting around.

Reference 41 - 0.17% Coverage

None that I can think of. May be that it is cheap only.

Reference 42 - 0.17% Coverage

affordable for everyone

Reference 43 - 0.17% Coverage

Lower Petrol cost

Reference 44 - 0.17% Coverage

saving money

Reference 45 - 0.17% Coverage

Affordable

Reference 46 - 0.17% Coverage

The cost is often cheap

Reference 47 - 0.17% Coverage

More economical

Reference 48 - 0.17% Coverage

Cost and efficiency

Reference 49 - 0.17% Coverage

Saving in fuel cost

Reference 50 - 0.17% Coverage

Cheaper

Reference 51 - 0.17% Coverage

Affordable

Reference 52 - 0.17% Coverage

In my country (England, UK), it will often cost significantly less than owning and maintaining a car.

Reference 53 - 0.02% Coverage

Cost

Reference 54 - 0.17% Coverage

Low costs

Reference 55 - 0.17% Coverage

Save petrol money

Reference 56 - 0.08% Coverage

I consider it a more cost and time efficient way of travelling.

Reference 57 - 0.17% Coverage

In many cases where the service is subsidised, it can be significantly cheaper than owning a car especially in countries with gas/emissions tax etc.

Reference 58 - 0.17% Coverage

cost effectiveness

Reference 59 - 0.07% Coverage

the cost and speed of the service are certainly two components I would consider.

Reference 60 - 0.17% Coverage

Reasonable pricing

Reference 61 - 0.05% Coverage

it can save time and money.

Reference 62 - 0.17% Coverage

Cheaper

Reference 63 - 0.17% Coverage

There isn’t anything I would consider as a benefit in contrast to using my own car. maybe only not having to put up with refueling, repairs, insurance, etc.

Reference 64 - 0.17% Coverage

Less expensive

Reference 65 - 0.11% Coverage

In certain circumstances, such as when being in a foreign country, it can be the most practical option in terms of price and distance

Reference 66 - 0.17% Coverage

Affordable

Reference 67 - 0.17% Coverage

Costs less compared to driving and owning a car.

Reference 68 - 0.17% Coverage

For reliable services, it can help eliminate the need and requirements involved in owning a car which, over time, can accumulate and become costly.

Reference 69 - 0.17% Coverage

Cost and more economical for long distances.

Reference 70 - 0.17% Coverage

Reduce petrol usage

Reference 71 - 0.17% Coverage

Saving money

Reference 72 - 0.17% Coverage

Affordable

Reference 73 - 0.17% Coverage

A cheaper way of getting around when on trips.

Reference 74 - 0.17% Coverage

Affordable for everyone

Reference 75 - 0.17% Coverage

Don’t have to search for parking or pay parking fees

Reference 76 - 0.17% Coverage

Often cheaper since they are heavily subsidized if not fully free in certain countries.

More Sustainable

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 16 references coded [1.44% Coverage]

Reference 1 - 0.09% Coverage

environment friendly

Reference 2 - 0.02% Coverage

Sustainability

Reference 3 - 0.08% Coverage

- Less emissions caused by personal car

Reference 4 - 0.03% Coverage

Using public transport will reduce the pollution

Reference 5 - 0.07% Coverage

aving the environment

Reference 6 - 0.17% Coverage

Environmental friendliness

Reference 7 - 0.10% Coverage

less impact on the environment.

Reference 8 - 0.11% Coverage

better for the environment.

Reference 9 - 0.05% Coverage

CO2 emissions

Reference 10 - 0.06% Coverage

a more sustainable option.

Reference 11 - 0.10% Coverage

Possibly to benefit the environment.

Reference 12 - 0.10% Coverage

reduce. Environmental mpact.

Reference 13 - 0.08% Coverage

less bolution

Reference 14 - 0.05% Coverage

It is good for the environment

Reference 15 - 0.17% Coverage

Good for the environment

Reference 16 - 0.17% Coverage

Public transport leads to less air pollution

No Need for Parking

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 24 references coded [4.00% Coverage]

Reference 1 - 0.17% Coverage

no need to find parking

Reference 2 - 0.17% Coverage

No need to look for parking

Reference 3 - 0.17% Coverage

No serching for parking space

Reference 4 - 0.17% Coverage

Not worrying about parking

Reference 5 - 0.17% Coverage

No need to park

Reference 6 - 0.17% Coverage

Not thinking about parking

Reference 7 - 0.17% Coverage

Not having to find parking

Reference 8 - 0.17% Coverage

Not having to bother with finding parking.

Reference 9 - 0.17% Coverage

I don’t need to find a parking spot for my vehicle.

Reference 10 - 0.17% Coverage

No parking issues

Reference 11 - 0.17% Coverage

No parking issues

Reference 12 - 0.17% Coverage

No Need of parking

Reference 13 - 0.17% Coverage

For certain journeys, within central Manama, where parking is difficult public transport helps.

Reference 14 - 0.17% Coverage

No worries about parking

Reference 15 - 0.17% Coverage

Parking issues

Reference 16 - 0.17% Coverage

Good for places that don’t have enough or available parking (City Center during Black Friday will be a good example).

Reference 17 - 0.17% Coverage

No parking problems

Reference 18 - 0.17% Coverage

No parking needs

Reference 19 - 0.17% Coverage

Don’t to bother with parking.

Reference 20 - 0.17% Coverage

Good when no parking available

Reference 21 - 0.17% Coverage

Don’t have to search for parking or pay parking fees

Reference 22 - 0.17% Coverage

With public transport, parking and driving become less of an issue.

Reference 23 - 0.17% Coverage

No worries about parking

Reference 24 - 0.17% Coverage

Parking becomes less of an issue especially in highly congested cities or business districts such as the diplomatic area and central Manama etc.

Provides Back up

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 7 references coded [1.17% Coverage]

Reference 1 - 0.17% Coverage

Good when my car not working

Reference 2 - 0.17% Coverage

A good alternative to driving if a car isnt available and affordable

Reference 3 - 0.17% Coverage

Good to have as an option during emergencies but definitely not as a long term option.

Reference 4 - 0.17% Coverage

Use when my car in garage

Reference 5 - 0.17% Coverage

If taxi expensive

Reference 6 - 0.17% Coverage

Good choice when my car in maintenan

Reference 7 - 0.17% Coverage

Good when my car in garage

Safe

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 1 reference coded [0.03% Coverage]

Reference 1 - 0.03% Coverage

It is safe,

Socializing

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 2 references coded [0.33% Coverage]

Reference 1 - 0.17% Coverage

Meeting people

Reference 2 - 0.17% Coverage

For family trips, it can actually be quite nice since it offers more time for us to chat with one another.

Speed (Fast)

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 24 references coded [3.32% Coverage]

Reference 1 - 0.05% Coverage

Time

Reference 2 - 0.05% Coverage

faster

Reference 3 - 0.17% Coverage

Depending on the type of public transport. Abroad, using public transport is a more practical, cheaper, and faster way of getting around.

Reference 4 - 0.17% Coverage

Saving time

Reference 5 - 0.17% Coverage

Reach destination quick

Reference 6 - 0.17% Coverage

Saving time

Reference 7 - 0.17% Coverage

Reach fast

Reference 8 - 0.17% Coverage

Depends on which public transport system we are referring to, in some countries the network is so reliable and comprehensive that it might drive people to seriously consider giving up their private car.

Reference 9 - 0.03% Coverage

speed

Reference 10 - 0.17% Coverage

Faster

Reference 11 - 0.08% Coverage

I consider it a more cost and time efficient way of travelling.

Reference 12 - 0.07% Coverage

the cost and speed of the service are certainly two components I would consider.

Reference 13 - 0.05% Coverage

it can save time and money.

Reference 14 - 0.17% Coverage

Faster

Reference 15 - 0.17% Coverage

Travel quickly

Reference 16 - 0.17% Coverage

Faster no traffic

Reference 17 - 0.17% Coverage

Does it get me to where I need to be faster than other options is the first thing I would consider.

Reference 18 - 0.17% Coverage

Save time

Reference 19 - 0.17% Coverage

Faster

Reference 20 - 0.17% Coverage

Quick

Reference 21 - 0.17% Coverage

Save time

Reference 22 - 0.17% Coverage

Time saving

Reference 23 - 0.17% Coverage

Faster

Reference 24 - 0.17% Coverage

Depending on the type of public transport system but not being stuck in traffic is certainly a plus.

Traffic Reduction

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 15 references coded [1.63% Coverage]

Reference 1 - 0.03% Coverage

cutting down traffic time

Reference 2 - 0.04% Coverage

Using public transport will reduce the pollution and traffic jums.

Reference 3 - 0.06% Coverage

Lesser congestion

Reference 4 - 0.08% Coverage

reduces traffic congestion.

Reference 5 - 0.08% Coverage

it minimizes traffic

Reference 6 - 0.17% Coverage

Reduce traffic

Reference 7 - 0.17% Coverage

I feel that I am contributing towards lowering congestion.

Reference 8 - 0.17% Coverage

When used collectively, it reduces the number of cars on the road.

Reference 9 - 0.17% Coverage

Less traffic

Reference 10 - 0.06% Coverage

Reduce congestion

Reference 11 - 0.08% Coverage

Less traffic

Reference 12 - 0.17% Coverage

No privet car problems

Reference 13 - 0.04% Coverage

nd for reducing traffic

Reference 14 - 0.17% Coverage

Less traffic

Reference 15 - 0.17% Coverage

Removes cars from the road.

Appendix B: PT Drawbacks

Does not accommodate locals

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 6 references coded [0.61% Coverage]

Reference 1 - 0.10% Coverage

It does not accommodate locals well, it’s a lot less common from a sociocultural perspective,

Reference 2 - 0.05% Coverage

its used mostly by expats

Reference 3 - 0.17% Coverage

Buses are used by expat labourers. This might be a discourging factor of using PT by Bahrainis of high to medium income.

Reference 4 - 0.06% Coverage

not socially acceptable.

Reference 5 - 0.06% Coverage

Used by labour workers

Reference 6 - 0.17% Coverage

Not suited for Bahrainis.

High Cost

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 4 references coded [0.67% Coverage]

Reference 1 - 0.17% Coverage

Cost more money

Reference 2 - 0.17% Coverage

Expensive if private

Reference 3 - 0.17% Coverage

Cost not fixed

Reference 4 - 0.17% Coverage

Expensive

Inconvenient

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 40 references coded [5.41% Coverage]

Reference 1 - 0.03% Coverage

You also don’t have the flexibility of leaving a place when you want.

Reference 2 - 0.17% Coverage

Weather and distance.

Reference 3 - 0.09% Coverage

Inconvenient location

Reference 4 - 0.09% Coverage

The possibility of the lack of perks like A/C

Reference 5 - 0.05% Coverage

The weather condition in Bahrain is not comftable especilly its hot for the entire year.

Reference 6 - 0.17% Coverage

Time of bus stops

Reference 7 - 0.14% Coverage

Lack of flexibility in terms of time schedules

Reference 8 - 0.17% Coverage

Not available door to door

Reference 9 - 0.07% Coverage

Not suited for family with kids.

Reference 10 - 0.17% Coverage

Lack of flexibility

Reference 11 - 0.17% Coverage

Not family friendly especially with young children.

Reference 12 - 0.17% Coverage

Not convenient due the schedule of buses and due severe weather.

Reference 13 - 0.08% Coverage

whether

Reference 14 - 0.17% Coverage

In summer too hot

Reference 15 - 0.17% Coverage

Time, speed and freedom

Reference 16 - 0.17% Coverage

Its coverage area, time required, air conditioning (in the hot Bahraini summer especially)

Reference 17 - 0.13% Coverage

hassle of waiting and walking to / from poorly placed stops

Reference 18 - 0.10% Coverage

A.C. conditions, uncomfortable conditions such as rocking of bus,

Reference 19 - 0.05% Coverage

Being uncomfortable

Reference 20 - 0.10% Coverage

the drop off areas are sometimes not exactly at the location i want to go

Reference 21 - 0.05% Coverage

The heat

Reference 22 - 0.10% Coverage

The availability

Reference 23 - 0.17% Coverage

Cannot expect female passengers to walk in this weather to the nearest stop/station.

Reference 24 - 0.12% Coverage

I have to plan around the timing of the public transport, I have to plan around where the pickup/drop off locations are,

Reference 25 - 0.17% Coverage

Personally, I would avoid them during family travel since they are impractical.

Reference 26 - 0.17% Coverage

The journey time and distance to destination from drop off

Reference 27 - 0.17% Coverage

The weather in Bahrain is not fit for anything other than direct door to door options.

Reference 28 - 0.17% Coverage

Not a practical option for a family with small children.

Reference 29 - 0.17% Coverage

Doesn’t stop everywhere

Reference 30 - 0.17% Coverage

The timing

Reference 31 - 0.12% Coverage

distance to stops/stations.

Reference 32 - 0.17% Coverage

Don’t reach place you want exactly

Reference 33 - 0.17% Coverage

Time flexibility

Reference 34 - 0.17% Coverage

Loud people

Reference 35 - 0.17% Coverage

Too loud

Reference 36 - 0.17% Coverage

Timing

Reference 37 - 0.17% Coverage

Not flexible timing

Reference 38 - 0.07% Coverage

Infrequent services

Reference 39 - 0.17% Coverage

Dont reach everywhere

Reference 40 - 0.17% Coverage

Need time to find or reach your home

Lack of Gender Segregation

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 3 references coded [0.50% Coverage]

Reference 1 - 0.17% Coverage

Don’t think the bus service here in Bahrain is made for female passengers.

Reference 2 - 0.17% Coverage

Not safe for women

Reference 3 - 0.17% Coverage

Not safe for women alone

Lack of Privacy

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 16 references coded [2.05% Coverage]

Reference 1 - 0.17% Coverage

Other people on board and privacy

Reference 2 - 0.17% Coverage

Safety and privacy might be an issue especially for women.

Reference 3 - 0.17% Coverage

Lack of privacy and security and cleanliness

Reference 4 - 0.17% Coverage

Riding with strangers.

Reference 5 - 0.17% Coverage

Limited privacy.

Reference 6 - 0.17% Coverage

Lack of privacy, security, and clean facilities.

Reference 7 - 0.07% Coverage

privacy

Reference 8 - 0.04% Coverage

I don’t have my provqcy in my own vehicle.

Reference 9 - 0.02% Coverage

privacy

Reference 10 - 0.17% Coverage

Safety, cleanliness, and privacy.

Reference 11 - 0.17% Coverage

Lack of privacy and security.

Reference 12 - 0.05% Coverage

Lack of privacy

Reference 13 - 0.17% Coverage

Riding with strangers

Reference 14 - 0.17% Coverage

Privacy is big issue in public transportation

Reference 15 - 0.12% Coverage

lack of privacy are my first and foremost concerns.

Reference 16 - 0.08% Coverage

Lack of privacy

Lack of Support

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 8 references coded [1.14% Coverage]

Reference 1 - 0.17% Coverage

Lack of support and infrastructure.

Reference 2 - 0.17% Coverage

Reliability of the service and the facilities tend to be underdeveloped here in Bahrain.

Reference 3 - 0.07% Coverage

poor stops and overall infrastructure

Reference 4 - 0.17% Coverage

Poorly funded network (we have bus stops located in empty areas without any shading, seating or an actual stop)

Reference 5 - 0.17% Coverage

Although clear improvements have been made to the Red bus service operating in the Kingdom over the last 5 years that I have been around, I notice that a number of areas remain underserved.

Reference 6 - 0.17% Coverage

Lack of coordination and planning with other modes often means that another transport mode is needed to get to and from stations.

Reference 7 - 0.06% Coverage

lack of proper infrastructure

Reference 8 - 0.17% Coverage

Poorly maintained and unclean cabins and stops will deter a lot of passengers.

Not User-friendly

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 23 references coded [2.54% Coverage]

Reference 1 - 0.06% Coverage

Unsure how to read the destinations

Reference 2 - 0.17% Coverage

Locating and getting to the nearest stop or station is often a challenge.

Reference 3 - 0.17% Coverage

Language barrier

Reference 4 - 0.17% Coverage

Working out how the system functions (buying a ticket etc.) can be quite daunting

Reference 5 - 0.08% Coverage

Difficult to understand.

Reference 6 - 0.14% Coverage

the information is difficult to understand and I find this is more the case in foreign countries that speak a different language.

Reference 7 - 0.17% Coverage

Most of the time I struggle in navigating the service.

Reference 8 - 0.17% Coverage

Using the service can be challenging

Reference 9 - 0.04% Coverage

service friendliness

Reference 10 - 0.04% Coverage

Language barrier

Reference 11 - 0.08% Coverage

lack of clarity in travel information.

Reference 12 - 0.04% Coverage

How easy it is to use the system

Reference 13 - 0.05% Coverage

Lack of clear information

Reference 14 - 0.08% Coverage

Difficult travel instructions

Reference 15 - 0.06% Coverage

Unclear information

Reference 16 - 0.12% Coverage

Lack of clear information (stops and operating schedules)

Reference 17 - 0.17% Coverage

Difficult to navigate through the system to figure out the stops, routes, costs etc.

Reference 18 - 0.17% Coverage

Not user friendly.

Reference 19 - 0.05% Coverage

Vague instructions.

Reference 20 - 0.05% Coverage

Unclear instructions

Reference 21 - 0.17% Coverage

Not user-friednly.

Reference 22 - 0.17% Coverage

The ease of use in buying a ticket, navigating through the network, connecting modes etc.

Reference 23 - 0.17% Coverage

Outdated, unclear, and/or inaccurate information

Overcrowded

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 30 references coded [3.83% Coverage]

Reference 1 - 0.06% Coverage

weekend crowded

Reference 2 - 0.17% Coverage

Congestion inside the bus or train.

Reference 3 - 0.04% Coverage

crowds

Reference 4 - 0.17% Coverage

crowded inside

Reference 5 - 0.17% Coverage

Crowded in Manama

Reference 6 - 0.17% Coverage

Crowded

Reference 7 - 0.07% Coverage

Crowded

Reference 8 - 0.17% Coverage

Crowded

Reference 9 - 0.07% Coverage

Crowded

Reference 10 - 0.04% Coverage

Crowded

Reference 11 - 0.04% Coverage

crowded

Reference 12 - 0.10% Coverage

crowded buses

Reference 13 - 0.07% Coverage

Crowded

Reference 14 - 0.17% Coverage

too crowded

Reference 15 - 0.17% Coverage

The crowd and hygiene

Reference 16 - 0.03% Coverage

High number of users, no enough seats

Reference 17 - 0.17% Coverage

Crowded

Reference 18 - 0.17% Coverage

Crowded

Reference 19 - 0.17% Coverage

Crowded, dangerous, time consuming

Reference 20 - 0.11% Coverage

ove-rcrowededness

Reference 21 - 0.17% Coverage

Overcrowded

Reference 22 - 0.17% Coverage

Too many people

Reference 23 - 0.17% Coverage

Overcrowded

Reference 24 - 0.17% Coverage

Crowded during peak hours

Reference 25 - 0.17% Coverage

Many people

Reference 26 - 0.17% Coverage

Can be crowded

Reference 27 - 0.10% Coverage

Over-crowdedness

Reference 28 - 0.17% Coverage

Depends on the type of journey but overall having a service that is not overly packed and is family friendly would be important to have

Reference 29 - 0.17% Coverage

Too crowded

Reference 30 - 0.09% Coverage

Overcrowdedness

Speed (Slow)

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 54 references coded [6.95% Coverage]

Reference 1 - 0.17% Coverage

Timing

Reference 2 - 0.06% Coverage

It takes so much time

Reference 3 - 0.06% Coverage

it takes you longer to get to your destination because buses make a lot of stops along the way.

Reference 4 - 0.17% Coverage

Time

Reference 5 - 0.17% Coverage

Takes so much time

Reference 6 - 0.17% Coverage

Time consuming. Waiting for the transport to arrive instead of using a car.

Reference 7 - 0.07% Coverage

timings

Reference 8 - 0.17% Coverage

Not suitable for my type of work which need less waiting time for my next public transport to arrive.

Reference 9 - 0.03% Coverage

Time

Reference 10 - 0.17% Coverage

Time

Reference 11 - 0.17% Coverage

waste time

Reference 12 - 0.17% Coverage

long-time journey and waiting for the public transport

Reference 13 - 0.09% Coverage

too many stops

Reference 14 - 0.17% Coverage

Many stop stations

Reference 15 - 0.07% Coverage

Time element

Reference 16 - 0.17% Coverage

Too much time consumed

Reference 17 - 0.17% Coverage

No. Possibly the only downside would be delays, but I would not consider this as a drawback.

Reference 18 - 0.06% Coverage

More time consuming

Reference 19 - 0.17% Coverage

The routes and stops prolong the journey.

Reference 20 - 0.17% Coverage

Sometimes delays.

Reference 21 - 0.17% Coverage

Takes longer time

Reference 22 - 0.17% Coverage

Waiting time

Reference 23 - 0.17% Coverage

waiting for the next train/metro

Reference 24 - 0.17% Coverage

Waiting

Reference 25 - 0.04% Coverage

Slow service

Reference 26 - 0.17% Coverage

Waiting and journey time

Reference 27 - 0.11% Coverage

many stops (which cause the delays and long trips and this normally happens when using buses), traffic (also when using buses).

Reference 28 - 0.17% Coverage

Crowded, dangerous, time consuming

Reference 29 - 0.17% Coverage

It'll go around different stops and not straight to the destination, additionally there's no extra benefit such as skipping the traffic through a specified bus lane, so along with the additional stops you'll be stuck in traffic.

Reference 30 - 0.17% Coverage

Time, speed and freedom

Reference 31 - 0.03% Coverage

Slow service

Reference 32 - 0.17% Coverage

The time it takes

Reference 33 - 0.04% Coverage

it takes longer to get places,

Reference 34 - 0.17% Coverage

Speed of the service.

Reference 35 - 0.17% Coverage

Maybe that the route can become longer and the drop off areas are sometimes not exactly at the location i want to go

Reference 36 - 0.10% Coverage

the waiting time

Reference 37 - 0.01% Coverage

slow

Reference 38 - 0.03% Coverage

excessive stops

Reference 39 - 0.12% Coverage

less efficient way of getting around.

Reference 40 - 0.08% Coverage

time wasted for people to leave and get on board, delays.

Reference 41 - 0.06% Coverage

Time consuming

Reference 42 - 0.10% Coverage

time consuming.

Reference 43 - 0.17% Coverage

Delays

Reference 44 - 0.17% Coverage

Less efficient and slower way of getting from one place to another.

Reference 45 - 0.17% Coverage

Not time efficient

Reference 46 - 0.17% Coverage

Not time efficient

Reference 47 - 0.12% Coverage

Not enough trips (long wait time in case you miss a bus).

Reference 48 - 0.17% Coverage

Time constraint.

Reference 49 - 0.17% Coverage

Not time efficient

Reference 50 - 0.17% Coverage

Time consuming and too many unnecessary stops.

Reference 51 - 0.07% Coverage

slow service

Reference 52 - 0.17% Coverage

Need time to reach you

Reference 53 - 0.09% Coverage

long time gaps between trips.

Reference 54 - 0.17% Coverage

Waiting time is definitely something that would put me off.

Unaccessible

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 26 references coded [3.17% Coverage]

Reference 1 - 0.08% Coverage

I wouldn’t do it in Bahrain though because the routes are insanely long and they will likely drop you off far from your destination, which means you’ll have to walk a lot

Reference 2 - 0.07% Coverage

and some areas do not have bus stops for locals to fully utilize them

Reference 3 - 0.17% Coverage

Unsure how to read the destinations (might be In a different language) or just unfamiliar with areas

Reference 4 - 0.04% Coverage

The stations are far from my home and place I use to travel to.

Reference 5 - 0.09% Coverage

he stations distribution are not suitable

Reference 6 - 0.17% Coverage

Public bus stations are quite far away from home

Reference 7 - 0.17% Coverage

Yes, Distance from location

Reference 8 - 0.17% Coverage

Location of bus stops

Reference 9 - 0.17% Coverage

Location of bus stop.

Reference 10 - 0.17% Coverage

Location of the bus stops not near my house.

Reference 11 - 0.08% Coverage

far from my house.

Reference 12 - 0.12% Coverage

Difficult to locate (the nearest bus stop is at least 5-7 mins driving away from where I live).

Reference 13 - 0.10% Coverage

Limited service in certain areas.

Reference 14 - 0.17% Coverage

Language barrier

Reference 15 - 0.17% Coverage

Walking to the nearest bus stop would take me at least 15 mins in this weather. None.

Reference 16 - 0.17% Coverage

Limited stations

Reference 17 - 0.14% Coverage

the information is difficult to understand and I find this is more the case in foreign countries that speak a different language.

Reference 18 - 0.06% Coverage

how far the dropoff is from the destination

Reference 19 - 0.01% Coverage

Far

Reference 20 - 0.05% Coverage

Not many stations

Reference 21 - 0.08% Coverage

difficulty accessing stations/stops.

Reference 22 - 0.17% Coverage

walking to the nearest bus station will require the use of a car which kind of defeats the purpose of using public transport in the first place.

Reference 23 - 0.17% Coverage

Security and proximity of stops/stations to city centers or key areas within a city.

Reference 24 - 0.08% Coverage

lack of access to certain areas.

Reference 25 - 0.17% Coverage

A number of areas not served by public transport meaning one has to walk long distances under extreme weather.

Reference 26 - 0.17% Coverage

Dont reach everywhere

Unclean

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 40 references coded [4.70% Coverage]

Reference 1 - 0.06% Coverage

smelly

Reference 2 - 0.08% Coverage

cleanliness

Reference 3 - 0.05% Coverage

Hygiene

Reference 4 - 0.06% Coverage

smelly

Reference 5 - 0.17% Coverage

Smell

Reference 6 - 0.06% Coverage

smelly

Reference 7 - 0.17% Coverage

Smell

Reference 8 - 0.10% Coverage

strong smell maybe

Reference 9 - 0.03% Coverage

Smell

Reference 10 - 0.04% Coverage

Smell

Reference 11 - 0.06% Coverage

smell.

Reference 12 - 0.03% Coverage

unhygienic

Reference 13 - 0.17% Coverage

Hygiene reasons

Reference 14 - 0.17% Coverage

Unsafe and not clean.

Reference 15 - 0.17% Coverage

Lack of privacy and security and cleanliness

Reference 16 - 0.17% Coverage

Not clean

Reference 17 - 0.17% Coverage

Maybe not clean

Reference 18 - 0.17% Coverage

The crowd and hygiene

Reference 19 - 0.08% Coverage

Hygiene

Reference 20 - 0.02% Coverage

unclean facilities

Reference 21 - 0.17% Coverage

Not clean

Reference 22 - 0.17% Coverage

Unclean

Reference 23 - 0.02% Coverage

cleanliness

Reference 24 - 0.17% Coverage

Cleanness etc

Reference 25 - 0.17% Coverage

Lack of privacy, security, and clean facilities.

Reference 26 - 0.17% Coverage

Not clean

Reference 27 - 0.17% Coverage

Not clean

Reference 28 - 0.17% Coverage

Safety, cleanliness, and privacy.

Reference 29 - 0.04% Coverage

cleanliness.

Reference 30 - 0.17% Coverage

Not clean

Reference 31 - 0.07% Coverage

unhygienic

Reference 32 - 0.17% Coverage

Not clean

Reference 33 - 0.17% Coverage

Not safe - not clean

Reference 34 - 0.17% Coverage

Not clean

Reference 35 - 0.17% Coverage

Cleanliness issues

Reference 36 - 0.17% Coverage

Not clean

Reference 37 - 0.09% Coverage

not clean

Reference 38 - 0.06% Coverage

Not clean

Reference 39 - 0.09% Coverage

Not clean

Reference 40 - 0.17% Coverage

Poorly maintained and unclean cabins and stops will deter a lot of passengers.

Unreliable

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 37 references coded [4.41% Coverage]

Reference 1 - 0.05% Coverage

we do not have a reliable public transport system

Reference 2 - 0.07% Coverage

Inconsistency in time schedules

Reference 3 - 0.17% Coverage

Time related

Reference 4 - 0.10% Coverage

unreliable service information.

Reference 5 - 0.17% Coverage

Reliability of the service and information available

Reference 6 - 0.06% Coverage

Also, the punctuality of the service remains an area of concern for me.

Reference 7 - 0.17% Coverage

Reliability of the service.

Reference 8 - 0.05% Coverage

Unreliable service.

Reference 9 - 0.05% Coverage

Not sure if the service is punctual.

Reference 10 - 0.11% Coverage

unreliable service

Reference 11 - 0.17% Coverage

Journey delays

Reference 12 - 0.17% Coverage

Reliability of the service and the facilities tend to be underdeveloped here in Bahrain.

Reference 13 - 0.17% Coverage

Some disruptions can happen which are difficult to deal with.

Reference 14 - 0.02% Coverage

Reliability,

Reference 15 - 0.17% Coverage

Disruptions, strikes, and safety issues concern me.

Reference 16 - 0.17% Coverage

The reliability and punctuality of the service are paramount especially when used as a monomodal option.

Reference 17 - 0.13% Coverage

unreliable sometimes and give people a sense that they are not in control.

Reference 18 - 0.17% Coverage

Staying on schedule

Reference 19 - 0.03% Coverage

unreliable

Reference 20 - 0.17% Coverage

Do not stop every where

Reference 21 - 0.04% Coverage

accuracy of information

Reference 22 - 0.17% Coverage

High risk for disruptions.

Reference 23 - 0.03% Coverage

service punctuality

Reference 24 - 0.17% Coverage

Lack of reliability.

Reference 25 - 0.17% Coverage

The bus service is not something one can fully rely on instead of a private car.

Reference 26 - 0.10% Coverage

lack of punctuality in the service.

Reference 27 - 0.17% Coverage

Service quality (timings and comfort etc.)

Reference 28 - 0.09% Coverage

Poor standard of service,

Reference 29 - 0.11% Coverage

Service punctuality and reliability

Reference 30 - 0.17% Coverage

Not reliable

Reference 31 - 0.17% Coverage

Still has a long way to go in terms of network scope before the bus services here in Bahrain can rival private automobile.

Reference 32 - 0.10% Coverage

eliable information/service

Reference 33 - 0.07% Coverage

Unreliable

Reference 34 - 0.17% Coverage

Cannot be consistently considered as an option for all journeys across Bahrain.

Reference 35 - 0.17% Coverage

Safety and service punctuality are my two top priorities.

Reference 36 - 0.17% Coverage

Safety and how reliable the service is.

Reference 37 - 0.04% Coverage

infrequent journeys

Unsafe

Files\\Mobility-as-a-Service in Bahrain (Responses) Open-endedV2 - § 60 references coded [7.19% Coverage]

Reference 1 - 0.17% Coverage

Lack of security especially during certain times of the day.

Reference 2 - 0.17% Coverage

Safety is my number one concern especially during late hours of the day.

Reference 3 - 0.02% Coverage

Unsafe

Reference 4 - 0.17% Coverage

Safety is certainly a concern. Especially when dealing with mass transit.

Reference 5 - 0.17% Coverage

Not safe

Reference 6 - 0.17% Coverage

Unsure of who you might come across. I dread going to bus stops or metro stations at night time.

Reference 7 - 0.04% Coverage

Safety

Reference 8 - 0.06% Coverage

Safety and security.

Reference 9 - 0.17% Coverage

Safety

Reference 10 - 0.17% Coverage

safety

Reference 11 - 0.17% Coverage

Unsafe and not clean.

Reference 12 - 0.17% Coverage

Lack of privacy and security and cleanliness

Reference 13 - 0.17% Coverage

Not safe

Reference 14 - 0.03% Coverage

unsafe.

Reference 15 - 0.17% Coverage

Crowded, dangerous, time consuming

Reference 16 - 0.17% Coverage

Safety is my number one priority and travelling which large groups of people makes me concerned.

Reference 17 - 0.01% Coverage

saftey

Reference 18 - 0.17% Coverage

Being robbed.

Reference 19 - 0.11% Coverage

the possibility of someone stealing your stuff

Reference 20 - 0.17% Coverage

Lack of privacy, security, and clean facilities.

Reference 21 - 0.17% Coverage

From my experience travelling abroad, the late hours can be unsafe when heading to public transport stops or stations.

Reference 22 - 0.03% Coverage

They can be unsafe

Reference 23 - 0.06% Coverage

Safety

Reference 24 - 0.17% Coverage

Not safe for women

Reference 25 - 0.01% Coverage

safety

Reference 26 - 0.03% Coverage

Pickpocketing

Reference 27 - 0.17% Coverage

Don’t feel safe when travelling with children or in a large family.

Reference 28 - 0.04% Coverage

Safety

Reference 29 - 0.03% Coverage

criminal activity,

Reference 30 - 0.04% Coverage

and security issues.

Reference 31 - 0.17% Coverage

Security and proximity of stops/stations to city centers or key areas within a city.

Reference 32 - 0.17% Coverage

Safety and security.

Reference 33 - 0.04% Coverage

Safety

Reference 34 - 0.17% Coverage

Not safe for women alone

Reference 35 - 0.17% Coverage

Security

Reference 36 - 0.17% Coverage

Safety, cleanliness, and privacy.

Reference 37 - 0.02% Coverage

extremely unsafe.

Reference 38 - 0.17% Coverage

Safety and security.

Reference 39 - 0.02% Coverage

safety

Reference 40 - 0.17% Coverage

Lack of privacy and security.

Reference 41 - 0.17% Coverage

Safety

Reference 42 - 0.05% Coverage

security

Reference 43 - 0.17% Coverage

Security

Reference 44 - 0.17% Coverage

Not safe for women

Reference 45 - 0.17% Coverage

Safety and service punctuality are my two top priorities.

Reference 46 - 0.17% Coverage

Not safe for single females

Reference 47 - 0.17% Coverage

Not safe for ladies

Reference 48 - 0.17% Coverage

Not safe

Reference 49 - 0.17% Coverage

Safety and how reliable the service is.

Reference 50 - 0.03% Coverage

Safety

Reference 51 - 0.17% Coverage

Not safe - not clean

Reference 52 - 0.17% Coverage

Not safe for women alone

Reference 53 - 0.17% Coverage

Not safe for ladies

Reference 54 - 0.05% Coverage

security

Reference 55 - 0.17% Coverage

Never know who is going to be seated next to you which can sometimes be alarming.

Reference 56 - 0.17% Coverage

Not safe for women alone

Reference 57 - 0.04% Coverage

Pickpocketing

Reference 58 - 0.08% Coverage

Not safe

Reference 59 - 0.11% Coverage

not safe for women

Reference 60 - 0.08% Coverage

not safe

Appendix C:RH Benefits

24-7 Availability

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 15 references coded [0.46% Coverage]

Reference 1 - 0.02% Coverage

It’s convenient to request a ride at any time.

Reference 2 - 0.05% Coverage

Advantage, having a ride when its very late or too early.

Reference 3 - 0.04% Coverage

always there when I don’t have a ride back

Reference 4 - 0.04% Coverage

They are available on demand.

Reference 5 - 0.05% Coverage

Availability on demand is definitely an advantage

Reference 6 - 0.02% Coverage

Availability throughout the day

Reference 7 - 0.01% Coverage

upon demand

Reference 8 - 0.02% Coverage

They available on-demand

Reference 9 - 0.02% Coverage

takes you door to door

Reference 10 - 0.05% Coverage

I value that they tend to operate around the clock b

Reference 11 - 0.01% Coverage

having a means of transportation at anytime.

Reference 12 - 0.02% Coverage

Available on demand

Reference 13 - 0.05% Coverage

The main benefit is the door to door service.

Reference 14 - 0.06% Coverage

always available

Reference 15 - 0.01% Coverage

on demand

Accessible

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 23 references coded [1.26% Coverage]

Reference 1 - 0.05% Coverage

Accessibility

Reference 2 - 0.07% Coverage

Benefits are that these services do not depend on being at a specific station or stop like bus services.

Reference 3 - 0.11% Coverage

All you have to do is drop your location and they show up.

Reference 4 - 0.01% Coverage

door to door

Reference 5 - 0.06% Coverage

one of the main benefits is the ability to pinpoint your location for both pickup and drop-off.

Reference 6 - 0.02% Coverage

ervice accessed through an app.

Reference 7 - 0.04% Coverage

that it arrives at my doorstep.

Reference 8 - 0.05% Coverage

the driver can pick you up

Reference 9 - 0.06% Coverage

I don’t have to be in a specific location at a specific time

Reference 10 - 0.08% Coverage

minimal to no walking distance since they arrive more or less at your doorstep.

Reference 11 - 0.06% Coverage

They pick me up at my exact location and drop me off close to where I need to go.

Reference 12 - 0.05% Coverage

door to door services

Reference 13 - 0.05% Coverage

proximity of stops does not become an issue with taxi/Uber services

Reference 14 - 0.04% Coverage

Door to door service is the main advantage

Reference 15 - 0.04% Coverage

the services are more flexible (timing-wise and location-wise)

Reference 16 - 0.07% Coverage

Perfect for pickup

Reference 17 - 0.05% Coverage

The main benefit that would lure me towards using an Uber service would be the door to door service they offer

Reference 18 - 0.07% Coverage

Not limited to specific routes and timings

Reference 19 - 0.05% Coverage

you don’t have to be in a specific location.

Reference 20 - 0.03% Coverage

They offer door to door services

Reference 21 - 0.05% Coverage

he door to door services these companies offer is certainly a key benefit.

Reference 22 - 0.11% Coverage

They cover the full, or at least the most, length of the journey.

Reference 23 - 0.07% Coverage

Drop you door to door

Convenient

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 75 references coded [4.05% Coverage]

Reference 1 - 0.05% Coverage

It’s convenient

Reference 2 - 0.06% Coverage

It would be convenient for people who don’t have a driver’s license or don’t own a car

Reference 3 - 0.05% Coverage

convenience

Reference 4 - 0.02% Coverage

It’s convenient to request a ride at any time.

Reference 5 - 0.09% Coverage

but needs only time of travelling

Reference 6 - 0.04% Coverage

timely help

Reference 7 - 0.11% Coverage

Convenience

Reference 8 - 0.04% Coverage

flexible in terms of service access.

Reference 9 - 0.07% Coverage

They are good when it comes to travel or tourists

Reference 10 - 0.01% Coverage

no parking issues

Reference 11 - 0.02% Coverage

you can choose time of departure.

Reference 12 - 0.07% Coverage

I like that the service can accessed through a mobile app

Reference 13 - 0.04% Coverage

The ease of arranging and paying for a trip, on short notice,

Reference 14 - 0.06% Coverage

The fact that I can hail a ride at any time of the day through my phone.

Reference 15 - 0.02% Coverage

convenience

Reference 16 - 0.02% Coverage

service accessed through an app.

Reference 17 - 0.06% Coverage

Convenient

Reference 18 - 0.04% Coverage

The flexibility of the service

Reference 19 - 0.07% Coverage

No parking difficulties/

Reference 20 - 0.07% Coverage

It allows me to access a private without having to own or drive one

Reference 21 - 0.07% Coverage

Taxi services are good when travelling in places that are difficult to navigate.

Reference 22 - 0.06% Coverage

No parking issue

Reference 23 - 0.08% Coverage

but good taking the luggage with you

Reference 24 - 0.07% Coverage

No parking problems

Reference 25 - 0.07% Coverage

No need to look for parking

Reference 26 - 0.07% Coverage

I like the convenience they offer

Reference 27 - 0.05% Coverage

The spontaneous nature of the service (considering it can be accessed online) is a plus

Reference 28 - 0.07% Coverage

Available on short notice main benefit.

Reference 29 - 0.03% Coverage

Convenient

Reference 30 - 0.11% Coverage

Comfort and ase of mind

Reference 31 - 0.05% Coverage

Flexible

Reference 32 - 0.08% Coverage

No Ned for parking

Reference 33 - 0.06% Coverage

I don’t have to be in a specific location at a specific time

Reference 34 - 0.09% Coverage

their benefit mostly comes down to convenience which is obviously reflected in the service cost.

Reference 35 - 0.01% Coverage

convenient

Reference 36 - 0.11% Coverage

Not having to drive in unfamiliar areas and not having to worry about parking my car

Reference 37 - 0.01% Coverage

convenient

Reference 38 - 0.03% Coverage

Convenient

Reference 39 - 0.08% Coverage

I can plan my trip more effectively, not worry about driving,

Reference 40 - 0.05% Coverage

Flexible

Reference 41 - 0.05% Coverage

No parking problem

Reference 42 - 0.02% Coverage

convenience

Reference 43 - 0.06% Coverage

Little preparation, or heads up, needed to arrange for trips.

Reference 44 - 0.07% Coverage

Good for spontaneous decisions

Reference 45 - 0.05% Coverage

Flexible

Reference 46 - 0.03% Coverage

flexible services

Reference 47 - 0.03% Coverage

More suited for families (with small children)

Reference 48 - 0.04% Coverage

the services are more flexible (timing-wise and location-wise)

Reference 49 - 0.04% Coverage

More flexible

Reference 50 - 0.01% Coverage

Convenience

Reference 51 - 0.05% Coverage

Good for on the spot decisions or short notice planning

Reference 52 - 0.08% Coverage

No parking problems

Reference 53 - 0.08% Coverage

Most convenient option available

Reference 54 - 0.01% Coverage

and time flexibility.

Reference 55 - 0.04% Coverage

The convenience and flexibility they offer

Reference 56 - 0.07% Coverage

Not limited to specific routes and timings

Reference 57 - 0.06% Coverage

More convenient

Reference 58 - 0.03% Coverage

Yet, they are only good for one-off journeys.

Reference 59 - 0.11% Coverage

They offer a lot of flexibility.

Reference 60 - 0.02% Coverage

More convenient

Reference 61 - 0.06% Coverage

No need to navigate through the system (platforms, lines, stations etc.)

Reference 62 - 0.05% Coverage

A logical option when in need of a ride on short notice.

Reference 63 - 0.02% Coverage

They are more convenient

Reference 64 - 0.08% Coverage

The benefits are that these services present a more flexible and convenient option

Reference 65 - 0.02% Coverage

and flexibility during planning

Reference 66 - 0.08% Coverage

Flexibility

Reference 67 - 0.04% Coverage

More flexible

Reference 68 - 0.05% Coverage

No parking issues

Reference 69 - 0.04% Coverage

Apart from convenience

Reference 70 - 0.09% Coverage

No parking problems

Reference 71 - 0.06% Coverage

Faster way to accommodate a family of 3 travelling short distances.

Reference 72 - 0.08% Coverage

No parking issues

Reference 73 - 0.07% Coverage

Going to the airport or hotel

Reference 74 - 0.07% Coverage

Drop you to destination exactly

Reference 75 - 0.03% Coverage

Faster and more convenient service

Fast Service

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 39 references coded [1.57% Coverage]

Reference 1 - 0.11% Coverage

Fast

Reference 2 - 0.01% Coverage

Speed

Reference 3 - 0.03% Coverage

Fast

Reference 4 - 0.04% Coverage

Reach fast

Reference 5 - 0.01% Coverage

direct trip

Reference 6 - 0.03% Coverage

Fast

Reference 7 - 0.04% Coverage

Quick

Reference 8 - 0.05% Coverage

benefit is getting where u want go in a more timely

Reference 9 - 0.04% Coverage

The speed of the service is an advantage

Reference 10 - 0.04% Coverage

Fast

Reference 11 - 0.08% Coverage

Time-efficient, no detours/stops are the benefits I consider the most.

Reference 12 - 0.01% Coverage

Saves time

Reference 13 - 0.02% Coverage

Fast

Reference 14 - 0.03% Coverage

Fast

Reference 15 - 0.03% Coverage

Fast

Reference 16 - 0.05% Coverage

Faster

Reference 17 - 0.03% Coverage

Fast

Reference 18 - 0.04% Coverage

Fast

Reference 19 - 0.06% Coverage

Reach fast

Reference 20 - 0.07% Coverage

Time saving

Reference 21 - 0.05% Coverage

Faster

Reference 22 - 0.01% Coverage

Fast

Reference 23 - 0.05% Coverage

Save time

Reference 24 - 0.04% Coverage

Fast

Reference 25 - 0.03% Coverage

Fast

Reference 26 - 0.04% Coverage

Quick

Reference 27 - 0.04% Coverage

Faster

Reference 28 - 0.07% Coverage

Time efficient

Reference 29 - 0.06% Coverage

Save time

Reference 30 - 0.04% Coverage

Faster

Reference 31 - 0.02% Coverage

Faster service

Reference 32 - 0.03% Coverage

so there aren’t any unnecessary stops for example

Reference 33 - 0.01% Coverage

Fast

Reference 34 - 0.04% Coverage

Reach faster

Reference 35 - 0.07% Coverage

Reach fast

Reference 36 - 0.03% Coverage

Faster and more convenient service.

Reference 37 - 0.07% Coverage

Save time

Reference 38 - 0.03% Coverage

Save time

Reference 39 - 0.03% Coverage

Faster service obviously

Less Traffic

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 4 references coded [0.19% Coverage]

Reference 1 - 0.02% Coverage

If we all used ride-sharing, then maybe there would be less traffic,

Reference 2 - 0.03% Coverage

Reducing traffic

Reference 3 - 0.06% Coverage

Reduce usage of personal cars

Reference 4 - 0.08% Coverage

Reduce personal car usage

Lower Cost

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 7 references coded [0.42% Coverage]

Reference 1 - 0.01% Coverage

Could be cheaper than traditional taxis.

Reference 2 - 0.02% Coverage

Cheaper

Reference 3 - 0.11% Coverage

Cheaper than taxi in Europe

Reference 4 - 0.11% Coverage

Cheaper than car rental.

Reference 5 - 0.04% Coverage

Cost reduction

Reference 6 - 0.05% Coverage

not too expensive

Reference 7 - 0.07% Coverage

Reduce fuel usage

Offers Back Up

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 30 references coded [2.06% Coverage]

Reference 1 - 0.02% Coverage

Benefits is when your car is being serviced and you have no other alternative.

Reference 2 - 0.11% Coverage

It moves the general public away from ordinary taxis.

Reference 3 - 0.11% Coverage

To be used in case of my car maintenance.

Reference 4 - 0.04% Coverage

always there when I don’t have a ride back

Reference 5 - 0.11% Coverage

Helpful for those who are not having cars and also who do not want to drive.

Reference 6 - 0.04% Coverage

available during emergencies

Reference 7 - 0.06% Coverage

Convenient during urgent moments.

Reference 8 - 0.04% Coverage

Good for times of need

Reference 9 - 0.11% Coverage

In situations where I cannot drive. Uber is certainly an option.

Reference 10 - 0.07% Coverage

It allows me to access a private without having to own or drive one

Reference 11 - 0.11% Coverage

I only consider using these during emergencies.

Reference 12 - 0.06% Coverage

I have my own car but just as an assurance, online taxi services help during situations where this isn't the case.

Reference 13 - 0.06% Coverage

It can as a second option when private car breakdown and readily available

Reference 14 - 0.05% Coverage

They good in situtions where they are needed

Reference 15 - 0.05% Coverage

The benefit is that they come in handy during certain situations

Reference 16 - 0.05% Coverage

makes transportation easier for those unwilling / poor at driving

Reference 17 - 0.03% Coverage

Good for emergency

Reference 18 - 0.05% Coverage

I always have them at the back of my mind in case of an emergency

Reference 19 - 0.05% Coverage

Good for emergencies

Reference 20 - 0.08% Coverage

if I want to go to the airport for example and I don't want to leave my car in the parking area.

Reference 21 - 0.07% Coverage

Good for short trips and short notice decisions when no other options are available.

Reference 22 - 0.10% Coverage

These are good in situations where it is difficult to drive (giving more or less the same benefits).

Reference 23 - 0.11% Coverage

Going to the airport

Reference 24 - 0.07% Coverage

Good for people who prefer not to use traditional public transport

Reference 25 - 0.08% Coverage

Good for situations where driving is difficult due to exhaustion or fatigue

Reference 26 - 0.07% Coverage

Substitute for my car

Reference 27 - 0.03% Coverage

A good alternative to public transport

Reference 28 - 0.11% Coverage

No need for personal car

Reference 29 - 0.04% Coverage

The best alternative next to using a car

Reference 30 - 0.08% Coverage

Replace own car

Offers Privacy

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 19 references coded [0.79% Coverage]

Reference 1 - 0.03% Coverage

privacy

Reference 2 - 0.11% Coverage

privacy

Reference 3 - 0.07% Coverage

Avoiding the crowd is what I value the most.

Reference 4 - 0.06% Coverage

The privacy aspect is a major benefit.

Reference 5 - 0.01% Coverage

private

Reference 6 - 0.04% Coverage

Private

Reference 7 - 0.05% Coverage

Your own privacy

Reference 8 - 0.03% Coverage

Avoiding the crowd is a core benefit.

Reference 9 - 0.03% Coverage

and private manner than a bus

Reference 10 - 0.04% Coverage

Having my own space is something I value the most

Reference 11 - 0.01% Coverage

More privacy

Reference 12 - 0.04% Coverage

Maybe its beneficial for people that have social anxiety

Reference 13 - 0.03% Coverage

I still have my privacy.

Reference 14 - 0.01% Coverage

privacy

Reference 15 - 0.06% Coverage

They offer a more practical way of getting around without being exposed to a lot of strangers.

Reference 16 - 0.05% Coverage

Have some privacy

Reference 17 - 0.02% Coverage

They offer more privacy

Reference 18 - 0.06% Coverage

Have your own privacy

Reference 19 - 0.04% Coverage

Privacy

Offers Safety

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 6 references coded [0.42% Coverage]

Reference 1 - 0.11% Coverage

safety

Reference 2 - 0.11% Coverage

Safety

Reference 3 - 0.11% Coverage

Safe

Reference 4 - 0.04% Coverage

more secure compared to higher capacity public transport

Reference 5 - 0.01% Coverage

safe

Reference 6 - 0.04% Coverage

Safety

Reliable

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 5 references coded [0.34% Coverage]

Reference 1 - 0.11% Coverage

Arriving in time

Reference 2 - 0.05% Coverage

benefit is getting where u want go in a more timely

Reference 3 - 0.11% Coverage

Reliable option for trips across the country.

Reference 4 - 0.04% Coverage

Reach on time

Reference 5 - 0.02% Coverage

reliable

Trackability

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 4 references coded [0.26% Coverage]

Reference 1 - 0.04% Coverage

Benefits are tracking your uber car

Reference 2 - 0.04% Coverage

track driver

Reference 3 - 0.07% Coverage

For me, the functions conducted through the app (tracking, payments, requesting a ride etc.) are the core benefits

Reference 4 - 0.11% Coverage

Tracking and cost estimation prior to using the service with Uber mostly.

User-Friendly

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 38 references coded [2.65% Coverage]

Reference 1 - 0.11% Coverage

easy access in aps

Reference 2 - 0.11% Coverage

Simple and practical

Reference 3 - 0.03% Coverage

easy to use

Reference 4 - 0.11% Coverage

Easy to book

Reference 5 - 0.11% Coverage

Easy to use the app

Reference 6 - 0.11% Coverage

Easy to book.

Reference 7 - 0.11% Coverage

Easy to book the ride.

Reference 8 - 0.11% Coverage

Easy to use and book ride.

Reference 9 - 0.11% Coverage

Easy to use app.

Reference 10 - 0.03% Coverage

Easy

Reference 11 - 0.11% Coverage

Easy to book.

Reference 12 - 0.11% Coverage

Easy

Reference 13 - 0.11% Coverage

Easy to use app

Reference 14 - 0.06% Coverage

Easy to book rides

Reference 15 - 0.02% Coverage

easy to use app

Reference 16 - 0.03% Coverage

easy

Reference 17 - 0.06% Coverage

Easy to use app.

Reference 18 - 0.07% Coverage

I like that the service can accessed through a mobile app

Reference 19 - 0.04% Coverage

The ease of arranging and paying for a trip, on short notice,

Reference 20 - 0.05% Coverage

The simplicity of the service and the fact that this can be conducted through an app.

Reference 21 - 0.11% Coverage

Very easy

Reference 22 - 0.10% Coverage

Ease of finding taxis at a click of a button

Reference 23 - 0.01% Coverage

ease of use

Reference 24 - 0.08% Coverage

Especially with apps and services such as Uber, the format and interface of the service is standardised across different countries/regions

Reference 25 - 0.05% Coverage

finding a way to go from somewhere to the other easily.

Reference 26 - 0.06% Coverage

Much easier to use compared to other public transport options.

Reference 27 - 0.07% Coverage

For me, the functions conducted through the app (tracking, payments, requesting a ride etc.) are the core benefits

Reference 28 - 0.05% Coverage

I know that these Uber services can be easily accessed through an app

Reference 29 - 0.03% Coverage

the service is transparent and simple to use

Reference 30 - 0.04% Coverage

The service is almost standardized anywhere you go so that is a bonus

Reference 31 - 0.04% Coverage

Easy to access and use service

Reference 32 - 0.04% Coverage

Simple to use

Reference 33 - 0.07% Coverage

Easy to request and pay for the service

Reference 34 - 0.07% Coverage

Their service remains standardised across different regions which makes acquiring and utilising the service much easier.

Reference 35 - 0.03% Coverage

easy to request.

Reference 36 - 0.07% Coverage

Highly customer centered

Reference 37 - 0.04% Coverage

A lot simpler to use in terms of getting around and buying the right ticket.

Reference 38 - 0.09% Coverage

App based service which makes it very convenient and straightforward especially for the newer generations.

Variety of Services

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 1 reference coded [0.08% Coverage]

Reference 1 - 0.08% Coverage

Wide variety of services XL, limousine, sharing rides with other people which cater to different customers

Appendix D: RH Drawbacks

Fluctuating Prices and High Cost

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 127 references coded [6.37% Coverage]

Reference 1 - 0.06% Coverage

not pocket friendly

Reference 2 - 0.01% Coverage

Drawback in Bahrain is that it’s expensive

Reference 3 - 0.07% Coverage

One drawback is the fluctuation in prices depending on the day/traffic

Reference 4 - 0.01% Coverage

- Surge pricing during high demand periods.

Reference 5 - 0.11% Coverage

cost

Reference 6 - 0.11% Coverage

Cost

Reference 7 - 0.11% Coverage

costly for long distance

Reference 8 - 0.03% Coverage

high cost

Reference 9 - 0.11% Coverage

Cost

Reference 10 - 0.10% Coverage

Expensive

Reference 11 - 0.02% Coverage

Cost

Reference 12 - 0.04% Coverage

Drawbacks their rates are often predatory and exploit the customer.

Reference 13 - 0.11% Coverage

The price can change depending on the time of day and season.

Reference 14 - 0.06% Coverage

expensive

Reference 15 - 0.07% Coverage

Disadvantage would be their pricing methods.

Reference 16 - 0.06% Coverage

expensive in some countries more than taxi.

Reference 17 - 0.02% Coverage

traffic delays can increase costs

Reference 18 - 0.11% Coverage

The drawback is that the price is not fixed

Reference 19 - 0.11% Coverage

Expensive compared to public bus

Reference 20 - 0.06% Coverage

Expensive

Reference 21 - 0.04% Coverage

Expensive

Reference 22 - 0.04% Coverage

I am concerned with hidden fees and costs involved in the pricing system

Reference 23 - 0.05% Coverage

However, the pricing of trip services is not transparent.

Reference 24 - 0.04% Coverage

The main drawback is both the cost

Reference 25 - 0.04% Coverage

costly

Reference 26 - 0.06% Coverage

The drawback is that the prices fluctuate wildly depending on the season and time of day.

Reference 27 - 0.03% Coverage

The cost is often exuberant.

Reference 28 - 0.04% Coverage

cost too much

Reference 29 - 0.04% Coverage

Can get pricey sometimes.

Reference 30 - 0.07% Coverage

expensive

Reference 31 - 0.04% Coverage

but the service can be expensive.

Reference 32 - 0.04% Coverage

Taxi can be very pricey

Reference 33 - 0.04% Coverage

They often scam people with their prices.

Reference 34 - 0.03% Coverage

too expensive

Reference 35 - 0.05% Coverage

expensive

Reference 36 - 0.04% Coverage

maybe expensive

Reference 37 - 0.11% Coverage

I like the convenience they offer but not their prices.

Reference 38 - 0.04% Coverage

I tend to find their pricing structure to be slightly murky.

Reference 39 - 0.05% Coverage

They tend to overcharge people.

Reference 40 - 0.04% Coverage

Price is a disadvantage

Reference 41 - 0.05% Coverage

but expensive if compared with private car or public transport.

Reference 42 - 0.11% Coverage

High cost

Reference 43 - 0.03% Coverage

surge pricing

Reference 44 - 0.01% Coverage

Greedy drivers/ frauds

Reference 45 - 0.02% Coverage

cost

Reference 46 - 0.07% Coverage

cost money

Reference 47 - 0.05% Coverage

expensive

Reference 48 - 0.05% Coverage

can be expensive

Reference 49 - 0.05% Coverage

but their rates, even for the same trips, can vary widely

Reference 50 - 0.09% Coverage

their benefit mostly comes down to convenience which is obviously reflected in the service cost.

Reference 51 - 0.06% Coverage

as for their downside their cost dramtically flucatues based on supply and demand.

Reference 52 - 0.08% Coverage

However, what they end up charging people for their service is often over the top.

Reference 53 - 0.11% Coverage

Expensive

Reference 54 - 0.02% Coverage

high price at peak times

Reference 55 - 0.01% Coverage

expensive

Reference 56 - 0.06% Coverage

I feel being ripped off when paying for the services they offer.

Reference 57 - 0.03% Coverage

The downside surely has to be the pricing based on algorithms.

Reference 58 - 0.02% Coverage

drawback is expenses

Reference 59 - 0.06% Coverage

but they have their limitations (cost wise and not friendly for a large family etc)

Reference 60 - 0.07% Coverage

but they tend to overcharge people - especially when demand is high.

Reference 61 - 0.05% Coverage

costs may vary and under companies like Uber which call their drivers “gig workers” there are many means of exploiting that “independent contractor” status.

Reference 62 - 0.06% Coverage

sometimes cost much

Reference 63 - 0.04% Coverage

but of course these come at a certain price which I sometimes find exorbitant.

Reference 64 - 0.01% Coverage

cost

Reference 65 - 0.05% Coverage

they are expensive

Reference 66 - 0.03% Coverage

Cost is definitely a drawback.

Reference 67 - 0.10% Coverage

depending on the time or season or if events are taking place, they can be exteremly expensive

Reference 68 - 0.04% Coverage

out of reach financially during periods of high demand.

Reference 69 - 0.05% Coverage

all of this comes at price which reflects the level of convenience.

Reference 70 - 0.03% Coverage

Prices are not fixed or clear.

Reference 71 - 0.04% Coverage

but at a steep price.

Reference 72 - 0.05% Coverage

on the other hand these services have a reputation for overcharging people.

Reference 73 - 0.06% Coverage

expensive

Reference 74 - 0.04% Coverage

it comes at a price.

Reference 75 - 0.04% Coverage

Rates are definitely a drawback.

Reference 76 - 0.01% Coverage

very expensive

Reference 77 - 0.02% Coverage

volatile prices

Reference 78 - 0.11% Coverage

Expensive

Reference 79 - 0.04% Coverage

For longer journeys it can be very expensive.

Reference 80 - 0.05% Coverage

Cost and lack of transparency.

Reference 81 - 0.04% Coverage

more expansive

Reference 82 - 0.03% Coverage

pricing

Reference 83 - 0.06% Coverage

some of their information and charging methods can be misleading.

Reference 84 - 0.07% Coverage

Too expensive

Reference 85 - 0.03% Coverage

costly

Reference 86 - 0.05% Coverage

They only discouraging aspect behind these services is that they are not a long-term option as they can get expensive

Reference 87 - 0.04% Coverage

but it comes with a premium price.

Reference 88 - 0.03% Coverage

Yet, their prices can be a bit overboard

Reference 89 - 0.05% Coverage

The routes they choose might be intentional to ensure profit maximization

Reference 90 - 0.06% Coverage

can be expensive sometimes

Reference 91 - 0.01% Coverage

Cost

Reference 92 - 0.03% Coverage

pricey

Reference 93 - 0.05% Coverage

can be expensive

Reference 94 - 0.04% Coverage

significantly more expensive.

Reference 95 - 0.04% Coverage

also more expensive.

Reference 96 - 0.05% Coverage

where they lack is how they price their services.

Reference 97 - 0.11% Coverage

Cost much

Reference 98 - 0.05% Coverage

Taxi drivers are known for taking longer routes so they can charge more.

Reference 99 - 0.06% Coverage

However, can get very expensive depending on traffic.

Reference 100 - 0.04% Coverage

However, like most regions, specifically with Uber/Lyft, surge pricing is a scam.

Reference 101 - 0.05% Coverage

cost much

Reference 102 - 0.04% Coverage

costly

Reference 103 - 0.03% Coverage

the cost is also a lot higher.

Reference 104 - 0.07% Coverage

Not a cost effective or long term option.

Reference 105 - 0.03% Coverage

cost

Reference 106 - 0.03% Coverage

cost much

Reference 107 - 0.07% Coverage

Money cost

Reference 108 - 0.06% Coverage

also more costly.

Reference 109 - 0.06% Coverage

expensive

Reference 110 - 0.02% Coverage

cost

Reference 111 - 0.04% Coverage

can be expensive

Reference 112 - 0.03% Coverage

costly

Reference 113 - 0.03% Coverage

becomes too expensive.

Reference 114 - 0.05% Coverage

Might be exposed to overpriced ’tourist’ prices.

Reference 115 - 0.03% Coverage

costs

Reference 116 - 0.05% Coverage

expensive

Reference 117 - 0.07% Coverage

more expensive if taxi

Reference 118 - 0.04% Coverage

price can be high

Reference 119 - 0.02% Coverage

costly

Reference 120 - 0.01% Coverage

cost

Reference 121 - 0.03% Coverage

cost

Reference 122 - 0.03% Coverage

also pricey.

Reference 123 - 0.06% Coverage

difficult to predict what the price of journey will be beforehand.

Reference 124 - 0.03% Coverage

cost

Reference 125 - 0.04% Coverage

of course at a much higher price point.

Reference 126 - 0.06% Coverage

taxi could be expensive

Reference 127 - 0.02% Coverage

cost

Inaccessible

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 4 references coded [0.33% Coverage]

Reference 1 - 0.11% Coverage

Requires credit cards to register

Reference 2 - 0.06% Coverage

some drivers avoid certain locations due to high traffic, so in some locations, it is difficult to get a ride from/ to.

Reference 3 - 0.06% Coverage

Yet, they can be difficult to access during high peak season.

Reference 4 - 0.09% Coverage

not reaching every where

Inconvenient

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 3 references coded [0.14% Coverage]

Reference 1 - 0.03% Coverage

Using a ride-hailing service here can limit you because you can't always leave places as soon as you want to.

Reference 2 - 0.06% Coverage

but they have their limitations (cost wise and not friendly for a large family etc)

Reference 3 - 0.05% Coverage

cannot accommodate large numbers/families

Increases Traffic

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 5 references coded [0.16% Coverage]

Reference 1 - 0.04% Coverage

at the same time it would increase the traffic in Bahrain

Reference 2 - 0.02% Coverage

The increase of such services could contribute to traffic congestion.

Reference 3 - 0.01% Coverage

traffic

Reference 4 - 0.05% Coverage

drawback: still fosters car centric city planning and fuel usage

Reference 5 - 0.04% Coverage

Furthermore, companies like Uber disrupt traditional transportation services and local taxis and cause congestion.

Lack of Privacy

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 2 references coded [0.10% Coverage]

Reference 1 - 0.04% Coverage

no privacy

Reference 2 - 0.06% Coverage

no privacy

Lack of Safety

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 19 references coded [0.99% Coverage]

Reference 1 - 0.04% Coverage

safety issues

Reference 2 - 0.07% Coverage

safety for women

Reference 3 - 0.04% Coverage

safety element (Uber drivers).

Reference 4 - 0.08% Coverage

not safe for females alone

Reference 5 - 0.05% Coverage

no safety

Reference 6 - 0.06% Coverage

security

Reference 7 - 0.01% Coverage

saftey from driver

Reference 8 - 0.04% Coverage

could be dangerous, can’t be fully comfortable

Reference 9 - 0.06% Coverage

safety

Reference 10 - 0.05% Coverage

security

Reference 11 - 0.01% Coverage

security

Reference 12 - 0.05% Coverage

security

Reference 13 - 0.06% Coverage

not safe

Reference 14 - 0.07% Coverage

security

Reference 15 - 0.06% Coverage

not safe

Reference 16 - 0.06% Coverage

safety

Reference 17 - 0.06% Coverage

security

Reference 18 - 0.02% Coverage

security

Reference 19 - 0.08% Coverage

not reliable for women

Slow Service

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 8 references coded [0.55% Coverage]

Reference 1 - 0.11% Coverage

It takes time to arrive

Reference 2 - 0.04% Coverage

having to wait for the ride (if not close)

Reference 3 - 0.06% Coverage

waiting period

Reference 4 - 0.11% Coverage

Time factor

Reference 5 - 0.07% Coverage

take time to get one

Reference 6 - 0.11% Coverage

Waiting time

Reference 7 - 0.01% Coverage

long wait times

Reference 8 - 0.04% Coverage

Waiting time

Unavailable

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 7 references coded [0.39% Coverage]

Reference 1 - 0.06% Coverage

Drawbacks, traffic delays can increase costs, can be difficult to find at pick times.

Reference 2 - 0.06% Coverage

some drivers avoid certain locations due to high traffic, so in some locations, it is difficult to get a ride from/ to

Reference 3 - 0.02% Coverage

Not available everywhere

Reference 4 - 0.06% Coverage

Yet, they can be difficult to access during high peak season.

Reference 5 - 0.04% Coverage

However, they might be inaccessible during times of high demand.

Reference 6 - 0.09% Coverage

although in some instances where demand is high they might become inaccessible.

Reference 7 - 0.06% Coverage

Main downside is that finding one, especially taxis, is not always guaranteed.

Unclean

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 3 references coded [0.14% Coverage]

Reference 1 - 0.07% Coverage

not clean

Reference 2 - 0.05% Coverage

hygiene

Reference 3 - 0.02% Coverage

not clean

Unreliable

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 6 references coded [0.35% Coverage]

Reference 1 - 0.06% Coverage

Drawbacks is lack of 100% confirmation when pre-booking.

Reference 2 - 0.05% Coverage

is less trusty compared to regular taxi services.

Reference 3 - 0.07% Coverage

might not available on time

Reference 4 - 0.06% Coverage

they could cancel the service last minute.

Reference 5 - 0.02% Coverage

the service can be unreliable

Reference 6 - 0.09% Coverage

not reaching every where

Untrustworthy Drivers

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 31 references coded [1.75% Coverage]

Reference 1 - 0.03% Coverage

Not every driver has the same ethics in which riders may encounter unprofessional or unsafe drivers.

Reference 2 - 0.07% Coverage

One drawback is that drivers are sometimes untrustworthy.

Reference 3 - 0.06% Coverage

the people recruited by these companies need to be properly vetted.

Reference 4 - 0.05% Coverage

As a drawback, specifically with Uber, the drivers sometimes concern me.

Reference 5 - 0.07% Coverage

I don’t prefer riding with strangers.

Reference 6 - 0.06% Coverage

With ride-hailing, the drivers are often unprofessional compared to a taxi service.

Reference 7 - 0.05% Coverage

In Bahrain it is not much of an issue but getting in a car with strangers can often be risky,

Reference 8 - 0.11% Coverage

I don’t get in a car with people I don’t know.

Reference 9 - 0.01% Coverage

Greedy drivers/ frauds

Reference 10 - 0.06% Coverage

but riding with strangers is not something I welcome

Reference 11 - 0.07% Coverage

get in a car with someone I don’t know is not something I would fathom.

Reference 12 - 0.09% Coverage

As for the drawback, I have come across pieces of news documenting unscrupulous behavior from drivers.

Reference 13 - 0.01% Coverage

saftey from driver

Reference 14 - 0.02% Coverage

some drivers are rude

Reference 15 - 0.07% Coverage

but as a drawback, I feel I am still being exposed to strangers with taxi/uber services.

Reference 16 - 0.04% Coverage

However, the drivers can be deceptive and underhanded.

Reference 17 - 0.05% Coverage

For the drawback, I would say riding with strangers.

Reference 18 - 0.05% Coverage

a taxi will have you only and the driver but in my opinion it may be dangerous

Reference 19 - 0.09% Coverage

the downside is that the drivers (especially with Uber and Lyft) are often untrustworthy.

Reference 20 - 0.04% Coverage

but I also know that the drivers can be a bit of an issue.

Reference 21 - 0.07% Coverage

ome of the drivers are not properly screened when recruited by the likes of Uber which raises concern on how they might act and behave.

Reference 22 - 0.04% Coverage

Some drivers might be not that friendly is possibly the main drawback.

Reference 23 - 0.06% Coverage

these companies have a bad reputation based on the people they employ

Reference 24 - 0.05% Coverage

The routes they choose might be intentional to ensure profit maximization.

Reference 25 - 0.03% Coverage

driver dishonesty

Reference 26 - 0.05% Coverage

Taxi drivers are known for taking longer routes so they can charge more.

Reference 27 - 0.09% Coverage

but I would rather not ride with strangers - especially untrained personnel that are employed by Uber

Reference 28 - 0.07% Coverage

As far as drawbacks are concerned, I know that issues with driver behavior have been documented in the news

Reference 29 - 0.04% Coverage

but of course the driver has to be someone that can be trusted.

Reference 30 - 0.07% Coverage

also risky getting in a car with a stranger.

Reference 31 - 0.07% Coverage

I know Uber as an example has been banned in certain countries based on certain acts carried out by nefarious drivers.

Appendix E: Externalities (Action)

Active Mobility

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 5 references coded [0.25% Coverage]

Reference 1 - 0.11% Coverage

Walk more than car use if I could

Reference 2 - 0.04% Coverage

walk nearby places

Reference 3 - 0.02% Coverage

walking, if possible.

Reference 4 - 0.05% Coverage

I always prefer to go by walk if it is walkable distance

Reference 5 - 0.04% Coverage

biking

Carpooling

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 15 references coded [1.16% Coverage]

Reference 1 - 0.11% Coverage

Carpooling

Reference 2 - 0.11% Coverage

My siblings and I use one car for most of our rides

Reference 3 - 0.11% Coverage

Carpooling

Reference 4 - 0.01% Coverage

Car pooling

Reference 5 - 0.01% Coverage

car pooling

Reference 6 - 0.06% Coverage

Car pooling

Reference 7 - 0.11% Coverage

Car pooling for my kids to go and come back from school

Reference 8 - 0.10% Coverage

by mobility in groups in one car if possible.

Reference 9 - 0.11% Coverage

Yes. Synchronize visits to cover other family members requirements

Reference 10 - 0.06% Coverage

We sometimes carpool if we’re a group on the same trip.

Reference 11 - 0.11% Coverage

Try to go out in one car

Reference 12 - 0.04% Coverage

I have started carpooling

Reference 13 - 0.05% Coverage

I try to carpool with friends and family members, especially for long distance travel.

Reference 14 - 0.11% Coverage

Carpooling

Reference 15 - 0.05% Coverage

more passengers.

Curbing of Consumerist Behavior

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 12 references coded [0.95% Coverage]

Reference 1 - 0.02% Coverage

reduce

Reference 2 - 0.06% Coverage

use organic products

Reference 3 - 0.08% Coverage

use better packaging and less bags.

Reference 4 - 0.11% Coverage

Use less plastic

Reference 5 - 0.11% Coverage

Use recyclable materials

Reference 6 - 0.11% Coverage

Use less plastic

Reference 7 - 0.05% Coverage

Use less plastic

Reference 8 - 0.11% Coverage

Use less plastic

Reference 9 - 0.11% Coverage

Use less plastic

Reference 10 - 0.11% Coverage

Using less plastic

Reference 11 - 0.06% Coverage

I also try to drive efficiently, prioritize more efficient car purchases, and hold onto cars as long as I can.

Reference 12 - 0.01% Coverage

not use plastic

Plant Trees

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 1 reference coded [0.02% Coverage]

Reference 1 - 0.02% Coverage

plant trees

Recycling

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 16 references coded [1.04% Coverage]

Reference 1 - 0.03% Coverage

recycle more

Reference 2 - 0.06% Coverage

reuse, and recycl

Reference 3 - 0.07% Coverage

Recycle more

Reference 4 - 0.11% Coverage

Recycle.

Reference 5 - 0.11% Coverage

Recycle more

Reference 6 - 0.11% Coverage

Recycle more

Reference 7 - 0.04% Coverage

I always recycle

Reference 8 - 0.03% Coverage

Recycle more

Reference 9 - 0.07% Coverage

recycle more

Reference 10 - 0.11% Coverage

Recycle more.

Reference 11 - 0.05% Coverage

recycle more.

Reference 12 - 0.07% Coverage

Recycle more

Reference 13 - 0.03% Coverage

I would like to recycle more

Reference 14 - 0.03% Coverage

recycling

Reference 15 - 0.10% Coverage

I try to recycle every now and then to make up for my carbon footprint.

Reference 16 - 0.03% Coverage

im trying to recycle as much as possible

Reduce Car Usage

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 12 references coded [0.98% Coverage]

Reference 1 - 0.11% Coverage

Walk more than car use if I could

Reference 2 - 0.11% Coverage

Reduce the use of car

Reference 3 - 0.04% Coverage

minimize using car

Reference 4 - 0.09% Coverage

using car for less time

Reference 5 - 0.09% Coverage

I am trying to lower my environmental footprint by driving only when needed,

Reference 6 - 0.11% Coverage

I try to limit unnecessary journeys using my personal car.

Reference 7 - 0.03% Coverage

Fewer trips

Reference 8 - 0.11% Coverage

Minimize my CAR usage

Reference 9 - 0.11% Coverage

Reduce trips as much as possible

Reference 10 - 0.04% Coverage

think if you can reduce the amount of using the car then you should do it

Reference 11 - 0.05% Coverage

Using less cars

Reference 12 - 0.09% Coverage

I am trying to minimize the number of non-essential trips or journeys I make.

Spread Awareness

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 1 reference coded [0.11% Coverage]

Reference 1 - 0.11% Coverage

Spread awareness

Switching to Electric Vehicles

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 1 reference coded [0.04% Coverage]

Reference 1 - 0.04% Coverage

Definitely, which is why I've considered switching to an electric vehicle to lower my carbon footprint

Use of Public Transport

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 5 references coded [0.34% Coverage]

Reference 1 - 0.11% Coverage

Use of public tranportation

Reference 2 - 0.03% Coverage

taking public transport more often

Reference 3 - 0.05% Coverage

public buses to commute from one place to another.

Reference 4 - 0.11% Coverage

Use public transportation if it is available

Reference 5 - 0.05% Coverage

We use metros and trains when traveling.

Appendix F: Externalities (Inaction)

Denial of Responsibility and Downplaying of Impact

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 24 references coded [2.20% Coverage]

Reference 1 - 0.11% Coverage

I am not the one to take action

Reference 2 - 0.11% Coverage

At the moment, I'm not currently doing anything, as I believe that my minimal to moderate use of a car doesn't car contribute to the aforementioned issue as heavily as intensive car users do.

Reference 3 - 0.08% Coverage

But you can't put the blame of all the ecological problems on the car using. It is a part of larger scale of factors.

Reference 4 - 0.05% Coverage

Not much I can do

Reference 5 - 0.04% Coverage

the reality is that this cannot be boiled down to individuals in areas where public transport is redundant or not even available. In Bahrain, where I currently reside, the only

Reference 6 - 0.11% Coverage

This has to be solved by the authorities.

Reference 7 - 0.11% Coverage

I feel I am part of a much bigger problem.

Reference 8 - 0.11% Coverage

I cannot consider myself part of the problem if I am owning a car out of necessity given the lack of alternatvies.

Reference 9 - 0.11% Coverage

Yes, but I not alone in taking the blame

Reference 10 - 0.09% Coverage

Not something I can control

Reference 11 - 0.02% Coverage

I do but I am too tired and unimpowered to do anything about it

Reference 12 - 0.07% Coverage

but I can’t bring myself to drastically inconvenience myself when corporations and business will negate it, with 1000x the impact, by taking the lowest-cost highest-profit option at the price of environmental and urban sustainability.

Reference 13 - 0.05% Coverage

dont feel responsible as the country has afforded me with no other option that would not decrease my quality of life

Reference 14 - 0.07% Coverage

I don’t think I am individually responsible but I am part of the car-oriented culture so I think I am contributing somewhat.

Reference 15 - 0.11% Coverage

That is government responsibility

Reference 16 - 0.09% Coverage

I can’t say I’m taking any actions to offset this.

Reference 17 - 0.11% Coverage

Can’t be the responsibility of one person.

Reference 18 - 0.11% Coverage

I don’t feel responsible for this.

Reference 19 - 0.11% Coverage

I will leave that to the experts

Reference 20 - 0.11% Coverage

I can’t take any actions to change that

Reference 21 - 0.11% Coverage

Not my position

Reference 22 - 0.11% Coverage

No, this has be considered in a more higher and official level.

Reference 23 - 0.11% Coverage

This is a much bigger problem, a societal problem. So, no.

Reference 24 - 0.11% Coverage

I don’t feel responsible.

Lack of Alternatives

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 16 references coded [1.28% Coverage]

Reference 1 - 0.01% Coverage

I do think it's hard to find an alternative.

Reference 2 - 0.08% Coverage

If Bahrain Metro operates, I will use it immediately most of the time.

Reference 3 - 0.01% Coverage

where public transport is redundant or not even available

Reference 4 - 0.09% Coverage

I would have to say yes but the lack of available alternatives is not something I can take responsibility for.

Reference 5 - 0.09% Coverage

Bahrain lacks alternative transportation options. So, no I cannot assume responsibility for this.

Reference 6 - 0.11% Coverage

I cannot consider myself part of the problem if I am owning a car out of necessity given the lack of alternatvies.

Reference 7 - 0.11% Coverage

Partly only given that I have no alternative options.

Reference 8 - 0.10% Coverage

Because the alternatives are limited in my country.

Reference 9 - 0.11% Coverage

Considering there aren't any viable options, no.

Reference 10 - 0.03% Coverage

I would work on alternative transportation methods such as Metros

Reference 11 - 0.05% Coverage

I don't know what I can do, save for advocating for more and better public transit options.

Reference 12 - 0.06% Coverage

if a valid option was presented that will get me where i need to be in a timely and comfortable way, i would surely decrease my use of the car.

Reference 13 - 0.10% Coverage

no since other options are not at the same level.

Reference 14 - 0.11% Coverage

Yes but the current available options in Bahrain are limited and better schemes should be introduced

Reference 15 - 0.11% Coverage

No suitable alternative in Bahrain until there is safe, accessible, reliable public transport with women only carriages.

Reference 16 - 0.11% Coverage

No, we all have our private cars here in Bahrain otherwise it will be impossible to practically get around in this country.

Lack of National Policy and Support

Files\\V3 Mobility-as-a-Service in Bahrain (RH Responses) Open-endedV2 copy - § 6 references coded [0.41% Coverage]

Reference 1 - 0.04% Coverage

And if there is one, I think it would have to be the creation of a well-connected metro (but even then, it's tough to go given the way residential areas are clustered in Bahrain)

Reference 2 - 0.10% Coverage

If organisation and government encouraged car pooling via tax/petrol/time of arrival to work or school.

Reference 3 - 0.07% Coverage

but there is a lack of infrastructure to support that decision, so my hands are tied. This needs to be supported by the Bahraini Government as a whole and it does not come down to an individual choice only.

Reference 4 - 0.11% Coverage

This has to be solved by the authorities.

Reference 5 - 0.04% Coverage

I would change the working hours of some jobs to reduce traffic. I would restrict heavy vehicles at peak hours.

Reference 6 - 0.05% Coverage

i dont feel responsible as the country has afforded me with no other option that would not decrease my quality of life.

Appendix G: Survey Introductory Statement

This questionnaire is part of my Ph.D. thesis entitled "*The Co-design of MaaS-Lite Bundles by Commuters in Bahrain: Environmental Implications of Customization Decisions and Bottom-up Mobility Planning*".

The questionnaire aims to shed light on commuters' behavioral stance (namely, their environmental conscientiousness) towards the following aspects of urban mobility:

Preferences towards multimodal transportation (bundling of several urban mobility modes i.e., public transport [national bus services] + ride-hailing [taxi/Uber] + active mobility [cycling/walking] etc.)

Preferences and openness towards active mobility (cycling, walking, and other forms of non-motorized transportation).

Readiness towards the adoption of Intelligent Mobility Services (ITS) in general and Mobility-as-a-Service in particular.

Gauging of commuter sentiment towards the (hypothetical) implementation of national congestion reduction measures and public transport priority measures.

Your participation in this study is highly appreciated and will aid in the development of a deeper understanding of how Bahrain can succeed in meaningfully and sustainably shifting away from the current over-dependence on private vehicles in general and, more importantly, overuse of private Single-Occupancy Vehicles (SOVs) in particular.

Appendix H: Survey Conclusionary Statement

As a concluding remark, it is fitting to invoke Braess's Paradox

"The Braess's Paradox (BP) is the observation that adding one or more roads to the existing road network will counter-intuitively increase traffic congestion and slow down the overall traffic flow."

An additional paradox can also be observed from an issue that has long plagued roads in Bahrain (with no end in sight!): A road network overstretched by privately owned single-occupancy vehicles transporting, mostly, empty seats.

Merging the two together and one is forced to question whether the aim of continuous road expansion projects is simply so we can continue moving more empty seats around?

Thank you for putting in the time and effort to complete this questionnaire.

If you have any further queries or observations arising from this study, please feel free to write to me by email (naser.ayman.naser@gmail.com)

Thank you.

الملخص

تُركز هذه الدراسة بشكل أساسي على مفهوم التنقل الناشئ (أنماط التنقل الحديثة) والمعروف بـ "التنقل كخدمة (Mobility as a Service - MaaS) " وتأثيراته المُستدامة على أنظمة النقل في مملكة البحرين. كما تتبنى الدراسة نطاقًا مُحددًا يركز على نوع واحد من الرحلات (التنقل إلى مكان العمل أو مؤسسات التعليم العالي) وخيارات النقل المتاحة في البحرين.

تم اعتماد نهج متعدد الأساليب يجمع بين التحليل الموضوعي والإحصائي لتفسير بيانات الاستبيانات والدراسات الاستقصائية التي تم جمعها من الركاب لفهم مواقفهم وسلوكياتهم وتصوراتهم تجاه أنماط النقل المختلفة وتأثيراتها البيئية. وعلى الرغم من أن النتائج الرئيسية تشير بشكل قوي إلى استمرار تفضيل خدمات النقل المعتمدة على السيارات، إلا أن إطلاق مبادرات تعتمد على إدخال أنماط نقل بديلة، وتوسيع نطاق استخدام تصنيف الانبعاثات وتسعيرها، وحملات التوعية، قد برزت بشكل عملي باعتبارها خيارات واعدة لتحفيز التوجه نحو التنقل المستدام في المملكة. وتم تحديد هذه الخيارات بناءً على أسئلة الاستبيان التي تقيّم عادات التنقل وتفضيلات الركاب في البحرين وعند سفرهم إلى دول أخرى بالخارج.

وعلى المستوى المفاهيمي، تُظهر الدراسة التنوع المستمر في كيفية تعريف وتطوير مفهوم التنقل كخدمة (MaaS) ليشمل مفاهيم جديدة. لذا تختتم الدراسة باقتراح إطار عمل يستنبط المفاهيم المختلفة لمفهوم التنقل كخدمة استنادًا إلى معايير مشتركة مستخلصة من مراجعة موسعة للدراسات السابقة. كما تقترح نسخة مُحسّنة من مفهوم التنقل كخدمة تتناسب مع نطاق هذه الدراسة: (التنقل-كخدمة للرحلات اليومية - Commute-Mobility as a Service - C-MaaS).

وأخيرًا، تقترح الدراسة اعتماد تقنيات نمذجة الانبعاثات لإجراء تحليل أكثر تفصيلًا لتأثيرات الاستدامة والانبعاثات الناتجة عن تطبيق مفهوم التنقل كخدمة (MaaS) في البحرين كموضوع للبحث المستقبلي.

جامعة البحرين

كلية العلوم **برنامج البيئة والتنمية المستدامة**

التصميم التشاركي لخدمات التنقل الخفيف (MaaS-Lite) من قبل المُسافرين في البحرين: دراسة الآثار البيئية لخيارات التخصيص ودور التخطيط التصاعدي في تحسين وتطوير أنظمة النقل

أطروحة مقدمة كجزء من متطلبات الحصول على درجة الدكتوراه في برنامج البيئة والتنمية المستدامة

إعداد

ناصر أيمن ناصر

202008060

إشراف

د. طارق محمود

إستاذ مشارك (كيمياء)

مملكة البحرين

فبراير 2025