



Politecnico
di Bari

Repository Istituzionale dei Prodotti della Ricerca del Politecnico di Bari

Reshaping mobility through MaaS: business model archetypes, actor dynamics, and system success

This is a PhD Thesis

Original Citation:

Reshaping mobility through MaaS: business model archetypes, actor dynamics, and system success / De Vita, Davide. - ELETTRONICO. - (2026).

Availability:

This version is available at <http://hdl.handle.net/11589/297580> since: 2026-03-02

Published version

DOI:

Publisher: Politecnico di Bari

Terms of use:

(Article begins on next page)

			DICATECh			
			2026	D.R.S.A.T.E.	POLITECNICO DI BARI	10
	Abstract This thesis examines how Mobility as a Service (MaaS) reshapes the mobility ecosystem, and which business model and ecosystem configurations are associated with successful multidimensional goal achievement. Adopting an ecosystem-level perspective, it conceptualises MaaS not as a single “app” solution but as a transformation process enacted through distributed firm-level business model adaptation and the (re)negotiation of interdependencies across services, data, interfaces, payments, and governance. Across four interrelated empirical studies, the thesis (i) maps recurring MaaS provider business model archetypes, (ii) analyses incumbents’ reconfiguration strategies in the transition to MaaS, (iii) traces role-based start-up trajectories (orchestrators, enablers, components), and (iv) links ecosystem configurations to multidimensional performance. The findings show that MaaS does not converge toward a single dominant design. Instead, heterogeneous actor logics, legacy asset positions, and contextual conditions generate multiple operational configurations characterised by distinct trade-offs in integration scope, governance, and monetisation, resulting in different viability conditions and uneven performance profiles. In particular, technical integration emerges as necessary but insufficient: outcomes depend on the alignment between business model choices, ecosystem governance arrangements, and actors’ orchestration and coordination capabilities, which helps explain why many initiatives remain pilot-bound while others evolve toward more stable configurations. From a theoretical perspective, the thesis advances MaaS and ecosystem research by shifting attention from static explanations based on barriers and enabling conditions toward a configurational view of ecosystem transformation, highlighting equifinality and fit as central explanatory mechanisms. From a practical perspective, the findings provide guidance for MaaS providers, incumbents, start-ups, and policy-makers, emphasising the need for configuration clarity, ecosystem-facing capabilities, and institutional frameworks that support coordination, interoperability, and scaling beyond pilots.		2026	PhD in Risk and Environmental, Territorial and Building Development		2026
			De Vita Davide	Coordinator: Prof. Francesco Fiorito		
				XXXVIII CYCLE Curriculum: ING-IND/35		
				DICATECh Department of Civil, Environmental, Building Engineering and Chemistry		
					De Vita Davide	
					Reshaping Mobility through MaaS: Business Model Archetypes, Actor Dynamics, and System Success	
			Reshaping Mobility through MaaS: Business Model Archetypes, Actor Dynamics, and System Success		Prof. Ing. Nunzia Carbonara Department of Mechanics, Mathematics and Management Polytechnic University of Bari Prof. Ing. Antonio Messeni Petruzzelli Department of Mechanics, Mathematics and Management Polytechnic University of Bari Prof. Ing. Michele Ottomanelli Department of Civil, Environmental, Land, Building and Chemical Engineering Polytechnic University of Bari	
			10			

			DICATEch			
				D.R.S.A.T.E.	POLITECNICO DI BARI	10
	Abstract This thesis examines how Mobility as a Service (MaaS) reshapes the mobility ecosystem, and which business model and ecosystem configurations are associated with successful multidimensional goal achievement. Adopting an ecosystem-level perspective, it conceptualises MaaS not as a single “app” solution but as a transformation process enacted through distributed firm-level business model adaptation and the (re)negotiation of interdependencies across services, data, interfaces, payments, and governance. Across four interrelated empirical studies, the thesis (i) maps recurring MaaS provider business model archetypes, (ii) analyses incumbents’ reconfiguration strategies in the transition to MaaS, (iii) traces role-based start-up trajectories (orchestrators, enablers, components), and (iv) links ecosystem configurations to multidimensional performance. The findings show that MaaS does not converge toward a single dominant design. Instead, heterogeneous actor logics, legacy asset positions, and contextual conditions generate multiple operational configurations characterised by distinct trade-offs in integration scope, governance, and monetisation, resulting in different viability conditions and uneven performance profiles. In particular, technical integration emerges as necessary but insufficient: outcomes depend on the alignment between business model choices, ecosystem governance arrangements, and actors’ orchestration and coordination capabilities, which helps explain why many initiatives remain pilot-bound while others evolve toward more stable configurations. From a theoretical perspective, the thesis advances MaaS and ecosystem research by shifting attention from static explanations based on barriers and enabling conditions toward a configurational view of ecosystem transformation, highlighting equifinality and fit as central explanatory mechanisms. From a practical perspective, the findings provide guidance for MaaS providers, incumbents, start-ups, and policy-makers, emphasising the need for configuration clarity, ecosystem-facing capabilities, and institutional frameworks that support coordination, interoperability, and scaling beyond pilots.		2026	PhD in Risk and Environmental, Territorial and Building Development		2026
			De Vita Davide	Coordinator: Prof. Francesco Fiorito XXXVIII CYCLE Curriculum: ING-IND/35 DICATEch Department of Civil, Environmental, Land, Building Engineering and Chemistry	De Vita Davide	
			Reshaping Mobility through MaaS: Business Model Archetypes, Actor Dynamics, and System Success	Prof. Ing. Nunzia Carbonara Department of Mechanics, Mathematics and Management Polytechnic University of Bari Prof. Ing. Antonio Messeni Petruzzelli Department of Mechanics, Mathematics and Management Polytechnic University of Bari Prof. Ing. Michele Ottomanelli Department of Civil, Environmental, Land, Building and Chemical Engineering Polytechnic University of Bari		
			10			

			
	D.R.S.A.T.E.	POLITECNICO DI BARI	10
	PhD in Risk and Environmental, Territorial and Building Development		2026
	Coordinator: Prof. Francesco Fiorito		
	XXXVIII CYCLE Curriculum: ING-IND/35		
	DICATECh Department of Civil, Environmental, Land Building Engineering and Chemistry		
		De Vita Davide	
		Reshaping Mobility through MaaS: Business Model Archetypes, Actor Dynamics, and System Success	
		Prof. Ing. Nunzia Carbonara <i>Department of Mechanics, Mathematics and Management Polytechnic University of Bari</i> Prof. Ing. Antonio Messeni Petruzzelli <i>Department of Mechanics, Mathematics and Management Polytechnic University of Bari</i> Prof. Ing. Michele Ottomanelli <i>Department of Civil, Environmental, Land, Building and Chemical Engineering Polytechnic University of Bari</i>	

EXTENDED ABSTRACT (eng)

Throughout the twentieth century, urban mobility systems became structurally organised around private car ownership, generating persistent patterns of car dependence with enduring consequences for land use, travel behaviour, and sustainability (Newman and Kenworthy, 1999; Banister, 2008). Although recent decades have witnessed a rapid expansion of digitally enabled, on-demand, and shared mobility services, these innovations have largely produced a fragmented landscape of alternatives that rarely challenges the systemic dominance of the private car (Ho et al., 2018; Lyons et al., 2019). Against this backdrop, Mobility as a Service (MaaS) has emerged as a prominent approach aimed at integrating multiple transport services into a single, user-oriented mobility offering (typically delivered through a digital platform) to enable seamless multimodal travel (Hietanen, 2014; MaaS Alliance, 2017; Jittrapirom et al., 2017). Realising MaaS, however, is inherently complex because it entails a structural transformation of the mobility ecosystem, requiring the alignment of heterogeneous services, data, and actors through interoperable technical architectures as well as viable commercial and ecosystem governance arrangements (Jacobides et al., 2006; Adner, 2017; Kapoor, 2018). Despite a rapidly expanding MaaS literature, the existing research has predominantly focused on user adoption (Ho et al., 2018), conceptual definitions (Jittrapirom et al., 2017), or lists of

barriers and enabling conditions (Butler et al., 2021), offering, however, only a limited insight into MaaS as a dynamic ecosystem-formation process on the supply side. Prior work recognises the importance of business models and governance for MaaS implementation (Hensher et al., 2020; Krauss et al., 2022), but offers limited insight into how incumbents and start-ups adapt over time to emerging interdependencies and how these distributed adaptations shape MaaS configurations and performance. Consequently, the literature still lacks an integrated understanding of how MaaS reshapes the mobility ecosystem through actor-level reconfiguration, and why this transformation so often results in stalled implementations or highly uneven outcomes across contexts. To address this gap, the thesis adopts a multilevel configurational perspective and conceptualises MaaS as an ecosystem transformation process enacted through distributed firm-level strategic adaptation. Through four interrelated empirical studies, the thesis develops a cumulative explanation linking actor-level business model reconfiguration to heterogeneous ecosystem configurations and, ultimately, to differentiated multidimensional goal achievement. Specifically, the studies examine (i) recurring MaaS provider business model configurations, (ii) incumbent business model reconfiguration strategies, (iii) role-based business model evolution of MaaS start-ups, and (iv) how alternative ecosystem configurations translate into multidimensional goal achievement. Overall, the thesis shows that MaaS does not converge on a single dominant design. Instead, heterogeneous actor logics and contextual conditions generate multiple ecosystem configurations with distinct viability conditions and uneven performance profiles. First, the thesis maps the MaaS provider design space and identifies recurring business model archetypes that capture different implementation logics and trade-offs in integration scope, governance, and monetisation. Second, it shows that MaaS induces systematic business model reconfiguration among incumbents, who reposition within an ecosystem architecture where competitive advantage increasingly hinges on the ability to access and coordinate complements, and to influence key control points such as the customer interface, data,

and ticketing and settlement. Third, it shows that start-ups contribute to ecosystem formation through role-based trajectories (whether as orchestrators, enablers, or components), each associated with distinct capability-building priorities and partnership requirements. Fourth, by conceptualising “success” as multidimensional goal achievement, the thesis reveals that performance is configurational: technical integration is necessary but insufficient when organizational coordination and revenue architectures remain fragile. Furthermore, differences in governance and orchestration capacity, together with the coherence between business model choices and contextual conditions, play a key role in explaining why many MaaS initiatives remain pilot-bound while others progress toward more stable configurations. These findings hold significant implications for theory and practice. From a theoretical perspective, the thesis advances MaaS and ecosystem scholarship in several ways. First, it shifts the analytical focus from static explanations based on barriers and enabling conditions toward a transformation-and-configuration perspective. By conceptualising MaaS as a dynamic ecosystem-formation process, the thesis shows that outcomes depend on how actors respond to constraints through distributed business model adaptation, capability development, and the renegotiation of interdependencies across services, data, interfaces, payments, and governance, rather than on the mere presence of favourable conditions (Adner, 2017; Jacobides et al., 2018; Cozzolino and Geiger, 2024). Second, the thesis strengthens the industry-side understanding of MaaS by providing an empirically grounded vocabulary of ecosystem building blocks—provider business model archetypes, incumbent adaptation mechanisms, and start-up roles and evolution paths, thereby reducing conceptual ambiguity and enabling systematic comparison across heterogeneous cases (König et al., 2016; Krauss et al., 2022; Massa et al., 2017). In addition, the findings reinforce a configurational and equifinal view of MaaS evolution, challenging assumptions of convergence toward a single dominant design. MaaS viability and scalability are shown to depend on alignment among actor portfolios, legacy asset bases, institutional positions, governance arrangements,

and contextual conditions, highlighting alignment as central explanatory mechanisms (Gresov and Drazin, 1997; Meyer et al., 1993; Hensher et al., 2020). Finally, the thesis reconnects MaaS formation to MaaS performance by theorising success as multidimensional goal achievement rather than as a single outcome variable. This perspective explains why initiatives may meet baseline technical requirements yet remain pilot-bound due to misalignment across organizational, economic, user, societal, and contextual dimensions, extending configurational thinking to multidimensional goal achievement assessment in platform-based ecosystems (Sochor et al., 2018; Pangbourne et al., 2020; Orozco-Fontalvo et al., 2024). From a practical perspective, results offer guidance for the main actors involved in MaaS ecosystems. For MaaS providers and ecosystem orchestrators, the key implication is the need for configuration clarity: rather than pursuing generic integration goals, providers must make explicit and coherent trade-offs—such as integration depth versus coordination complexity, subscription-based versus transaction- or commission-based revenues, B2C reach versus B2B stability, and scalability versus control over service quality—to avoid unstable hybrid configurations. For incumbent service providers and technology firms, the thesis shows that MaaS requires genuine business model innovation rather than the deployment of a standalone platform. Effective participation depends on developing ecosystem-facing capabilities, including partner onboarding, contractual governance, interface and data management, and service-level orchestration, alongside traditional operational or technological strengths. For start-ups and investors, the role-based lens clarifies that MaaS ventures face distinct capability-building requirements depending on whether they act as orchestrators, enablers, or components. Making these requirements explicit supports more disciplined scaling strategies and investment decisions and reduces the risk of costly role pivots. For cities, public transport authorities, and policymakers, MaaS should be governed as an ecosystem configuration challenge rather than as the procurement of an app or a sequence of pilots. The main public levers lie in the institutional and contractual architecture enabling

multi-actor integration—particularly access to ticketing and payments, interoperability standards, data governance, and the allocation of roles and decision rights. The benchmarking framework proposed in the thesis further supports diagnostic, evidence-based governance by enabling systematic comparison across initiatives and over time.

keywords

Urban mobility; Mobility as a Service (MaaS); Mobility ecosystems; Business model archetypes; Ecosystem governance; Platform orchestration; Business model innovation; Start-up roles and evolution; Incumbent adaptation; MCDA.

EXTENDED ABSTRACT (ita)

Nel corso del XX secolo, i sistemi di mobilità urbana si sono progressivamente strutturati attorno al possesso dell'automobile privata, consolidando un assetto autocentrico che ha generato effetti di lungo periodo sull'uso del suolo, sui comportamenti di mobilità e sulla sostenibilità dei contesti urbani (Newman e Kenworthy, 1999; Banister, 2008). Sebbene negli ultimi decenni si sia assistito a una rapida diffusione di servizi di mobilità digitali, on-demand e condivisi, tali innovazioni hanno prevalentemente prodotto un insieme frammentato di alternative che raramente mette in discussione il predominio sistemico dell'automobile privata (Ho et al., 2018; Lyons et al., 2019). In questo scenario, la Mobility as a Service (MaaS) è emersa come un approccio volto a integrare molteplici servizi di trasporto in un'unica offerta di mobilità orientata all'utente — generalmente erogata tramite una piattaforma digitale — consentendo la pianificazione, la prenotazione e il pagamento di viaggi multimodali door-to-door (Hietanen, 2014; MaaS Alliance, 2017; Jittrapirom et al., 2017). La realizzazione della MaaS è tuttavia intrinsecamente complessa, poiché implica una trasformazione strutturale dell'ecosistema della mobilità, richiedendo l'allineamento di servizi, dati e attori eterogenei attraverso architetture tecniche interoperabili, nonché assetti commerciali e di governance in grado di garantirne la sostenibilità nel tempo (Jacobides et al., 2006; Adner, 2017; Ka-

poor, 2018). Nonostante la rapida espansione della letteratura sulla MaaS, gran parte della ricerca si è concentrata sull'adozione da parte degli utenti (Ho et al., 2018), sulle definizioni concettuali (Jittrapirom et al., 2017) o su elenchi di barriere e condizioni abilitanti (Butler et al., 2021), offrendo tuttavia un contributo limitato alla comprensione della MaaS come processo dinamico di formazione dell'ecosistema dal lato dell'offerta. Sebbene la letteratura riconosca che i modelli di business dei provider influenzano l'implementazione e la sostenibilità delle iniziative MaaS (Krauss et al., 2022) e che gli assetti di governance incidano sulle modalità concrete di organizzazione del servizio (Hensher et al., 2020), raramente viene analizzato come incumbent e start-up riconfigurino nel tempo modelli di business, capacità, partnership e ruoli in risposta alle interdipendenze emergenti, né come tali processi di adattamento distribuito si traducano in specifiche configurazioni ecosistemiche e nei relativi esiti di performance. Di conseguenza, permane una comprensione integrata ancora parziale di come la MaaS rimodelli l'ecosistema della mobilità attraverso processi di adattamento strategico a livello di impresa e del perché tali trasformazioni producano esiti eterogenei e spesso difficili da consolidare e scalare nei diversi contesti di implementazione. Per colmare questo gap, la tesi adotta una prospettiva configurazionale a livello di ecosistema e analizza la MaaS come un processo di trasformazione attuato attraverso l'adattamento strategico degli attori. Il lavoro si articola in quattro studi empirici interconnessi che esaminano: (i) le configurazioni ricorrenti dei modelli di business dei provider MaaS; (ii) le strategie di riconfigurazione adottate dagli incumbent; (iii) l'evoluzione dei modelli di business delle start-up MaaS in relazione al ruolo ecosistemico ricoperto; e (iv) la relazione tra configurazioni dell'ecosistema e raggiungimento multidimensionale degli obiettivi. Nel complesso, la tesi mostra che la MaaS non converge verso un unico design dominante; al contrario, l'interazione tra logiche attoriali eterogenee e condizioni contestuali genera molteplici configurazioni ecosistemiche, caratterizzate da differenti condizioni di sostenibilità e da profili di performance diseguali. In primo luogo, la tesi mappa lo spazio di progettazione dei provider

MaaS e identifica un insieme di archetipi ricorrenti di modelli di business che riflettono differenti logiche di implementazione e i relativi trade-off in termini di profondità di integrazione, assetti di governance e meccanismi di monetizzazione. In secondo luogo, mostra come la MaaS inneschi processi sistematici di riconfigurazione tra gli incumbent, i quali si riposizionano all'interno di un'architettura ecosistemica in cui il vantaggio competitivo dipende sempre più dall'accesso ai complementi e dalla capacità di influenzare punti chiave di coordinamento, quali l'interfaccia utente, i dati e i sistemi di bigliettazione e clearing. In terzo luogo, evidenzia come le start-up contribuiscano alla formazione dell'ecosistema attraverso traiettorie differenziate in funzione del ruolo ricoperto — orchestratori, abilitatori o componenti — ciascuna associata a specifiche priorità di sviluppo delle capacità e a distinti fabbisogni di partnership. Infine, concettualizzando il successo come raggiungimento multidimensionale degli obiettivi, la tesi dimostra che la performance è di natura configurazionale: l'integrazione tecnica rappresenta una condizione necessaria ma non sufficiente quando il coordinamento organizzativo e le architetture di ricavo risultano fragili. Le differenze nelle capacità di governance e di orchestrazione, insieme alla coerenza tra scelte di modello di business e condizioni contestuali, risultano pertanto decisive nel spiegare perché molte iniziative MaaS rimangano limitate a implementazioni instabili, mentre altre evolvono verso configurazioni più solide e durature. Dal punto di vista teorico, la tesi contribuisce alla letteratura sulla MaaS e sugli ecosistemi spostando l'attenzione analitica da spiegazioni statiche, basate su barriere e condizioni abilitanti, verso una prospettiva di trasformazione e configurazione. In questa prospettiva, gli esiti della MaaS dipendono da come gli attori rispondono ai vincoli attraverso l'adattamento distribuito dei modelli di business, lo sviluppo di nuove capacità e la rinegoziazione delle interdipendenze tra servizi, dati, interfacce, pagamenti e assetti di governance (Adner, 2017; Jacobides et al., 2018; Cozzolino e Geiger, 2024). La tesi rafforza inoltre la comprensione della MaaS dal lato industriale fornendo un vocabolario empirica-

mente fondato dei principali building blocks dell’ecosistema — archetipi di modello di business dei provider, meccanismi di adattamento degli incumbent e ruoli ed evoluzioni delle start-up — riducendo l’ambiguità concettuale e consentendo confronti sistematici tra casi eterogenei (König et al., 2016; Krauss et al., 2022; Massa et al., 2017). I risultati sostengono infine una visione configurazionale ed equifinale dell’evoluzione della MaaS, mostrando che sostenibilità e scalabilità dipendono dall’allineamento tra portafogli di attori, asset legacy, posizioni istituzionali, assetti di governance e condizioni contestuali (Gresov e Drizin, 1997; Meyer et al., 1993; Hensher et al., 2020). Dal punto di vista pratico, i risultati offrono indicazioni operative per i principali attori coinvolti negli ecosistemi MaaS. Per i provider MaaS e gli orchestratori emerge l’importanza della chiarezza configurazionale: più che perseguire obiettivi generici di integrazione, è necessario compiere scelte coerenti sui principali trade-off — tra profondità di integrazione e complessità di coordinamento, modelli di ricavo in abbonamento o transazionali, copertura B2C o stabilità B2B, nonché tra scalabilità e controllo della qualità del servizio — al fine di evitare configurazioni ibride instabili. Per gli incumbent e le imprese tecnologiche, la MaaS richiede una reale innovazione del modello di business e lo sviluppo di capacità orientate all’ecosistema, quali l’onboarding dei partner, la governance contrattuale, la gestione di interfacce e dati e l’orchestrazione dei livelli di servizio. Per start-up e investitori, la lente basata sui ruoli chiarisce che le iniziative MaaS presentano requisiti di sviluppo delle capacità differenti a seconda del ruolo ricoperto, favorendo strategie di crescita più disciplinate e riducendo il rischio di pivot costosi. Infine, per città, autorità di trasporto pubblico e policy-maker, la MaaS dovrebbe essere governata come una sfida di configurazione ecosistemica piuttosto che come l’acquisizione di un’app o una sequenza di progetti pilota. Le principali leve pubbliche risiedono nell’architettura istituzionale e contrattuale che abilita l’integrazione multi-attore — in particolare l’accesso ai sistemi di bigliettazione e pagamento, gli standard di interoperabilità, la governance dei dati e la chiara allocazione di ruoli e diritti decisionali —

mentre il framework di benchmarking proposto nella tesi supporta una governance diagnostica ed evidence-based, consentendo confronti sistematici tra iniziative e nel tempo.

keywords

Mobilità urbana; Mobility as a Service (MaaS); Ecosistemi di mobilità; Archetipi di modello di business; Governance degli ecosistemi; Orchestrazione di piattaforma; Innovazione del modello di business; Ruoli ed evoluzione delle start-up; Adattamento degli incumbent; MCDA.

INDEX

INTRODUCTION	2
1. The Global Design Space of MaaS: Business Model Archetypes and Provider Roles	12
Archetypal Business Models for Mobility as a Service (MaaS): Bridging Theory and Practice	13
1.1. Abstract and Keywords	13
1.2. Introduction	14
1.3. Theoretical Background	17
1.4. Methods	21
1.5. Results	32
1.5.1. Archetype 1: Mobility Platforms	32
1.5.2. Archetype 2: Highly-diversified Providers	34
1.5.3. Archetype 3: Lowly-diversified Providers	36
1.5.4. Archetype 4: Enablers	39
1.5.5. Archetype 5: Mobility Embedded Providers	41
1.6. Discussion and Conclusion	42
1.6.1. Implications of the study	Error! Bookmark not defined.
1.6.2 Limitations and Research Agenda	51
1.7. References	54

2. How Established Organizations Adapt to MaaS: Business Model Innovation Pathways 60

Embracing New Disruptions: Business Model Innovation in the Transition to Mobility as a Service (MaaS) 61

2.1	Abstract and Keywords	61
2.2	Introduction	62
2.3	Theoretical Background	67
2.4	Methods	74
2.5	Findings	84
2.5.1.	Service Providers	88
2.5.2.	Technology Providers	96
2.6	Discussion and Conclusion	104
2.6.1.	Implications for theory	107
2.6.2.	Implications for practice	108
2.6.3.	Limitations and Future Research Directions	109
2.7	References	111

3. Entrepreneurial Role Formation in MaaS Ecosystems: Start-ups' Adaptive Trajectories 122

Driving Mobility Innovations: Examining Mobility as a Service (MaaS) Start-ups Evolution from a Resource-Based View 123

3.1.	Abstract and Keywords	123
3.2.	Introduction	124
3.3.	Theoretical Background	129
3.4.	Methods	136
3.5.	Results	144
3.5.1.	MaaS Global (Orchestrator)	147
3.5.2.	SkedGo (Enabler)	150
3.5.3.	RideMovi (Component)	152

3.5.4.	Cross-case analysis	154
3.6.	Discussion and Conclusion	155
3.6.1.	Inception Phase	157
3.6.2.	Development Phase	157
3.6.3.	Scaling Phase	159
3.6.4.	Implications for theory	160
3.6.5.	Implications for practice	161
3.6.6.	Limitations and further research avenues	161
3.7.	References	162
3.8.	APPENDIX A – INTEVIEW QUESTIONS	172
4.	From Configurations to Outcomes: Benchmarking Success in MaaS Systems	173
	Towards Excellence: Developing a Multidimensional Benchmarking Framework for Assessing Success in Mobility as a Service (MaaS) Systems	174
4.1.	Abstract and Keywords	174
4.2.	Introduction	175
4.3.	Theoretical Background	180
4.3.1.	Disentangling the MaaS concept	180
4.3.2.	Research Gap	182
4.3.3.	A multidimensional framework for evaluating MaaS initiatives	184
4.4.	Methods	188
4.4.1.	Framework development	190
4.4.2.	Weighting of Dimensions using AHP	193
4.4.3.	Benchmarking and ranking using TOPSIS	199
4.4.4.	Data Collection	203
4.5.	Results	204

4.5.1. Weighting results	204
4.5.2. KPI results and Ideal MaaS	210
4.5.3. MaaS systems' evaluation results and rankings	218
4.5.4. Sensitivity Analysis	223
4.6. Discussion and Conclusion	225
4.6.1. Implications	228
4.6.2. Limitations	231
4.7. References	233
CONCLUSIONS	241
ACKNOWLEDGEMENTS	256
LIST OF FIGURES	257
LIST OF TABLES	259
BIBLIOGRAPHY	260
CURRICULUM	289

INTRODUCTION

Urban mobility constitutes a socio-technical system in which infrastructures, technologies, institutions, organisations, and everyday practices are deeply interdependent, in turn shaped by a long and path-dependent historical evolution (El-Sherif, 2021; Geels, 2005). Over the past two centuries, urban transport systems have progressed from compact “walking cities” to rail- and streetcar-based urban forms, and eventually to automobile-centred development. The widespread diffusion of the private car in the second half of the twentieth century, enabled by mass production, rising incomes, and substantial investment in road and highway infrastructure, fundamentally reshaped urban form and travel behaviour (Newman and Kenworthy, 1999; Banister, 2008). Over time, mobility systems became increasingly organised around individually owned vehicles, while public transport and non-motorised modes were often marginalised.

In recent decades, this deeply rooted car-centred system has been increasingly influenced by a combination of evolving societal values and technological innovations. Indeed, growing environmental awareness, concerns about resource efficiency, and a broader shift towards sustainability have progressively challenged the dominance of private car ownership, while changing user expectations have increased the demand for more flexible, on-demand, and service-oriented mobility solutions (Mukhtar-Landgren et al., 2016). In this context, new digital technologies have enabled the rapid proliferation of platform-based mobility services grounded in principles of access rather than ownership (Geissinger et al., 2020). Car sharing, bike sharing, scooter sharing, ride-hailing, and demand-responsive transport have expanded across cities, offering flexible, pay-per-use alternatives to the private car. Designed to support a wide range of use cases, from first- and last-mile connections to short intra-urban trips, these

services enable travellers to select modes according to situational needs rather than rely exclusively on a single, privately owned asset.

This variety of services reflects the logic of the sharing economy (Hamari et al., 2016) and, more specifically, the access economy (Belk, 2014), in which users prioritise temporary access to mobility assets over long-term ownership in exchange for lower fixed costs, higher flexibility, and reduced resource consumption. For many travellers, these solutions provide mobility precisely when needed, without the financial, environmental, and logistical burdens associated with maintaining a private vehicle (Machado et al., 2018).

At the same time, the digital technologies that underpin these new services have also enhanced the performance of existing mobility provision, particularly public transport. The widespread availability of smartphones and high-speed mobile internet enables travellers to access real-time information on traffic conditions, service availability, routing alternatives, and vehicle locations with minimal effort, thereby improving the perceived reliability and convenience of public transport services (Li and Shalaby, 2024). When combined with dense networks of Internet of Things (IoT) sensors, connected vehicles, and GPS-enabled devices, these technologies significantly increase the volume, granularity, and immediacy of mobility data, which can be exploited to improve operational control, fleet management, and service optimisation (Oladimeji et al., 2023). Advanced data analytics further allow operators to anticipate demand patterns and allocate resources more efficiently, hence strengthening the overall performance of individual services. Furthermore, digital identity systems, account-based ticketing, and modern payment infrastructures facilitate seamless authentication, ticketing, and fare collection across modes, thus lowering barriers to multimodal journeys and enabling integrated pricing and access policies (Zitricky et al., 2025; UITP, 2020).

Despite ongoing innovation, the underlying architecture of urban mobility has remained largely unchanged, and core challenges rooted in strong dependence on private vehicles continue to persist. According to recent analyses, cities worldwide continue to experience high levels of congestion, persistent safety issues, and significant environmental externalities. McKinsey estimates that drivers in the world's most congested cities lose on average around 130 hours per year to traffic delays, with figures exceeding 140 hours annually in cities such as London during peak conditions (McKinsey, 2023). Road safety remains a critical concern, with more than 1.3 million fatalities per year globally attributable to traffic accidents, disproportionately affecting rapidly growing urban areas in emerging economies. At the same time, air quality and emissions continue to pose major health and sustainability challenges: over 90% of the global urban population lives in areas that do not meet World Health Organization air-quality standards, particularly in highly car-dependent cities (Boston Consulting Group, 2024). These problems are expected to intensify further by 2050, when global urbanisation is projected to add around two billion people, placing additional pressure on already constrained urban road space and infrastructure.

This highlights that the diversification of mobility services and the performance improvements achieved through digitalisation do not, by themselves, translate into systemic improvement. Instead, the outcome is a fragmented set of mobility alternatives which, despite their individual merits, rarely match the flexibility, coverage, and perceived level of service offered by the private car (Ho et al., 2018; Lyons et al., 2019). Several of these alternatives, moreover, continue to rely on automobiles as their core asset, thereby reproducing car-based travel rather than fundamentally challenging it. As a result, shared and on-demand services often coexist with private car use rather than substituting for it and, when introduced without coordination, may even contribute to additional traffic volumes (Hensher et al., 2020).

Against this backdrop, Mobility as a Service (MaaS) has emerged as a prominent concept and has attracted growing attention from both policymakers and market actors as a potential response to the structural challenges of contemporary urban mobility. MaaS can be defined as the integration of multiple transport services into a single, user-oriented mobility offering, typically delivered through a digital platform, that enables travellers to plan, book, and pay for multimodal door-to-door journeys through a unified interface (Hietanen, 2014; MaaS Alliance, 2017). In this sense, MaaS shifts the focus from mode-specific provision to service-based, on-demand access to mobility, aiming to make multimodal travel simpler and more seamless for users (Jittrapirom et al., 2017). First articulated more than a decade ago (Heikkilä, 2013), MaaS gained early visibility in the early 2010s within broader debates on digitalisation, servitisation, and sustainable transport systems, and has progressively evolved from a conceptual vision into a focal point of policy agendas and large-scale experimentation across Europe, Asia, and other regions. This growing attention is reflected in both market dynamics and public-sector engagement. Industry estimates suggest that the global MaaS market surpassed USD 120 billion in 2021 and is projected to grow at a compound annual growth rate of around 16.8% through 2030 (P&S Intelligence, 2021). In parallel, national governments, metropolitan authorities, and supranational institutions have promoted MaaS through regulatory initiatives, public funding programmes, and pilots. The European Union, in particular, has endorsed MaaS within its transport, digitalisation, and sustainability agendas, financing a range of research and innovation projects—such as CIVITAS, MaaSIFIE, IP4MaaS, and related initiatives—aimed at testing MaaS concepts, developing standards, and refining implementation strategies.

Conceptually, MaaS is widely regarded as a highly ambitious approach to mobility provision because it seeks to deliver a level of convenience, reliability, and flexibility that can be perceived as comparable to the private car, while

avoiding its negative environmental, spatial, and social externalities (Mulley, 2017; Lyons et al., 2019; Smith & Hensher, 2020).

However, its promise is inherently complex to realise, as it requires a transformation of the mobility industry architecture (Jacobides et al., 2006) towards an ecosystem configuration (Kamargianni and Matyas, 2017). Drawing on the ecosystems and platform literature, existing mobility services can be conceptualised as autonomous yet complementary modules that are individually unable to deliver the MaaS value proposition, but rather need to be structurally aligned and coordinated to do so (Adner, 2017). The seamless, door-to-door journey promised by MaaS depends on the effective combination of these modules, whose interdependencies become structural conditions for systemic value creation (Kapoor, 2018).

This alignment is enabled – in this specific case – through a platform layer and associated commercial and contractual arrangements that organise how mobility providers contribute their assets (such as vehicles, data, and operational capabilities) to the ecosystem (Baldwin et al., 2024). An orchestrator (or ecosystem sponsor) governs this layer by coordinating these distributed resources and making them accessible to users through a unified service interface (Jacobides et al., 2018). Consistent with platform theory, the platform layer establishes shared interfaces, standards, and rules that enable interoperability among heterogeneous actors (Gawer, 2021; Cenamor et al., 2021). In doing so, it mediates access to users, data, and transactions, reshaping interaction patterns and redistributing control over key coordination mechanisms within the ecosystem (Autio, 2022). Ecosystem participants co-invest in specialised capabilities and align their operations to enhance overall system performance, producing value that exceeds the sum of individual contributions (Kapoor, 2018). This system-level value – manifested in improved user experience, multimodal efficiency, and potential societal benefits (Pangbourne et al., 2020) – depends

on the degree of co-specialisation and effective orchestration across actors, while value capture remains contingent on each actor's position and role within the ecosystem (Jacobides et al., 2018; Adner, 2017). As a result, MaaS not only forces incumbent actors to strategically reposition themselves but also enables the emergence of entirely new roles within the mobility ecosystem. Yet, how these ecosystem-level transformations unfold in practice remains insufficiently understood. To date, MaaS research has predominantly developed along streams that privilege the user-side and the conceptual–functional dimensions of MaaS (Giesecke et al., 2016; Utriainen and Pöllänen, 2018; Kriswardhana and Esztergár-Kiss 2023), rather than systematically examining the industry-side dynamics through which MaaS ecosystems are actually formed, governed, and made viable. A large portion of the literature has focused on defining MaaS and clarifying its constitutive elements and integration levels (e.g., Jittrapirom et al., 2017; Sochor et al., 2018; Lyons et al., 2019), exploring adoption drivers, behavioural intentions, and the demand potential of MaaS (e.g., Ho et al., 2018; Fioreze et al., 2019; Guidon et al., 2019), or assessing readiness and enabling conditions at the city or system level (e.g., Kamargianni and Goulding, 2018; Roumboutsos et al., 2021; Aba and Esztergár-Kiss, 2024). In parallel, a well-established stream has examined barriers and implementation challenges – such as regulatory frictions, organizational complexity, and coordination problems – often emphasizing why MaaS is difficult to scale beyond pilots (e.g., Mukhtar-Landgren et al., 2016; Butler et al., 2020; Karlsson et al., 2020; Zhao et al., 2020; Krauss et al., 2022; Kandanaarachchi et al., 2024). While these contributions are essential, they tend to explain MaaS difficulties through lists of obstacles or enabling factors, rather than unpacking the ecosystem reconfiguration mechanisms through which actors adapt, re-align, and co-specialise over time. When the literature engages more directly with the industry side, a prominent focus has been placed on MaaS business models and governance arrangements, acknowledging that viability hinges on how MaaS is organised and

commercialised (e.g., König et al., 2016; Holmberg et al., 2016; Sarasini et al., 2017; Ebrahimi et al., 2018; Polydoropoulou et al., 2020; Krauss et al., 2022). However, much of this work has primarily produced static, prototype-oriented representations of MaaS provider business models, often using the Business Model Canvas as the main framework of analysis (Osterwalder and Pigneur, 2010), and has typically framed the central design choice around who acts as the MaaS provider and how governance is structured (public, private, PPP) (e.g., Aapaoja et al., 2017a; Smith et al., 2018; Narupiti, 2019; Wong et al., 2020; Zhang and Zhang, 2021). Still, existing studies rarely capture MaaS as a dynamic ecosystem-formation process in which business models, integration strategies, and governance arrangements co-evolve, and in which incumbents and new ventures adjust their roles and operating logics as new interdependencies emerge (Jacobides et al., 2024; Cozzolino and Geiger, 2024). What remains missing, therefore, is a comprehensive perspective that accounts for MaaS transformation at the ecosystem-level. Indeed, MaaS should not be approached as a single organizational design problem, but as a reconfiguration of the mobility system's architecture that requires alignment across operations, digital interfaces, data-sharing practices, commercial terms, and institutional rules. Importantly, this reconfiguration does not converge on a single dominant design: MaaS can materialise through multiple, qualitatively different configurations of actors and business models, each implying distinct coordination requirements, governance challenges, and pathways to value creation and capture. Without a systemic understanding of how these elements cohere (or fail to cohere) into viable configurations, it becomes difficult to explain why seemingly similar MaaS initiatives lead to divergent outcomes, or why integration efforts often remain bounded to pilots rather than scaling into stable market and policy solutions.

Building on this argumentation, this thesis asks:

How is MaaS reshaping the mobility ecosystem, and which business model and ecosystem configurations are associated with successful goal achievement?

To address this overarching question, the thesis articulates four interrelated research sub-questions that reconstruct MaaS transformation from complementary angles. It begins by clarifying how MaaS is implemented and made operational on the supply side. This is a necessary first step because MaaS is not only a policy vision or a digital interface, but a service reality enacted through providers' business models. In practice, provider business model choices shape the scope and depth of multimodal integration that can be delivered, the partner dependencies and coordination mechanisms that must be stabilised, and the viability and scalability conditions under which an initiative can persist beyond pilots. Mapping provider business models therefore delineates the empirical design space of MaaS, identifies recurring implementation logics and trade-offs, and provides an actor-level vocabulary of "building blocks" that is required to interpret how ecosystem reconfiguration unfolds and why performance may vary. The first research sub-question is thus formulated as follows:

RQ1. *How does MaaS materialise into heterogeneous business model configurations among MaaS providers, and what recurring patterns structure the current MaaS design space?*

Chapter 1 addresses RQ1 by developing a global, empirically grounded mapping of MaaS providers and deriving recurring business model archetypes that capture distinct implementation logics and their associated trade-offs.

Building on the identification of recurring provider logics, the thesis then turns to the process through which MaaS configurations emerge over time. MaaS does not materialise as a ready-made organizational design; rather, it results from a transformation process in which incumbent actors must reconfig-

ure business models, capabilities, and inter-organizational relationships to cope with newly emerging ecosystem-level interdependencies. At the same time, this transformation creates space for entrepreneurial entrants, whose business models crystallise around specialised ecosystem roles and whose strategic choices contribute to reshaping complementarities and coordination structures. Understanding MaaS therefore requires examining both how established organisations adapt to MaaS-induced pressures and how start-ups participate in ecosystem formation by developing, revising, and scaling role-specific business models. The second and third research sub-questions are thus formulated as follows:

RQ2. *How does the introduction of MaaS trigger business model reconfiguration among incumbent actors, and which strategies do they adopt to reposition themselves within the mobility ecosystem?*

RQ3. *How do MaaS start-ups contribute to MaaS ecosystem formation through role-based business model evolution?*

Chapter 2 addresses RQ2 by examining how established service providers and technology providers adapt their business models in response to MaaS-induced interdependencies, uncovering the mechanisms through which value creation, delivery, and capture are reconfigured as firms reposition themselves within the emerging MaaS ecosystem. Chapter 3 addresses RQ3 by analysing how MaaS start-ups evolve their business models, resources, and competences across stages of the new venture creation process, showing how distinct ecosystem roles are associated with distinct evolutionary paths and capability-building requirements.

Finally, while the first three sub-questions explain how MaaS is operationalised on the supply side and how heterogeneous actor-level adaptation pathways give rise to alternative system-level configurations, they do not yet clarify whether and under what conditions such configurations achieve their in-

tended goals. If MaaS is conceptualised as a configurational ecosystem transformation process, then a critical theoretical and practical question follows: do different configurations generate systematically different performance outcomes?

Because MaaS materialises through qualitatively distinct combinations of technical architectures, governance arrangements, coordination mechanisms, economic logics, user propositions, and societal ambitions, variation in alignment is likely to produce variation in results. A configurational perspective therefore requires moving beyond explaining how ecosystems form to assessing how alternative patterns of alignment translate into multidimensional goal achievement, and according to which criteria “success” can be meaningfully evaluated across heterogeneous implementations. The fourth research sub-question is therefore formulated as follows:

RQ4. *How do different MaaS ecosystem configurations translate into distinct profiles of multidimensional goal achievement, and what explains variation in performance across implementations?*

RQ4 therefore builds directly upon the configurational space delineated in RQ1–RQ3 by examining how alternative patterns of actor-level alignment translate into heterogeneous ecosystem-level outcomes. Chapter 4 addresses this question through the development and application of a multidimensional evaluation framework that systematically compares MaaS initiatives across technical, organizational, economic and financial, user, societal, and contextual dimensions, thereby linking ecosystem configurations to differentiated performance profiles rather than to isolated pilot-level indicators.

1. The Global Design Space of MaaS: Business Model Archetypes and Provider Roles

In relation to the overarching thesis question – “How is MaaS reshaping the mobility ecosystem, and which business model and ecosystem configurations are associated with successful goal achievement?” – this first empirical chapter provides a necessary point of departure by establishing the supply-side design space of MaaS. Specifically, it addresses RQ1 – “How does MaaS materialise into heterogeneous business model configurations among providers, and what recurring patterns structure the current MaaS design space?” – by clarifying which provider-level implementation logics are empirically observable. The chapter presents the study entitled “Archetypal Business Models for Mobility as a Service (MaaS): Bridging Theory and Practice”, which asks: “Which archetypal business models have emerged among MaaS providers worldwide?”. To answer this question, the study adopts an inductive multiple-case research design and systematically reconstructs MaaS provider business models using the Business Model Canvas as a common analytical template, enabling consistent cross-case comparison across a global and heterogeneous sample of MaaS providers. The findings show that MaaS does not converge on a single dominant design. Instead, MaaS is enacted through multiple, context-dependent business model configurations that reflect differences in local mobility systems and, critically, in the type of actor implementing and positioning the MaaS service within the broader ecosystem. At the same time, this diversity can be synthesised into five recurring archetypes, namely Mobility Platforms, Highly-diversified Providers, Lowly-diversified Providers, Enablers, and Mobility-embedded Providers, which synthesise the main patterns through which MaaS services are developed and implemented worldwide and provide the building-block vocabulary used by

subsequent chapters to examine ecosystem transformation and performance heterogeneity.

Archetypal Business Models for Mobility as a Service (MaaS): Bridging Theory and Practice

1.1. Abstract and Keywords

Abstract – *Mobility as a Service (MaaS) is reshaping urban transportation by integrating multiple mobility options into seamless digital platforms. Despite its transformative potential, uncertainties persist regarding its scalability and economic viability. This study bridges theory and practice by developing MaaS business model archetypes that guide providers and policymakers in structuring effective services. Using a multiple-case study approach, data from 40 MaaS companies were analyzed through the Business Model Canvas framework. Five distinct archetypes emerged: Mobility Platforms, Highly-diversified Providers, Lowly-diversified Providers, Enablers, and Mobility Embedded Providers. Each archetype reflects different strategic configurations, value propositions, and revenue mechanisms. The findings offer a structured understanding of MaaS business models, supporting industry stakeholders in refining their strategies and informing policymakers on regulatory frameworks that foster innovation and sustainable mobility. By linking conceptual insights with real-world applications, this research provides practical guidance for advancing integrated urban mobility solutions.*

Keywords— Mobility as a Service (MaaS); Business Models; Case Study

1.2. Introduction

Over the past decade, Mobility as a Service (MaaS) has emerged as one of the most influential paradigms in the debate on the future of mobility. The concept envisions the integration of multiple transport modes into a single digital interface, promising to deliver seamless, efficient, and sustainable mobility while reducing reliance on private cars (Kamargianni and Matyas, 2017; Carbonara et al., 2024). Beyond individual convenience, MaaS is often positioned as a driver of broader societal goals, such as reducing greenhouse gas emissions, enhancing accessibility, and promoting more equitable transport systems (Smith and Hensher, 2020). This vision has attracted the attention of researchers, policymakers, and practitioners, each engaging with MaaS from different perspectives and expectations. Since the mid-2010s, numerous initiatives have been launched worldwide, often supported by substantial public and private investment (Hensher et al., 2020).

Yet the trajectory of MaaS implementation has been far less promising than its vision suggests. The majority of initiatives fail to progress beyond pilot projects, and those that do typically remain limited to basic levels of integration (Sochor et al., 2018; Krauss et al., 2022). The difficulties extend well beyond technological development (Karlsson et al., 2020; Maas, 2022). Providers struggle to coordinate stakeholders with divergent interests, negotiate revenue-sharing arrangements, and navigate fragmented or rigid regulatory frameworks (Mukhtar-Landgren et al., 2016; Butler et al., 2021). Additional challenges include establishing data-sharing protocols, ensuring interoperability across systems, and creating value propositions capable of sustaining user adoption (Mulle and Kronsell, 2018; Karlsson et al., 2020).

These issues indicate that the barriers to MaaS are primarily organizational and strategic rather than purely technical. Realizing MaaS's potential depends on how providers configure their organizations, partnerships, and reve-

nue models to deliver value effectively (Carbonara et al., 2024; Lepak et al., 2007). Business models provide a powerful lens for analyzing these dynamics. They capture the underlying logic of how organizations create, deliver, and capture value (Teece, 2010), offering a structured framework to examine how MaaS providers attempt to overcome barriers and translate an ambitious vision into operational reality. Research on MaaS business models has gradually progressed from initial conceptualizations and boundary definitions (e.g., Heikkilä, 2014; Giesecke et al., 2016) toward more structured analyses, including taxonomies of MaaS schemes (Lyons et al., 2019), integration levels (Sochor et al., 2018), bundling of services (Reck et al., 2020), prototypes of business models (König et al., 2016; Polydoropoulou et al., 2020), and formalized models (van den Berg, 2022). However, the majority of this work remains either conceptual (e.g., Krauss et al., 2022) or focused on limited pilot cases, meaning that large-scale empirical evidence on how MaaS providers actually structure their business models is still missing. Furthermore, the literature has not kept pace with the evolution of MaaS in practice. Over the past decade, providers that have managed to commercialize their services have, in many cases, reshaped the concept itself. Through experimentation with diverse organizational arrangements, pricing logics, and integration strategies in pursuit of economic viability, new business models have emerged (Hensher et al., 2021). Yet systematic empirical evidence on how MaaS providers worldwide have structured these models remains scarce.

In response to this important gap, this study aims at answering the following research question:

- *Which archetypal business models have emerged among MaaS providers worldwide?*

To address this research question, we adopted a multiple-case study methodology (Yin, 1994) and examined a diverse, selected set of MaaS provid-

ers worldwide (Eisenhardt and Graebner, 2007). Clear boundaries for defining MaaS services and providers were first established, drawing on existing literature (Hensher et al., 2021) and industry standards to ensure analytical consistency. Data were then collected from both secondary sources, such as industry reports, academic publications, and company documents, and primary sources, including interviews and surveys with MaaS stakeholders and experts. The resulting dataset enabled both intra-case analysis, which provided detailed insights into individual MaaS providers, and cross-case analysis, which allowed us to identify recurring patterns across contexts. The Business Model Canvas (Osterwalder and Pigneur, 2010) was employed as the primary analytical framework to organize the data, compare cases, and derive conclusions. Through this process, we identified five distinct MaaS business model archetypes currently operating worldwide: Mobility Platforms, Highly-diversified Providers, Lowly-diversified Providers, Enablers, and Mobility-embedded Providers.

This study offers important contributions to both theory and practice. Theoretically, it advances the field of MaaS business models by bridging earlier conceptual work with large-scale empirical evidence. By developing a comparative framework that links theory and practice, it provides a foundation for future research on the performance, scalability, and governance of different archetypes. Practically, the archetypes provide a tool for diagnosis and comparison. MaaS providers can use them to understand their current configuration, identify gaps, and plan the steps needed to scale beyond pilots. For policymakers and city authorities, the archetypes help move away from one-size-fits-all approaches by showing that different models require different types of support, whether through procurement, data policies, subsidies, or competition safeguards. This allows interventions to be better aligned with broader goals such as decarbonization, accessibility, and financial sustainability.

The remainder of this paper is structured as follows. Section 1.3 briefly reviews the existing literature on MaaS business models. Section 1.4 details the methodological approach adopted. Section 1.5 presents the results of the analysis and the five archetypes. Finally, Section 1.6 discusses the theoretical and practical implications of the findings, outlines the study's limitations, and identifies possible directions for future research.

1.3. Theoretical Background

1.3.1. The vision of MaaS

Mobility as a Service (MaaS) has been widely portrayed as a transformative development in the way mobility is organized, delivered, and consumed. Building on earlier ideas of mobility management, which aimed to improve public transport efficiency and encourage multimodality (Mulley, 2017; Lyons et al., 2019), MaaS extends this ambition by integrating diverse transport services – including public transport, ride-hailing, car- and bike-sharing, scooters, taxis, and related services such as parking and charging – into a single digital interface. Through this platform, users can seamlessly plan, book, and pay for multimodal journeys (Kamargianni and Matyas, 2017; Jittrapirom et al., 2017). The promise of such integration lies in offering a door-to-door travel experience that rivals the flexibility of private car ownership while contributing to broader societal goals of decarbonization, accessibility, and equity (Hensher et al., 2020; Smith and Hensher, 2020). From the outset, however, no universally accepted definition has been established (Arias-Molinares and García-Palomares, 2020). Conceptually, MaaS can be understood as a result-oriented Product–Service System (PSS), in which users purchase the function of mobility –reliable access to movement from point A to point B – rather than a specific vehicle or single operator (Cook et al., 2006; Enoch and Potter, 2023). This framing underscores

two key aspects of the vision: the emphasis on access over ownership, reflecting broader cultural shifts, and the role of digital orchestration in aligning multiple services with real-time user demand (Hensher et al., 2023). In this sense, MaaS aligns closely with service-dominant logic and the sharing economy, paradigms that prioritize flexible resource use and rely on platforms to match supply and demand (Lee et al., 2018; Geissinger et al., 2020). Delivering on the MaaS vision requires the coordinated involvement of a wide range of actors, operating in a unique and collaborative ecosystem (Hietanen, 2014; Kamargianni and Matyas, 2017). Thus, fostering such an environment ultimately depends on regulatory frameworks that can enable coordination among diverse stakeholders and reduce existing institutional frictions (Pangbourne et al., 2020; Carbonara et al., 2024).

1.3.2. The reality of MaaS

While compelling, the actual implementation of this vision has proven uneven. Following the first conceptualizations, a wave of enthusiasm for MaaS has led to numerous experiments and pilot projects across Europe and worldwide, involving public authorities, private operators, and mixed consortia, with the aim of testing both the feasibility and potential impacts of the service at the urban and regional scale (Hensher et al., 2020; Karlsson et al., 2020). From the outset, however, it became clear that translating the vision of MaaS into practice requires overcoming significant regulatory, institutional, and organizational barriers (Merkert and Wong, 2020; Alyavina et al., 2022; Mukhtar-Landgren et al., 2016). In many jurisdictions, unresolved issues around fare integration, data sharing, and licensing have emerged as major obstacles, often demanding targeted policy interventions and legal reforms (Hensher et al., 2020). Beyond regulation, MaaS also faces the fundamental challenge of aligning stakeholders with diverse and sometimes conflicting interests (Kamargianni and Matyas, 2017). Public agencies and private companies must negotiate roles and respon-

sibilities, frequently making compromises over pricing, branding, and customer relationships (Meurs et al., 2018; Karlsson et al., 2020). These negotiations are further complicated by disputes over revenue distribution, liability, and service standards (Kandanaarachchi et al., 2024). At the same time, MaaS requires not only robust digital infrastructures capable of handling real-time bookings, payments, ticketing, and fleet coordination, but also significant investment in user experience design. Competing with the private car – the benchmark for convenience – means matching a standard that has been shaped by decades of industry refinement and substantial investments in usability and comfort (Hensher et al., 2023; Hensher, 2024). Such levels of investment are difficult to sustain for individual MaaS operators, as illustrated by the recent bankruptcy of MaaS Global – the first MaaS provider. These difficulties help explain why, after more than a decade of experimentation, most MaaS implementations remain narrow in scope. Many operators have limited their efforts to “testing the market” by opening APIs to third-party platforms, without pursuing the deeper integration required for full service delivery (Harrison et al., 2020; van den Huevel et al., 2020). As a result, most schemes stall at Level 2 of integration (as described in Sochor et al., 2018; Hensher et al., 2020), where users can plan, book, and pay for trips through a single interface but still lack unified pricing mechanisms or bundled subscriptions (Reck et al., 2020). Yet, in response to these practical difficulties, the very concept of MaaS has evolved (Hensher et al., 2023). The initial “one-size-fits-all” vision of a universal mobility platform – the so-called “Netflix for mobility” – has gradually been replaced by more contextualized approaches, where service portfolios are tailored to local conditions and specific user needs (Hensher et al., 2021). Over the past decade, an increasing number of providers have embraced this perspective, experimenting with business models and refining value propositions in the ongoing search for user adoption and economic viability. However, the literature has only partially captured this evolution, with most studies remaining either conceptual or focused on small-scale pilots, leav-

ing limited systematic evidence on how MaaS providers have actually structured their business models in practice.

1.3.3. Research on MaaS business models

Given the central role of business models in determining the viability of MaaS, both academics and practitioners have increasingly devoted attention to this theme. Most studies rely on the Business Model Canvas (BMC) (Osterwalder and Pigneur, 2010) as their primary analytical framework. Early contributions were largely exploratory, focusing on defining the MaaS ecosystem and clarifying the roles of its actors rather than offering empirically validated models. Holmberg et al. (2016) presented UbiGo's BMC as an illustrative case, highlighting the potential role of public transport either as MaaS operator or partner, while Kamargianni and Matyas (2017) emphasized governance and ecosystem coordination. Building on these foundations, projects such as MAASiFiE (König et al., 2016) and Rural-MaaS (Aapaoja et al., 2017; Eckhardt et al., 2017) developed one of the first typologies of MaaS business models, distinguishing four possible provision logics: MaaS run by a private operator, by a public transport operator, through a public-private partnership (PPP), or through a public-private-people partnership (PPPP). These categories offered a basic classification based on who holds control over service integration and were linked to the geographical scope of operations (urban, suburban, national, or international). However, they remained generic and only partially characterized. Parallel work by Ebrahimi et al., 2018 explored alternative business architectures, identifying dimensions such as integration versus separation in supply and marketing functions, thus mapping initial trade-offs among organizational forms.

Subsequent contributions sought to structure MaaS business models more systematically. Polydoropoulou et al. (2020) proposed a prototype BMC for MaaS providers and examined its adaptability across operational contexts. Krauss et al. (2022) advanced this approach by combining morphological analy-

sis (Zwicky, 1967) with the BMC, producing a framework that identified the key elements of MaaS business models from the provider perspective. Complementing this, van den Berg et al. (2022) developed a consistent economic modeling framework to study how different ways of organizing MaaS (integrator, platform, intermediary, and regulated models) affect prices, profits, consumer surplus, and welfare. Their work did not propose new archetypes but formalized and tested existing ones through mathematical and econometric analysis, strengthening the economic foundations of MaaS business model research. More recently, Srivastava and Wong (2023) conducted a macro-level study of the Chinese MaaS market, proposing three new business models tailored to automobile manufacturers, while Carbonara et al. (2024) analyzed a small set of case studies, offering valuable insights but from a narrow empirical base.

Despite these advancements, the literature remains fragmented and marked by notable limitations. Most contributions offer conceptual frameworks or generic prototypes, often derived from pilot cases, with little empirical validation across diverse real-world contexts. Comparative studies of MaaS providers on a global scale are particularly scarce. Furthermore, much of the research presents static representations of “how MaaS should work” rather than systematic evidence of how providers are actually structuring their models in practice. This study seeks to fill this gap by offering a comprehensive account of how MaaS is currently implemented and by identifying the archetypal business models that have emerged. The next section outlines the methodology adopted.

1.4. Methods

In this study, we adopt an inductive, multiple-case study approach (Eisenhardt, 1989; Yin, 1994; Eisenhardt and Graebner, 2007) to investigate how MaaS providers worldwide structure their business models. This choice is motivated by several considerations. First, as highlighted in the literature review, re-

search on MaaS business models is still fragmented and largely conceptual, with limited empirical grounding. A multiple-case design is therefore particularly suitable for advancing theory-building in this emerging field (Eisenhardt, 1989). Second, business models are inherently complex constructs, encompassing multiple interrelated dimensions such as value creation, delivery, and capture. To properly understand and compare them, detailed examination through structured analytical frameworks is required (Teece, 2010; Osterwalder and Pigneur, 2010). A multiple-case study design enables this kind of granular examination by allowing large amounts of qualitative data to be systematically analyzed and compared across cases, making it particularly suitable for our research objective (Eisenhardt and Graebner, 2007). Finally, using several independent cases strengthens the robustness and generalizability of the findings, offering richer insights than those obtainable from single-case studies (Davis et al., 2007).

For the analysis, we employ the Business Model Canvas (BMC) (Osterwalder and Pigneur, 2010) as the guiding analytical framework. The BMC is widely used in both scholarly and industry research on MaaS (e.g., Holmberg et al., 2016; Polydoropoulou et al., 2020), making it a consistent point of reference that facilitates comparability with prior studies. Importantly, the BMC provides a structured way to dissect and compare business models across cases, organizing them into nine interrelated components that capture how value is created, delivered, and captured (Teece, 2010). This structure is particularly appropriate for a sector like MaaS, where business models are not yet standardized and where systematic cross-case comparison is necessary to detect archetypes (Krauss et al., 2022).

The following sections detail the methodological steps of the study.

1.4.1. Research Sample

The empirical setting for this study consists of a global sample of MaaS providers, encompassing both established players and emerging start-ups. To

ensure analytical coherence, we first established clear boundaries by defining what constitutes a MaaS service. Following Hensher et al. (2021), we considered MaaS as the integration of multiple transportation and mobility-related services—such as public transport, ride-hailing, shared micromobility, parking, and EV charging—into a unified digital platform, typically accessed via smartphone applications or web interfaces. In this perspective, a service does not need to integrate every possible mode; rather, the essential requirement is that it offers a portfolio of multimodal mobility services through a unified platform. Consistent with this definition, we also included companies providing white-label solutions that enable MaaS ecosystems.

The identification process combined multiple sources. Major providers were selected through specialized industry and consultancy reports (e.g., McKinsey and Company, P&S Intelligence), mobility-focused media (ITS International, TechCrunch, Bloomberg), and sectoral organizations such as the MaaS Alliance. To capture start-ups, we conducted a systematic search of directories and databases, with Crunchbase serving as the primary source. Using its advanced search functions, we applied the terms “Mobility as a Service,” “Mobility-as-a-Service,” and “MaaS,” combined with filters aligned with the domain (“Transportation,” “Mobile Apps,” “Mobile Payments”). Each result was manually reviewed and cross-checked against official websites to verify compliance with our definition. This process yielded a consolidated pool of 178 companies (102 start-ups and 76 established players).

From this pool, we applied three additional selection criteria to identify firms for detailed analysis (Eisenhardt and Graebner, 2007). First, sufficient secondary sources had to be available, including annual reports, press releases, industry analyses, and sector-specific knowledge bases. Second, firms needed to be widely recognized in the MaaS domain through participation in major projects and partnerships or with renowned MaaS implementations. Third, we required that each company had concretely implemented MaaS solutions for a

minimum period of three years, thereby ensuring the inclusion of firms with a proven track record of operational MaaS services, rather than those only at the pilot, conceptual, or planning stage. Applying these criteria resulted in a final sample of 50 firms that provides the empirical foundation for the comparative analysis presented in the following sections. Table 1.1 presents the companies included in the sample.

Table 1.1 - Refined sample of MaaS providers and basic descriptors

Company name	HQ city, Country	Flagship app / brand	Organization type
MaaS Global Oy	Helsinki, Finland	Whim	Startup–Scale-up
Uber Technologies, Inc.	San Francisco, USA	Uber	Established firm
Lyft, Inc.	San Francisco, USA	Lyft	Established firm
Google LLC	Mountain View, USA	Google Maps	Established firm
Grab Holdings Inc.	Singapore, Singapore	Grab	Established firm
DiDi Global (DiDi Chuxing)	Beijing, China	Didi	Startup–Scale-up
Citymapper Ltd. (a Via company)	London, UK	Citymapper	Startup–Scale-up
Moovit App Global Ltd. (Mobileye)	Ness Ziona, Israel	Moovit	Established firm
Entur AS	Oslo, Norway	Entur	Public incumbent
EMT Madrid	Madrid, Spain	Madrid Mobility 360	Public incumbent
ÖBB-Holding AG	Vienna, Austria	ÖBB	Public incumbent
SNCF Connect and Tech	Paris, France	SNCF Connect	Public incumbent
Transdev Group	Issy-les-Moulineaux, France	MooVizy	Public incumbent

Reshaping Mobility through MaaS: Business Model Archetypes, Actor Dynamics, and System Success

Transport for London	London, UK	TfL Go	Public incumbent
Wiener Linien	Vienna, Austria	WienMobil	Public incumbent
Rejsekort and Rejseplan A/S	Copenhagen, Denmark	Rejseplanen	Public incumbent
Keolis Group	Paris, France	STAR	Public incumbent
Cubic Transportation Systems	San Diego, USA	Traveler (NextCity™)	Startup–Scale-up
Conduent Transportation	Florham Park, USA	Mobility Companion Platform	Established firm
Bolt Technology OÜ	Tallinn, Estonia	Bolt	Startup–Scale-up
Intelligent Apps GmbH	Hamburg, Germany	FREE NOW	Joint Venture (established firm)
GoTo Group	Jakarta, Indonesia	GoJek	Established firm
Instant System	Valbonne, France	STACK	Startup–Scale-up
Iomob Technologies	Barcelona, Spain	(Iomob's platform)	Startup–Scale-up
Berliner Verkehrsbetriebe (BVG)	Berlin, Germany	Jelbi	Public incumbent
Flit Technologies Ltd.	London, UK	Karhoo	Established firm
TIER Mobility	Berlin, Germany	TIER	Startup–Scale-up
Neutron Holdings, Inc.	San Francisco, USA	Lime	Startup–Scale-up
SkedGo Pty Ltd	Sydney, Australia	TripGo	Startup–Scale-up
Mastercard (Transit Solutions)	Purchase, NY, USA	Pick	Established firm
Telepass	Rome, Italy	Telepass Pay X	Startup–Scale-up
MooneyGo	Rome, Italy	MooneyGo	Startup–Scale-up

UbiGo AB	Gothenburg, Sweden	UbiGo	Startup–Scale-up
Tranzer B.V.	Amersfoort, Netherlands	Tranzer	Startup–Scale-up
Mobilleo (Fleetondemand)	Saltaire/Bradford, United Kingdom	Mobilleo	Startup–Scale-up
Mobimeo GmbH	Berlin, Germany	Mobimeo	Public incumbent
Meep (Fostering Mobility S.L.)	Madrid, Spain	Meep	Startup–Scale-up
ANI Technologies / Ola	Bengaluru, India	Ola	Startup–Scale-up
Fluidtime	Vienna, Austria	FluidHub	Startup–Scale-up
Gaiyo B.V.	Utrecht, Netherlands	Gaiyo	Startup–Scale-up
Arriva Group	Heerenveen, Netherlands	glimble	Startup–Scale-up
Lyko SAS	Paris, France	Lyko Suite	Startup–Scale-up
Masabi Ltd.	London, United Kingdom	Justride	Startup–Scale-up
MOBIAN Global	Haarlem, Netherlands	Mobian	Startup–Scale-up
RideMovi S.p.A.	Milan, Italy	RideMovi	Startup–Scale-up
Siemens Mobility GmbH	Munich, Germany	HAFAS NextGen	Established firm
Transit App, Inc.	Montréal, Canada	Transit	Startup–Scale-up
umob B.V.	Amsterdam, Netherlands	umob	Startup–Scale-up
UnipolTech	Bologna, Italy	UnipolMove	Established firm
MTR Corporation	Hong Kong, China	MTR Mobile	Public incumbent

The composition of the sample reflects both the diversity and the maturity of the current MaaS landscape. The predominance of European firms (70%; see Figure 1.1) is not coincidental: Europe has been at the forefront of

MaaS development, supported by EU-level policy frameworks and flagship projects such as MaaS4EU. At the same time, the inclusion of North American (16%) and Asia-Pacific (12%) companies ensures that the analysis is not Euro-centric, but instead considers alternative trajectories driven by ride-hailing, micromobility, and platformization logics. In terms of governance (see Figure 1.2), the sample is almost evenly split. Privately held start-ups and scale-ups account for the largest share (27 firms, 54%). However, public incumbents (11 firms, 22%)—mostly transport authorities or public operators—also feature prominently, alongside established corporates and listed companies (11 firms, 22%) such as Uber, Google, and Siemens. This balance underscores MaaS as a hybrid innovation field, where entrepreneurial ventures, corporates, and public actors contribute complementary capabilities.

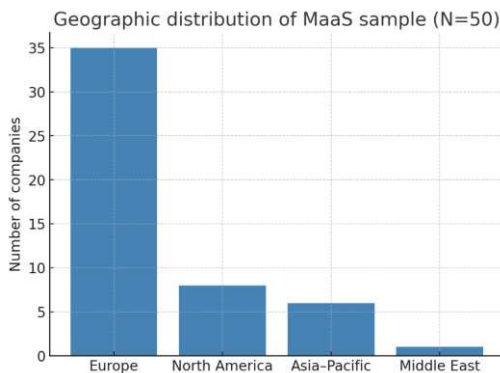


Figure 1.1 – Geographic distribution of MaaS sample

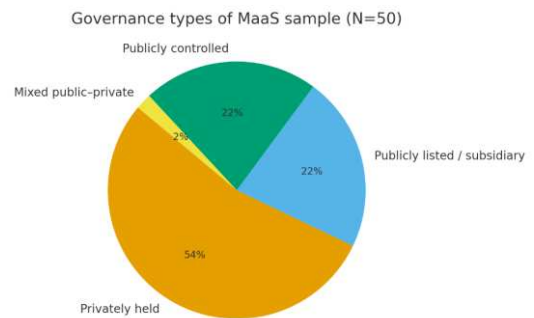


Figure 1.2 - Governance types of MaaS sample

The country-level distribution (see Figure 1.3) further strengthens the analytical relevance of the sample. The United States leads with seven firms, followed by the United Kingdom, the Netherlands, France, and Germany with five each. Italy, Spain, and Austria also appear as national hubs, while pioneering cases from Finland, Israel, Singapore, and other countries ensure broader

global coverage. Taken together, the sample is not intended to be statistically representative, but rather analytically representative of the breadth of MaaS configurations currently in operation (Eisenhardt and Graebner, 2007).

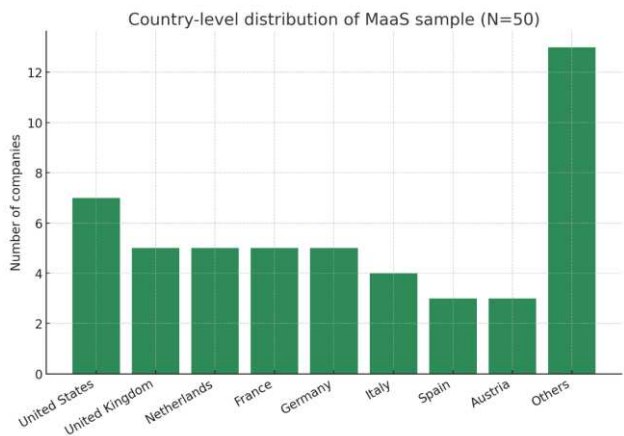


Figure 1.3 – Country-level distribution of MaaS sample

1.4.2. Data Collection

Data for this study were collected through a combination of secondary sources and primary interviews. For each firm in the sample, we compiled a consolidated dossier based exclusively on publicly available information. This included company websites, blogs, and official press releases, as well as annual reports and investor presentations. We also examined technical documentation such as product pages, developer portals, and API or SDK materials, together with app-store descriptions and release notes. In addition, we drew on procurement notices, tender documents, trade and consultancy reports, and specialized media coverage of MaaS and transit technology. To enhance reliability, we triangulated information wherever possible by cross-checking across at least two independent sources, and we archived URLs and screenshots to ensure transparency and auditability.

To complement this desk research, we conducted a total of 34 interviews with key stakeholders. Seventeen of these were face-to-face conversations with company representatives, including founders, CEOs, product managers, chief technology officers, and senior officials from public transport operators and authorities. Eight additional interviews were conducted in person with industry experts such as consultants, integrators, representatives of standards bodies, and policy specialists. Finally, nine interviews were carried out asynchronously by e-mail with company representatives, following the same question guide as the face-to-face conversations. The e-mail format also allowed respondents to attach supporting evidence such as white papers, presentation slides, or internal performance metrics. The interviews were guided by a semi-structured questionnaire designed to align with the study's central constructs. The guide was modular in nature and applied consistently across formats, with minor adaptations to reflect the respondent's role—whether as a company representative, industry expert, or public-sector official. This ensured both comparability across cases and flexibility to explore issues specific to each type of actor.

1.4.3. Data Analysis

Adhering to the methodological principles of Strauss and Corbin (1990), our data analysis followed an iterative, multi-step process. We employed the Business Model Canvas (BMC) (Osterwalder and Pigneur, 2010) as the central analytical framework, using its nine building blocks as coding categories. Case material from secondary sources was systematically allocated to these categories to reconstruct each firm's business model. As interview data became available, we integrated these insights to refine and enrich the case reconstructions.

To move from empirical evidence to theoretical insight (Glaser and Strauss, 1967), we combined intra-case and cross-case analyses (Eisenhardt, 1989; Yin, 1994). In the intra-case analysis, data for each firm were consolidated into a BMC template, providing a structured overview of its configuration. In-

terview transcripts, e-mail exchanges, and documentary evidence were open-coded within the BMC categories, with coding refined through constant comparison across cases (Strauss and Corbin, 1998). Case memos were then developed to highlight distinctive features and interdependencies across building blocks. In the cross-case analysis, we systematically compared coded matrices to identify recurring configurations and notable divergences. Through axial coding, we grouped cases that exhibited similar combinations of value propositions, governance arrangements, and revenue logics. Selective coding was then applied to distill these clusters into a set of Business Model Archetypes, each capturing a coherent and recurrent configuration observable in the MaaS market. To strengthen the robustness of findings, we applied triangulation across data sources (company documents, industry reports, and interviews) (Jick, 1979) and maintained a transparent audit trail of coding decisions. Iterative team discussions and sense-making sessions ensured that emerging archetypes were both empirically grounded and theoretically consistent. The result is a typology of MaaS business model archetypes that reflects the current structure of the market.

1.4.4. Validation and Refinement Process

To ensure a rigorous validation of the MaaS business model archetypes, we designed a multi-method approach that combines survey-based evaluation with in-depth expert interviews. This approach aligns with established practices in business model validation (Teece, 2010; Massa et al., 2017) and follows principles of stakeholder-driven research validation (Mitchell et al., 1997; Chesbrough, 2010). The process unfolded in four main steps. The first step involved developing an evaluation framework against which the archetypes could be systematically assessed. Drawing from prior literature on business model analysis (Bujang et al., 2022; Aithal and Aithal, 2020; Lusch and Nambisan, 2015; Casadesus-Masanell and Ricart, 2010), we identified four key dimensions: (i)

Conceptual soundness—the extent to which archetypes are theoretically coherent; (ii) Clarity and distinction—the degree to which each archetype is internally consistent and externally differentiated from others; (iii) Relevance and completeness—the capacity of the set of archetypes to capture the variety of existing MaaS business models; and (iv) Applicability in practice—their usefulness and transferability to real-world contexts for both researchers and practitioners. These criteria served as benchmarks throughout the validation process. We then developed a structured questionnaire to capture both quantitative assessments and qualitative feedback (Rowley, 2014). Following a mixed-methods design (Creswell and Clark, 2017), the instrument included closed-ended items—primarily yes/no and Likert-type scales—to obtain standardized judgments, alongside open-ended questions that encouraged respondents to elaborate, highlight ambiguities, or suggest refinements. The questionnaire was distributed to a purposive sample of 171 experts covering three key stakeholder domains: academia (transport and urban studies researchers), industry (MaaS entrepreneurs, technology providers, consultants), and public sector (government officials and policy advisors). To broaden outreach, the survey was also shared in two closed professional LinkedIn groups dedicated to MaaS. In total, 52 valid responses were collected, providing a balanced mix of quantitative evaluations and qualitative insights. Closed-ended responses were analysed using descriptive statistics to identify levels of agreement and disagreement across the four dimensions of evaluation. Open-ended responses were coded thematically (Braun and Clarke, 2006), allowing us to identify recurring themes, highlight sources of ambiguity, and uncover suggestions for improvement. Finally, findings from the questionnaire were systematically integrated to update and refine the proposed set of MaaS business model archetypes.

1.5. Results

Our analysis resulted in the identification of five distinct business model archetypes for MaaS. These archetypes capture recurring configurations across the nine building blocks of the Business Model Canvas and reflect the diversity of strategic logics currently shaping the MaaS ecosystem. Specifically, we distinguish between: Mobility Platforms (see Figure 1.4), Highly-diversified Providers (see Figure 1.5), Lowly-diversified Providers (see Figure 1.6), Enablers (see Figure 1.7), Mobility Embedded Providers (see Figure 1.8). Follows a discussion of their distinctive elements.

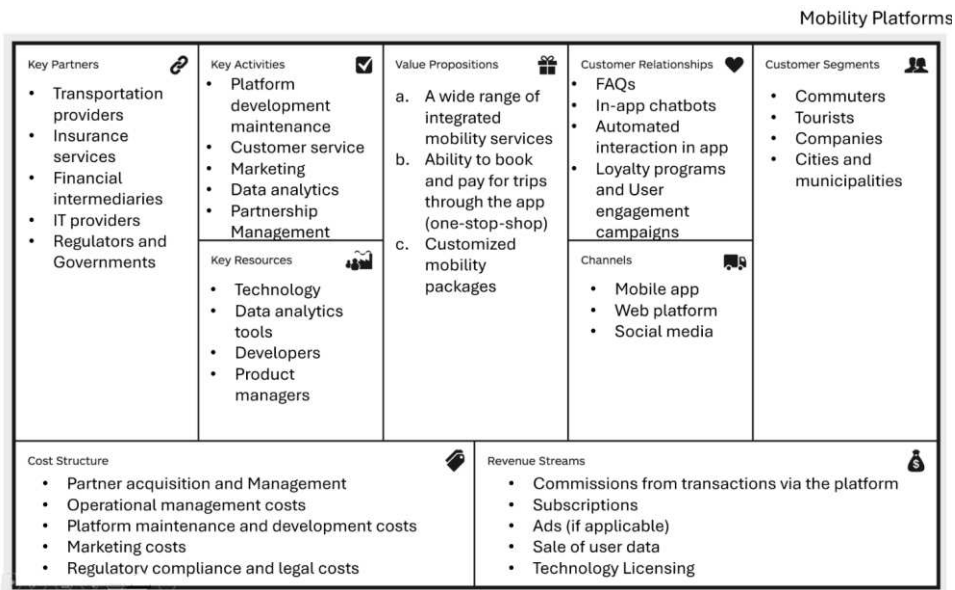


Figure 1.4 - Business Model Canvas for Mobility Platforms

1.5.1. Archetype 1: Mobility Platforms

The Mobility Platform archetype refers to consumer-facing digital intermediaries that bring together multiple transport modes within a single digital environment. Rather than operating fleets or infrastructure, these platforms in-

tegrate public transport, ride-hailing, shared cars, bikes and scooters, parking, and increasingly also EV charging into one interface in which users can plan, book, and pay seamlessly for their needs. The primary customer base is found among everyday commuters and occasional visitors in the B2C segment, who benefit from simplified access to multimodal transport. A secondary market, although increasingly important, consists of B2B and B2G arrangements, whereby platforms deploy their systems as white-label or co-branded solutions for employers, municipalities, or public transport authorities seeking to expand digital mobility offerings under their own brand. Real-world examples include MaaS Global (Whim), Citymapper, Moovit, and UbiGo, which are widely cited as pioneering references in the MaaS field. They exemplify both the potential and the limitations of the model. Each has sought to deliver a comprehensive, user-centric interface, yet their experiences also show the difficulties of achieving financial sustainability while negotiating access to transport services and data.

A distinctive feature of Mobility Platforms is their asset-light orientation. Value is not derived from vehicles, depots, or infrastructure, but from the ability to orchestrate an ecosystem of partners, build interoperability across heterogeneous services, and facilitate seamless transactions. This orientation enables platforms to scale across regions without massive capital investments, but also creates a structural dependence on the willingness of third parties to cooperate. The model thus requires sustained negotiation with both private operators and public transport incumbents to secure the necessary rights to integrate ticketing, fares, and data feeds. In terms of offerings, most platforms still rely on pay-as-you-go (PAYG) access, reflecting both consumer expectations and the challenges of sustaining subscription economics. Nonetheless, several initiatives have experimented with bundled mobility subscriptions, which combine public transport access with allowances for micromobility or ride-hailing services. These curated packages are often targeted at regular commuters and corporate clients, promising predictable costs and convenience. Even where such bundles

have struggled to gain traction, many platforms attempt to increase value through personalization of offerings—for example by tailoring route suggestions, discounts, or service bundles to particular segments of users. The revenue logic underpinning this archetype is typically based on transaction commissions and service fees form the backbone of income streams, but these are inherently thin-margin businesses that depend heavily on volume. Subscription packages, where adopted, are intended to generate recurring revenues and deeper customer relationships, but their sustainability has so far been uneven. A further strand of revenue derives from B2B and B2G licensing, as platforms offer their technology as a white-label MaaS solution. Ancillary revenues, such as from advertising, affiliate services, or privacy-compliant analytics, remain supplementary and heavily constrained by regulatory environments such as the GDPR in Europe. To sustain these activities, Mobility Platforms depend on robust technological and organizational capabilities. On the technical side, they must ensure scalable applications and back-end systems capable of routing, dynamic pricing, clearing and settlement, fraud prevention, and guaranteed service levels. On the organizational side, their survival hinges on ecosystem-building, that is, the capacity to secure and manage partnerships with a wide variety of transport providers and public authorities. The long-term viability of this archetype depends on its adaptability to evolving mobility preferences—for example, shifts in demand between PAYG and subscription models, post-pandemic changes in commuting patterns, or rising expectations for personalized and sustainable travel options.

1.5.2. Archetype 2: Highly-diversified Providers

Highly-diversified providers represent multi-service MaaS actors that combine the direct operation of transport services with selective partnership-based integration. Real-world examples include BVG with its Jelbi platform in

Berlin, Transport for London (TfL) with TfL Go, and ÖBB with WienMobil in Vienna, which operate core public transport networks while simultaneously integrating complementary services through partnerships.

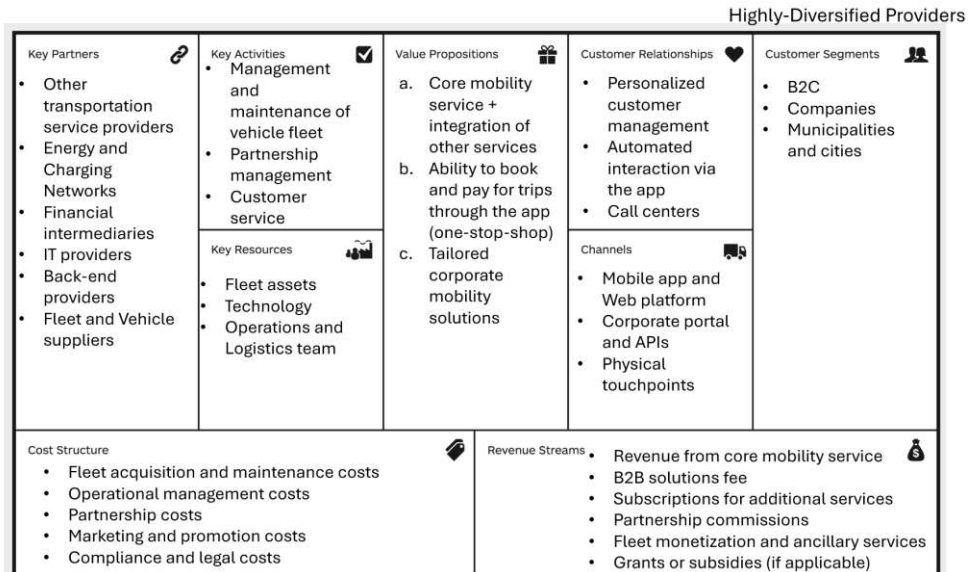


Figure 1.5 - Business Model Canvas for Highly-Diversified Providers

Unlike asset-light platforms, these providers own and manage their core mobility services—typically public transit lines, demand-responsive shuttles, or car-sharing fleets, and then extend their offering by incorporating third-party providers such as ride-hailing, micromobility, parking, or EV charging. Direct operation allows these actors greater autonomy over service quality, pricing, reliability, and safety, while partnerships are strategically used to fill modal or spatial gaps without requiring additional capital expenditure. In the consumer market, their offerings typically center on pay-as-you-go access to the core service, which may be complemented—where viable—by bundled or subscription packages that combine the owned service with allowances for integrated modes. The model is particularly attractive to commuters who value reliable, predicta-

ble access and who constitute the principal B2C customer base. Some providers are rooted in local ecosystems, focusing on a metropolitan area, while others operate at a national scale, as in the case of Entur in Norway or ÖBB in Austria. From a technological standpoint, platforms are generally developed in-house or built through close collaboration with specialized technology partners. The primary income stream derives from their own transport operations (e.g., fare revenues, sharing fees, or ticket sales. To this they add (i) subscription revenues, where bundles are offered. Unlike the personalized bundles typical of asset-light platforms, these packages are usually structured around fixed fares, reflecting the providers' emphasis to reach the broadest possible market. Further revenue streams include (ii) partner commissions for third-party services transacted through their channels and, in certain contexts, (iii) public grants or subsidies when their services demonstrably advance policy objectives such as extended coverage, decarbonization, or social inclusion. The cost structure of highly-diversified providers is marked by significant fixed costs associated with asset ownership and operation: vehicle acquisition or leasing, charging or depot infrastructure, maintenance, insurance, and staffing. High vehicle use and efficient matching of supply to demand are therefore critical to maintaining financial sustainability. In turn, this requires advanced operational capabilities in scheduling, dispatching, and predictive analytics, often enabled by the same digital platforms that underpin the MaaS offering.

1.5.3. Archetype 3: Lowly-diversified Providers

Lowly-diversified providers are vertically focused actors that deliver a narrow set of mobility services—typically one or two closely related offers such as bike-sharing, e-scooter sharing, or car-sharing—sometimes complemented by adjacent functionalities such as parking payments or EV charging access. Well-known real-world examples include Lime, TIER Mobility, and Mobian,

which have become prominent players in urban micro-mobility and related niches. These firms own and directly operate their fleets, focusing managerial and financial resources on the depth and efficiency of their operations rather than on breadth of service integration. The user proposition is delivered by a dedicated app where customers can locate, unlock, ride, and pay with minimal friction.

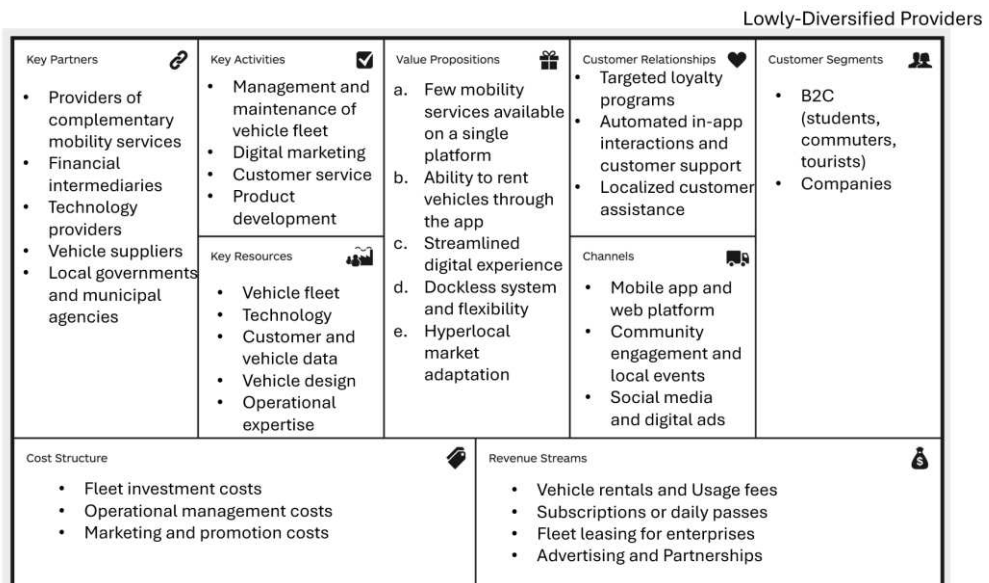


Figure 1.6 - Business Model Canvas for Lowly-Diversified Providers

Many of these services adopt dockless formats, allowing flexible pick-up and drop-off points across the city, thereby reducing reliance on fixed docking infrastructure and enhancing convenience. The promise is speed, convenience, and predictability for short urban trips and first/last mile connections. In terms of revenue model, the dominant logic is pay-as-you-go (PAYG), where users are charged per minute, per kilometer, or per ride. This structure is often complemented by passes or subscriptions (daily, weekly, or monthly), designed to stabilize usage and appeal to frequent travelers. While the B2C market domi-

nates—with key segments including students, commuters, and tourists—providers are increasingly exploring B2B arrangements with campuses, business parks, employers, and municipalities. Such contracts offer guaranteed demand in specific zones or time windows, thus mitigating volatility in consumer demand. Revenues arise primarily from usage fees on the owned fleet, with subscriptions and passes improving customer retention and predictability. Ancillary income streams include B2B fleet leasing or service contracts, localized advertising and co-branding. Growth and scalability rely on a city-by-city replication of a standardized playbook: obtaining permits, deploying fleets, and establishing local partnerships. This process is more repeatable than the expansion of mobility platforms, but remains capital- and permit-constrained, with scaling limited by the availability of licenses and the upfront costs of deploying vehicles and supporting infrastructure. Moreover, market entry is exposed to regulatory volatility (e.g., tenders, pilot renewals, fleet caps) and competitive churn in micromobility, which has produced frequent cycles of consolidation and exit. From an operational perspective, lowly-diversified providers succeed or fail on their ability to execute fleet maintenance, charging, and redistribution with high efficiency. This requires a combination of reliable apps and IoT systems, geofencing and parking compliance, fraud prevention measures, and data-driven analytics for demand prediction and pricing. Many providers deploy or source AI-assisted positioning and routing algorithms to improve the accuracy of vehicle redistribution, raise utilization rates, and reduce the costs associated with manual fleet management (e.g., truck-rolls for rebalancing). Some even experiment with in-house product design of vehicles to improve durability and service life, thereby lowering long-term costs.

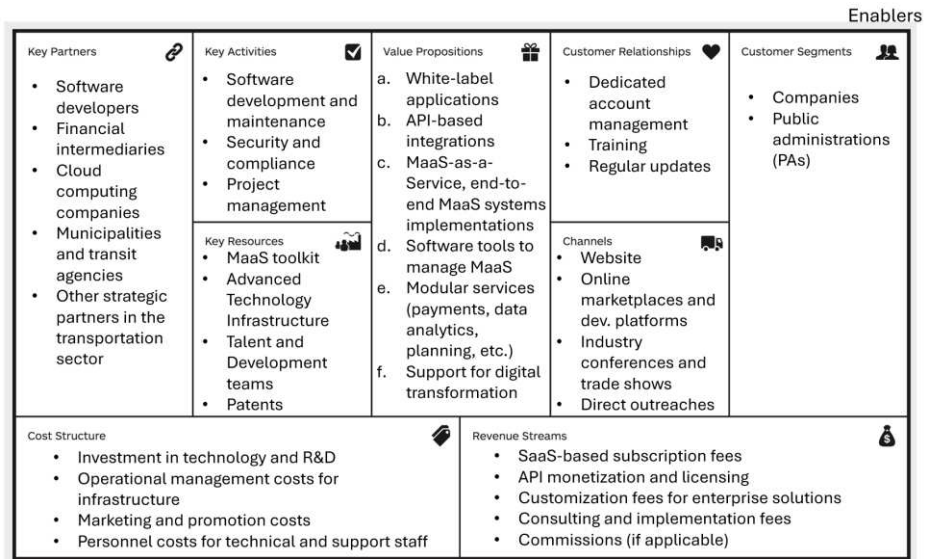


Figure 1.7 - Business Model Canvas for Enablers

1.5.4. Archetype 4: Enablers

Unlike consumer-facing Mobility Platforms, which aggregate services and interact directly with end-users, Enablers operate in the background, equipping companies, public authorities, and transport operators with the software, data, and payment infrastructures needed to assemble and manage MaaS solutions. Notable real-world examples include Traqi, SkedGo, Lyko, Siemens Mobility, Masabi, and Conduent Transportation, all of which provide critical enabling technologies to a wide variety of MaaS initiatives worldwide. In practice, Enablers productize integration by offering white-label journey planning applications and portals, API gateways that interconnect public transport, micromobility, and ride-hailing services, and account-based ticketing systems incorporating contactless EMV modules. Many also provide specialized capabilities such as clearing and settlement engines, fare capping, corporate mobility budget tools, data analytics and reporting dashboards, and developer sandboxes to support ecosystem partners. This “MaaS-as-a-Service” model lowers entry barriers for public and private clients who wish to launch MaaS offerings with-

out developing the technical stack internally. Solutions can be delivered either as full-service platforms or as discrete modules—such as ticketing, journey planning, or analytics, typically relying on proprietary algorithms—depending on client requirements. Revenue models are predominantly based on Software-as-a-Service (SaaS) and licensing schemes, where clients pay recurring fees for platform access, API usage, and maintenance or updates. Additional revenues stem from implementation and integration projects, premium technical support, and consultancy services in areas such as requirements scoping, change management, and fare policy design. Where Enablers are directly involved in ticketing and payments, they may capture per-transaction fees or merchant service margins. Participation in smart-city programs and public tenders is also a significant revenue source, often complemented by grants and subsidies linked to policy goals such as digitalization, decarbonization, or social inclusion. The business model is asset-light and highly scalable, as marginal costs for adding new clients or geographies are minimal relative to upfront RandD and compliance investments. Once deployed in multi-tenant mode, such platforms achieve attractive unit economics and stable recurring income. Go-to-market strategies combine procurement-driven sales—where success often depends on winning competitive tenders from cities or PTAs—with strategic alliances that package complementary services (e.g., ticketing and payments integration). Increasingly, Enablers also pursue OEM and ISV partnerships, embedding their modules into third-party platforms or hardware solutions. Their key activities include software development and maintenance, security and compliance management (e.g., GDPR, AML/KYC), project management for large-scale rollouts, B2B client support and training, and the continuous delivery of updates and new functionalities.

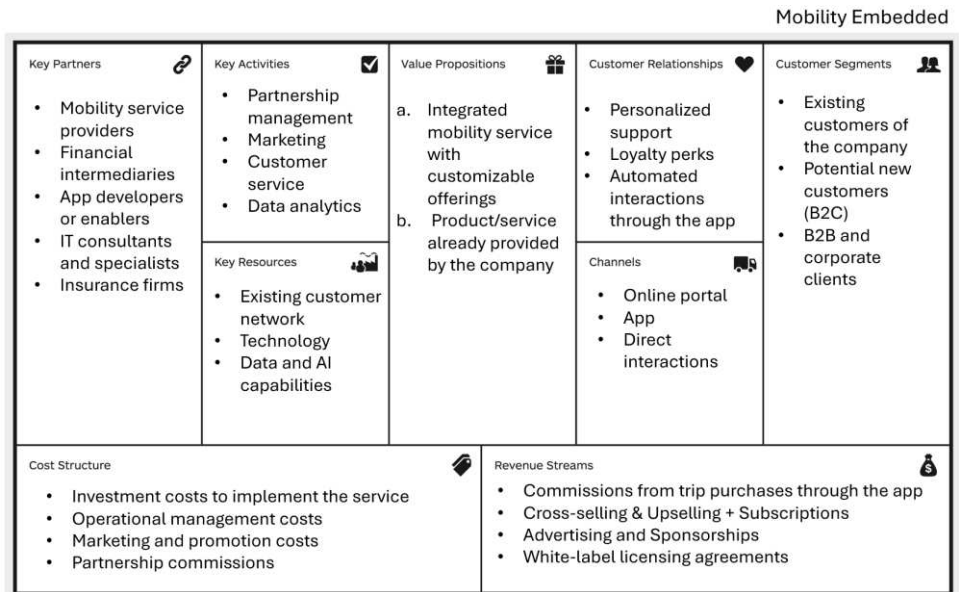


Figure 1.8 - Business Model Canvas for Mobility Embedded Providers

1.5.5. Archetype 5: Mobility Embedded Providers

Mobility-embedded providers are firms from adjacent industries—including insurance, telecommunications, retail, IT, and financial services—that integrate mobility into their product portfolios as an ancillary, value-adding feature rather than as a standalone business. Unlike the archetypes discussed previously, these actors neither build dedicated mobility brands nor operate fleets. Instead, they leverage their installed customer bases, loyalty programs, and digital channels to make mobility accessible within familiar service environments such as a banking app, an insurance policy, or a retail membership. Illustrative examples include UnipolSai and Telepass in Italy, which embed services like tolling, parking, and car-sharing within their insurance and payment ecosystems, as well as international cases such as Mastercard (Transit Solutions). The integration of mobility is designed to be seamless and unobtrusive: entitlements are surfaced within existing customer touchpoints through single sign-on, unified

payments, and frictionless redemption. This approach ensures that mobility is perceived as a natural extension of the core service. Moreover, because these firms hold extensive first-party data, they can personalize offerings—for instance, tailoring bundles for commuters versus occasional travelers, or pushing contextual incentives such as last-mile credits after public-transport trips, off-peak discounts, or city-specific promotions. The outcomes are twofold. From the customer perspective, mobility is experienced as a convenient perk that enhances the attractiveness of the primary service. From the provider perspective, mobility becomes a tool to strengthen engagement and loyalty, creating positive spillovers for the core business. Direct revenues usually stem from per-transaction commissions or fees on integrated services (e.g., ride-hailing, vehicle sharing, parking), complemented by marketing allowances or co-branding agreements with mobility partners. More strategically significant, however, are the indirect benefits: higher average revenue per user (ARPU), greater conversion into premium tiers, reduced churn, and increased share of wallet in the core business. Some firms further introduce bundled subscriptions—for example, “gold” plans including monthly mobility credits—that serve as differentiators for higher-margin packages. Adoption strategies typically follow three pathways: default inclusion (mobility credits bundled into standard plans), tiered bundles (mobility positioned as a premium benefit), and targeted campaigns (contextual offers triggered by behavior or location). Geographic rollout, in turn, is shaped by the provider’s existing market footprint, but remains contingent on the availability and quality of local mobility supply as well as on regulatory frameworks, particularly municipal rules governing transport services.

1.6. *Discussion and Conclusion*

The objective of this study is to develop a more empirically grounded and theoretically informed typology of business models for MaaS. By systemati-

cally analyzing a sample of fifty companies active in the MaaS domain— with a case study approach (Yin, 1994)—we reconstructed their business models using the Business Model Canvas (Osterwalder and Pigneur, 2010) and conducted intra- and cross-case analysis (Eisenhardt, 1989). Through this process, we identified five distinct business model archetypes: Mobility Platforms, Highly-Diversified Providers, Lowly-Diversified Providers, Enablers, and Mobility-Embedded Providers. These archetypes were not conceived as ideal types but rather as empirically grounded configurations that capture how MaaS is currently implemented in practice. While each archetype is illustrated in detail through its respective Canvas (see Figures 1.4–1.8), their main differences can be distilled by comparing them across a set of strategic and operational dimensions derived from the BMC. To this end, we developed a comparative framework that highlights how distinct business models align—or diverge—across key aspects of value creation, delivery, and capture. Specifically, the framework considers market orientation, service integration, asset ownership, geographical scope, revenue architecture, scalability potential and go-to-market, core strategic orientation, and viability triggers. Table 1.2 synthesizes these differences and provides a structured overview. Finally, to complement this analysis, we discuss the main strengths and weaknesses associated with each archetype, offering a systematic assessment of their pros and cons (summarized in Table 1.3), which further clarifies the strategic trade-offs and viability conditions across the MaaS landscape.

Mobility Platforms represent consumer-facing aggregators that integrate public transport, micromobility, ride-hailing, and ancillary services into a seamless “plan–book–pay” journey. Their asset-light structure and reliance on partnerships enable high scalability across cities and even global markets. The main value lies in orchestration and user experience, with revenues derived from commissions, subscriptions, and B2B/B2G licensing. However, their viability hinges on achieving two-sided density—sufficient supply coverage and active

demand—while also securing long-term access to ticketing rights and mobility data. This exposes them to dependency on third-party operators, regulatory constraints, and profitability challenges unless strong network effects are established. Highly-diversified providers, by contrast, combine digital integration with direct operation of fleets and infrastructures such as depots and charging facilities. They offer multimodal coverage through in-app ticketing, bundles, and selective partnerships, but expansion is more measured, often limited to national or large-urban footprints. Their diversified revenue mix—combining owned-service fares, contracts, subsidies, and partner commissions—provides resilience and stability, particularly in alignment with public policy objectives like coverage, decarbonization, or social equity. Yet this robustness comes with trade-offs: high capital intensity, slower scalability, and governance frictions with partners. Their model reflects a strategy of vertical control and reliability rather than rapid global expansion. Instead, Lowly-diversified providers adopt a narrower scope, typically operating one to three owned modes (e.g., e-scooters, bikes, or car-sharing) within specific local contexts. Their growth logic is permit-constrained, proceeding city-by-city, and their revenues are dominated by pay-as-you-go fares with some subscriptions, B2B contracts, and local advertising. Operational efficiency—maximizing rides per vehicle per day, uptime, and utilization—is the central strategic focus. This model offers strong local presence and tight service control, but it remains vulnerable to regulatory volatility, seasonality, asset risks, and competitive churn, which often lead to cycles of market entry and exit. Scalability is therefore more limited than in the platform or enabler models. Enablers occupy a distinct position by supplying the technological and operational backbone of MaaS without engaging directly with end-users. Their offerings—white-label journey apps, API gateways, account-based ticketing, clearing and settlement systems, and analytics—make them indispensable for cities, operators, and corporates aiming to implement MaaS without building infrastruc-

ture from scratch. Entirely asset-light, they scale globally through SaaS contracts, licensing, and procurement-led sales, often complemented by public tenders and grants. Their strategic orientation is toward interoperability and standardization, lowering the total cost of ownership for clients. The advantages are high scalability and stable recurring revenues, but risks include commoditization, dependence on public procurement cycles, and limited visibility with end-users. Sustained success requires continuous RandD investment and strong compliance in areas such as security and data governance. Finally, Mobility-embedded providers originate from adjacent industries such as insurance, telecommunications, retail, or finance. Rather than building standalone mobility brands, they integrate mobility features—credits, vouchers, or bundled entitlements—into their existing digital ecosystems. Customers access these within familiar touchpoints like banking or telecom apps, with single sign-on, unified payments, and frictionless redemption. The model is asset-light, leveraging partner operators for service provision, and geographically mirrors the footprint of the parent firm. Revenue comes from transaction fees and co-branding agreements, though the greater value is indirect: uplift in average revenue per user, reduced churn, and premium-tier conversions in the core business. Strategically, mobility acts as a differentiator that strengthens loyalty and cross-sell opportunities. The main vulnerabilities lie in proving attribution—demonstrating that mobility features genuinely drive retention or revenue—and in dependency on partner quality.

The dimensions listed in Table 1.2 can be used to graphically compared the business model archetypes. For instance, Figures 1.9 and 1.10 further illustrate the positioning of the five archetypes across two key comparative dimensions. Figure 1.9 contrasts the degree of service integration with the extent of asset ownership. Platforms and enablers sit at the low end of asset intensity, relying on orchestration or technological infrastructure rather than fleet ownership, while highly- and lowly-diversified providers embody asset-heavy models,

investing directly in fleets and operational facilities. This contrast underscores the strategic choice between scalability and control, with asset-light models achieving rapid expansion but facing dependency risks, and asset-heavy models offering reliability and vertical control but at the cost of slower growth.

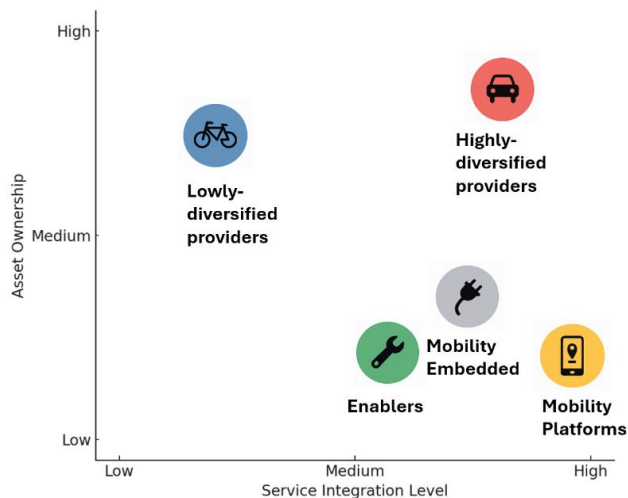


Figure 1.9 - Positioning of MaaS business model archetypes by degree of service integration and asset ownership

Figure 1.10 positions the archetypes according to service integration and geographical scope. Enablers and platforms emerge as the most scalable configurations, extending their reach across multiple regions or even globally, thanks to SaaS architectures and asset-light aggregation. In contrast, lowly- and highly-diversified providers remain more geographically constrained: the former due to permit-driven, hyper-local expansion, and the latter due to capital-intensive infrastructures tied to national or metropolitan contexts. Mobility-embedded providers occupy an intermediate position, their reach shaped not by mobility-specific assets but by the broader footprint of their parent industries.

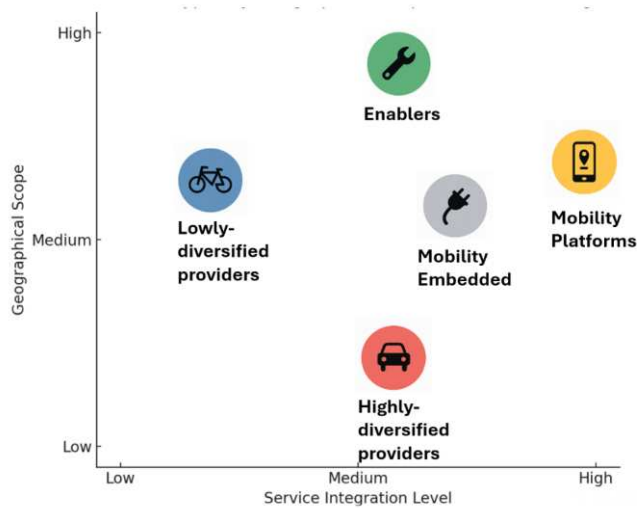


Figure 1.10 - Positioning of MaaS business model archetypes by degree of service integration and geographical scope

1.6.1. Implications of the study

This study advances current debates by offering a more detailed and empirically grounded typology of business models for MaaS, an area that remains conceptually fragmented and empirically underexplored. In contrast to previous literature (e.g., König et al., 2016; Aapaoja et al., 2017; Krauss et al., 2022), it characterizes MaaS business model archetypes in detail, offering both empirical granularity and validated examples that illustrate how these models actually operate in practice. Beyond being schematic or largely conceptual, we provide fine-grained descriptions of the mechanisms through which value is created, delivered, and captured across different MaaS configurations. For this purpose, we deliberately focus not on pilots or hypothetical constructs (e.g., Polydoropoulou et al., 2020), but on verified firms that have implemented MaaS solutions over several years, thereby allowing us to capture models that have been tested and refined in real operational contexts.

Table 1.2 - Comparative framework across MaaS business-model archetypes

Dimension	Mobility Platforms	Highly-diversified Providers	Lowly-diversified Providers	Enablers	Mobility embedded providers
Market orientation	B2C segmentation with B2B/B2G extensions via white-label or co-branded deployments	Mainly B2C. Can sometimes go B2B.	Primarily B2C (students, commuters, tourists) with targeted B2B (campuses, parks, municipalities).	Exclusively B2B/B2G (cities, PTAs/PTOs, operators, employers)	Embedded B2C/B2B via existing channels in adjacent industries. Mobility used to enhance the core product.
Service integration	High: Multimodal aggregation with plan-book-pay (Level 2-3, bundling if necessary); deep API integrations across every mode.	Medium-High: owned backbone (PT/DRT/car/bike/scooter, hubs) plus selective partner integration; in-app ticketing and bundles (Level 2-3)	Low-Medium: 1-3 owned modes with in-app booking/pay; often dockless; optional add-ons (parking/charging) (Typical Level 2).	Componentized, high-depth for clients: white-label journey apps/portals, API gateways, Account based ticketing and contactless pay, financial backend, analytics.	Low (add-on): mobility entitlements/credits/vouchers surfaced inside the host app, frictionless redemption, unified payments.
Asset ownership	Low (asset-light): no fleets or depots; relies on partner supply.	High: owns/leases fleets and/or infrastructure; sometimes depots/charging and mobility hubs.	High: owns/leases micromobility or car-share fleets; local depots/charging/logistics.	None: software and services only.	None: integrates third-party mobility; leverages host's digital assets and customer base.
Geographical scope	Multi-city/global where standards and partnerships allow.	National / large-urban footprints; expansion tied to assets and local partnerships.	Local / hyper-local; city-by-city permits – Global expansion	Multi-regional/global through multi-tenant SaaS	National to multi-country, mirroring the parent firm's footprint and partner availability.
Revenue architecture	Commissions and subscriptions/bundles, B2B/B2G licensing, ad-	Fares/tariffs on owned services + bundles/subscriptions, partner	PAYG (per minute/trip) + passes/subscriptions; B2B leasing/contracts; localized ads/co-	SaaS and licensing (recurring) + implementation, premium support,	Per-transaction commissions/fees + marketing allowances/co-branding; bundled

Reshaping Mobility through MaaS: Business Model Archetypes, Actor Dynamics, and System Success

	vertising/affiliates, privacy-compliant insights.	commissions; grants/subsidies.	branding.	consulting; where ticketing/payments are handled, per-transaction fees; public tenders/grants.	premium tiers with mobility credits; indirect Average Revenue Per User uplift.
Scalability potential	High scalability if two-sided density achieved.	Low-Medium scalability; slower multi-city replication due to assets-heavy model.	Medium scalability; permit-constrained	Very high scalability; procurement-driven sales (RFPs), OEM/ISV alliances	Medium scalability; limited by partner coverage and local rules.
Core strategic orientation	Orchestration and UX excellence; personalization/segmentation; network-effects building.	Vertical control and bundling on an owned backbone; quality/reliability; alignment with city goals; multimodal coverage via ownership + partnerships.	Operational excellence and hyper-local focus; fleet utilization, uptime, safety/compliance; strong street-level brand presence.	Enablement and standardization; interoperability; total cost-of-ownership reduction for clients.	Loyalty and cross-sell; embed mobility to differentiate the core offer; data-driven personalization and contextual perks.
Viability triggers	Two-sided density (supply coverage × active users), plan→book conversion, subscription penetration, low churn; ticketing/data access.	High utilization of owned assets + long-term contract tenor; bundle uptake; partnership breadth/quality.	Rides/vehicle/day and uptime thresholds; stable permits; efficient rebalancing/maintenance; strong local retention.	Multi-tenant adoption and contract backlog; SLA performance (uptime/latency); time-to-launch.	ARPU uplift and churn reduction in the core business; attach/redemption rates for mobility credits; partner SLA quality.

Table 1.3 - Advantages and Disadvantages of each archetype

Archetype	PROs	CONS
Mobility Platforms	• High scalability due to asset-light model • Strong user value via seamless integration and segmentation • potential for AI-driven personalization	• Dependency risk on third-party operators • Complex partner acquisition and management • Profitability challenges without significant user adoption and network effects. • Regulatory exposure (data/ticketing/API)
Highly-diversified Providers	• Control of quality, pricing, UX on the core • Diversified and more solid revenue structure • Increase in customer loyalty	• Capital intensity (fleets/depots/charging) • Slower, path-dependent expansion across cities • Potential subsidy dependence • Partnership frictions (profit-sharing, brand)
Lowly-diversified Providers	• Tight operational control • Niche specialization and strong local presence • Fewer partner dependencies than pure aggregators • B2B pockets (campus, employers) to stabilize demand	• Permit volatility • Asset risks (vandalism, theft, battery degradation); • Narrow diversification → sensitivity to shocks, seasonality and demand shifts • Competitive churn and consolidation
Enablers	• Asset-light and highly scalable • stable recurring revenue (SaaS, municipal contracts) • modular fit to diverse client needs • lowers barriers for cities/firms • shapes industry standards and data flows	• Commoditization/disintermediation (clients insource or hyperscalers bundle) • Dependence on public tenders and budget cycles • Continuous RandD/security investment • Limited end-user brand visibility
Mobility Embedded Providers	• Large pre-existing customer bases lower customer acquisition costs • Strengthens retention through cross-sell/upsell • Differentiates the core service • Scalable where partner supply is mature • Balanced B2C/B2B potentials.	• Risk of under-utilized perks (weak ROI) – may not have an impact on Average Revenue Per User • Integration complexity and regulatory exposure (data sharing, tying/bundling) • mobility may be non-core, risking dilution and de-prioritization.

A key managerial implication of this study lies in the clarification of strategic trade-offs. MaaS operators can use the archetypes as design templates to make deliberate choices about their positioning. The framework also makes explicit structural decisions, such as the breadth of modal integration, segments

to serve, or whether to own or orchestrate supply. By highlighting these trade-offs, the typology helps firms avoid “muddled hybrids” that mix incompatible economic logics, a common pitfall in the MaaS field where strategic experimentation has often lacked clarity about viability conditions. Closely related, the framework enables viability diagnostics by associating each archetype with specific tipping points and risk profiles. For instance, Mobility Platforms hinge on achieving two-sided density to monetize thin commissions; Highly-diversified Providers depend on asset utilization and long-term contracts to absorb high fixed costs; Lowly-diversified Providers face permit volatility and seasonality risks; Enablers must secure multi-tenant deployments to offset RandD investments; and Mobility-embedded Providers succeed only if mobility perks demonstrably enhance loyalty economics in their core industries. By linking archetypes to their distinct performance drivers, the framework equips both managers and investors with diagnostic tools to monitor viability, anticipate risks, and design credible pivot paths. From a policy perspective, the framework supports smarter procurement and governance of MaaS. Each dimension identified in the analysis can be operationalized into procurement-oriented KPIs that help cities evaluate competing providers. City governments considering MaaS schemes can therefore use the framework not only to understand the strategic profiles of providers, but also to anticipate the opportunities and challenges of each model when promoting investments, designing transport policies, or deploying MaaS as a travel-demand management tool.

1.6.2 Limitations and Research Agenda

This study holds several limitations that need to be acknowledged, each of which opens promising avenues for further research. First, the dataset is predominantly European, reflecting the region’s early policy

support and experimentation with MaaS. While this provides depth in a context where integration has matured most, it underrepresents dynamics in North America, Asia–Pacific, and especially the Global South. In these regions, distinctive features – such as the prevalence of informal transport modes, cash-based transactions, or weaker open-data regimes – may yield archetypes that differ substantially from those observed here. Future research should adopt a sampling strategy that covers cases from diverse institutional environments, to test whether the five archetypes identified are globally generalizable or context-specific. Comparative regional studies could also highlight how regulatory traditions, fare policies, and infrastructural legacies condition MaaS business model design.

Second, our inclusion criteria required that companies had implemented MaaS for at least three years and exhibited a minimum degree of integration. This decision enhanced reliability by filtering out pilot projects and immature concepts, but it may also have excluded potential innovators experimenting with novel forms of MaaS. Consequently, the typology developed here reflects the “established” layer of the MaaS market rather than the frontier of innovation. Future studies should consider adopting a broader definitional scope, explicitly including pilots and early-stage experiments. Such inclusion could reveal emerging archetypes that foreshadow future industry trajectories, even if their sustainability has not yet been tested.

Third, the archetypes presented here are derived through qualitative categorization, coding, and cross-case comparison. While this approach provides rich interpretive insight, it remains exploratory and interpretative in nature. Future research could employ quantitative techniques – such as cluster analysis (e.g., K-means, latent class analysis) or configurational methods (e.g., QCA) – to test the robustness of the archetypes against larger samples. Such methods could leverage the attributes identified in this study (integration scope, revenue mix, asset intensity, etc.) to statistically validate, refine, or extend the typology. A

mixed-methods approach, combining qualitative theorization with quantitative classification, would strengthen both internal validity and external generalizability. Furthermore, such methods would make it possible to capture hybrid forms that our categorical approach may have flattened, as firms often combine elements from different archetypes (e.g., operating as both Platforms and Enablers in different markets). Finally, the use of the Business Model Canvas (BMC) as the core analytical framework ensured comparability across cases but also carries risks of reductionism. Complex governance arrangements – such as data ownership, API access rights, or contractual asymmetries between public authorities and private firms – are not easily captured within the nine BMC blocks. Similarly, ecosystem power dynamics and the institutional underpinnings of MaaS (e.g., concession rights, exclusivity clauses, data mandates) are only partially reflected in the framework. Further research could complement BMC-based analyses with governance- or ecosystem-oriented lenses, such as platform governance frameworks or institutional logics, to account for these structural dimensions. Multilevel approaches could help bridge the gap between firm-level strategies and the broader regulatory or policy environment in which MaaS is embedded. Furthermore, the BMC does not easily accommodate the study of evolutionary trajectories across archetypes. Firms often pivot over time—for instance, Mobility Platforms may evolve into Enablers by licensing APIs, or Lowly-diversified Providers may scale into Highly-diversified configurations. Capturing these transitions requires longitudinal and process-oriented approaches, which could illuminate the triggers (e.g., regulation, capital intensity, partner access) and the path-dependencies that shape how MaaS business models evolve in practice.

1.7. References

Aapaoja, A., Eckhardt, J., Nykanen, L., 2017a. "Business Models for MaaS". 1st International Conference on Mobility as a Service (ICOMaaS). Tampere, Finland.

Aithal A., Aithal P.S. (2020). Development and Validation of Survey Questionnaire and Experimental Data – A Systematical Review-based Statistical Approach. *International Journal of Management, Technology, and Social Sciences (IJMTS)*, 5(2), 233-251. ISSN: 2581-6012.

Alyavina E., Nikitas, A., Njoya Tchouamou, E. (2024). Mobility-as-a-Service and unsustainable travel behaviour: Exploring the car ownership and public transport trip replacement side-effects of the MaaS paradigm. *Transport Policy*, Volume 150, Pages 53-70

Arias-Molinares, D., Garcia-Palomares, J.C., 2020. The Ws of MaaS: understanding mobility as a service from a literature review. *IATSS Res.* 44 (3), 253–263.

van den Berg, V. A. C., Verhoef, E. T., and Rietveld, P. (2022). Business models for Mobility as a Service (MaaS). *Transportation Research Part B*, 157, 203–229

Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101.

Bujang M.A., Yoon H., Lee K., Yee K. (2022). *A Step-by-step Guide to Questionnaire Validation Research*. Institute for Clinical Research, NIH MYISBN

Butler, L., Yigitcanlar, T., Paz, A., 2021. Barriers and risks of Mobility-as-a-Service (MaaS) adoption in cities: a systematic review of the literature. *Cities* 109, 103036.

Carbonara N., Messeni Petruzzelli A., Panniello U., De Vita D., 2024. Embracing new disruptions: Business model innovation in the transition to Mobility as a Service (MaaS). *Journal of Cleaner Production*, 464 (142744).

Casadesus-Masanell, R., Ricart J.E. (2010). From strategy to business models and onto tactics. *Long Range Planning*, 43 (2–3), pp. 195-215

Chesbrough, H. (2010). Business model innovation: Opportunities and barriers. *Long Range Planning*, 43(2–3), 354–363.

Cook, M. B., Bhamra, T., and Lemon, M. (2006). The transfer and application of product service systems: From academia to UK manufacturing firms. *Journal of Cleaner Production*, 14(17), 1455–1465.

Creswell, J. W., and Plano Clark, V. L. (2017). *Designing and Conducting Mixed Methods Research* (3rd ed.). SAGE.

Cruz, C.O., Sarmento, J.M., 2020. Mobility as a Service" platforms: a critical path towards increasing the sustainability of transportation systems. *Sustainability* 12 (16), 6368.

Davis, Jason P., Eisenhardt, Kathleen M., Bingham, Christopher B., 2007. Developing theory through simulation methods. *Acad. Manag. Rev.* 32 (2), 480–499.

Ebrahimigharehbaghi S., Sharmeen F., Meurs H. (2017). Innovative Business Architectures (BAs) for Mobility as a Service (MaaS) – exploration, assessment, and categorization using operational MaaS cases. Conference paper.

Eckhardt, J., Aapaoja, A., Nykänen, L., Sochor, J., 2017. Mobility as a Service business and operator models. In: 12th ITS European Congress. Strasbourg, France.

Eckhardt, J., Nykänen, L., Aapaoja, A., and Niemi, P. (2018). MaaS in rural areas – case Finland. *Research in Transportation Business and Management*, 27, 75–83.

Eisenhardt K.M. (1989). "Building Theories from Case Study Research". *The Academy of Management Review*, Vol. 14, No. 4, pp. 532-550

Eisenhardt, K.M., Graebner, M.E., (2007). Theory building from cases: opportunities and challenges diverse. *Acad. Manag. J.* 50, 25–32.

Enoch M., Potter S. (2023). MaaS (Mobility as a Service) market futures explored. *Transport Policy* 134 31–40

Geissinger, A., Laurell, C., Sandström, C., 2020. Digital disruption beyond uber and airbnb—tracking the long tail of the sharing economy. *Technol. Forecast. Soc. Change* 155, 119323. <https://doi.org/10.1016/j.techfore.2018.06.012>.

Giesecke, R., Surakka, T., Hakonen, M., 2016. Conceptualising mobility as a service. In: Proceedings of the Eleventh International Conference on Ecological Vehicles and Renewable Energies (EVER), Monte Carlo, Monaco, pp. 1–11.

Glaser, B.G., Strauss, A.L., 1967. The Discovery of Grounded Theory: Strategies for Qualitative Research. Aldine Transaction.

Harrison G., Gühnemann A., Shepherd S. (2020). The business case for a journey planning and ticketing app-Comparison between a simulation analysis and real-world data. Sustainability (Switzerland)

Heikkilä, S., 2014. Mobility as a service—a proposal for action for the public administration, case helsinki. Master of Science in Technology). Aalto University, Helsinki.

Hensher D.A., Ho C.Q., Mulley C., Nelson J.D., Smith G., Wong Y.Z. (2020). “Understanding Mobility as a Service (MaaS): Past, Present and Future”. Book, Elsevier Ed.

Hensher D.A., Ho C.Q., Reck D.J., Smith G. (2021). The Sydney Mobility as a Service (MaaS) Trial Design, Implementation, Lessons and the Future. iMove project final report.

Hietanen, S. (2014). Mobility as a Service—The new transport model? ITS and Transport (Finland).

van den Heuvel, C., Kao, P.-J., Matyas, M., 2020. Factors driving and hindering business model innovations for mobility sector start-ups. Research in Transportation Business and Management 37, 100568.

Holmberg, P.E., Collado, M., Sarasini, S., Willander, M., 2016. MaaS framework. Final Report of MaaSterplan Project (Vinnova).

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. Administrative Science Quarterly, 24(4), 602–611.

Jittrapirom P., Caiati V., Feneri A.-M., Ebrahimi S., González M.J.A., Narayan J. (2017). “Mobility as a service: a critical review of definitions, assessments of schemes, and key challenges”. Urban Plan, 2(2), 13-25.

Kamargianni M., Matyas M. (2017). “The business ecosystem of mobility-as-a-service”. In: Paper Presented at the 96th Transportation Research Board (TRB) Annual Meeting, Washington, DC.

Kandanaarachchi, T., Nelson, J., Ho, C., 2022. Building Trust and Collaboration Among the Stakeholders in a Mobility as a Service Ecosystem—Insights from Two MaaS Case Studies. Available at: SSRN 4253442.

Karlsson, I.C.M., Mukhtar-Landgren, D., Smith, G., Koglin, T., Kronsell, A., Lund, E., Sarasini, S., Sochor, J., 2020. Development and implementation of Mobility-as-a-Service –A qualitative study of barriers and enabling factors. *Transport. Res. Part A* 131, 283–295.

König, D., Eckhardt, J., Aapaoja, A., Sochor, J., Karlsson, M., 2016. Deliverable 3 –Business and Operator Models for MaaS. MaaSIFIE Project funded by CEDR.

Krauss, K., Moll, C., Kohler, J., Axhausen, K.W., 2022. Designing mobility-as-a-service business models using morphological analysis. *Transportation Business and Management* 45 (Part C), 100857.

Lee, Z.W.Y., Chan, T.K.H., Balaji, M.S., Chong, A.Y.L., 2018. Why people participate in the sharing economy: an empirical investigation of Uber. *Internet Res.* 28, 1–34. <https://doi.org/10.1108/IntR-01-2017-0037>.

Lusch, R. F., and Nambisan, S. (2015). Service innovation: A service-dominant logic perspective. *MIS Quarterly*, 39(1), 155–175.

Lyons, G., Hammond, P., Mackay, K., 2019. The importance of user perspective in the evolution of MaaS. In: Hensher, D.A., Mulley, C. (Eds.), *Transportation Research Part A: Policy and Practice*. 22–36. Special Issue on Developments in Mobility as a Service (MaaS) and Intelligent Mobility, vol. 121.

Maas, G. (2022). Literature review of Mobility as a Service (MaaS). *Sustainability*. 14(14):8962

Massa, L., Tucci, C. L., and Afuah, A. (2017). A critical assessment of business model research. *Academy of Management Annals*, 11(1), 73–104.

Meurs, H., Sharmeen, F., Marchau, V., van der Heijden, R., 2018. Organizing integrated services in mobility-as-a-service systems: principles of alliance formation applied to a MaaS-pilot in The Netherlands. *Transport. Res. Pol. Pract.* 131, 178–195.

Mitchell, R. K., Agle, B. R., and Wood, D. J. (1997). Toward a theory of stakeholder identification and salience. *Academy of Management Review*, 22(4), 853–886.

Mukhtar-Landgren, D., Karlsson, M., Konglin, T., Kronsell, A., Lund, E., Sarasini, S., Smith, G., Sochor, J., Wendle, B., 2016. Institutional conditions for integrated mobility services (IMS): towards a framework for analysis. K2 Working Papers 2016: 16. Available at: <https://portal.research.lu.se/en/publications/institutional-conditions-for-integrated-mobility-services-ims-tow>

Mulley, C., Kronsell, A., 2018. Workshop 7 report: the “uberisation” of public transport and mobility as a service (MaaS): implications for future mainstream public transport. *Res. Transport. Econ.* 69, 568–572.

Osterwalder, A. and Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Hoboken, NJ: Wiley.

Pangbourne, K., Stead, D., Mladenović, M., and Milakis, D. (2020). Questioning mobility as a service: Unanticipated implications for society and governance. *Transport Policy*, 93, 31–36.

Polydoropoulou, A., Pagoni, I., Tsirimpa, A., Roumboutsos, A., Karmargianni, M., Tsouros, I., 2020. Prototype business models for Mobility-as-a-Service. *Transp. Research Part A* 131 (C), 149–162.

Reck, D. J., Hensher, D. A., and Ho, C. Q. (2020). Exploring consumer preferences for Mobility-as-a-Service (MaaS) plans. *Transportation Research Part A: Policy and Practice*, 131, 282–295.

Rowley, J. (2014). Designing and using research questionnaires. *Management Research Review*, 37(3), 308–330.

Smith, G., and Hensher, D. A. (2020). Towards a framework for Mobility-as-a-Service (MaaS) policy and systems. *Transport Policy*, 89, 54–65.

Sochor J., Arby H., Karlsson I.C.M., Sarasini S. (2018). “A topological approach to mobility as a service: a proposed tool for understanding requirements and effects, and for aiding the integration of societal goals”. *Res. Transp. Bus. Manag.*;27:3–14.

Srivastava, M., Wong, Y.H., 2023. The development of mobility as a service in China and its impact on automobile manufacturers: a business model innovation. *Journal of Innovation Economics and Management* 40 (1), 225–263.

Strauss, A., and Corbin, J. (1990). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. SAGE.

Strauss, A., and Corbin, J. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* (2nd ed.). SAGE.

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, 43(2–3), 172–194.

Wong, Y. Z., Hensher, D. A., and Mulley, C. (2020). Mobility as a service (MaaS): Charting a future context. *Transportation Research Part A*, 131, 5–19.

Yin, R. K. (1994). *Case study research: Design and methods*. Sage Publications.

Zwicky, F. (1967). The morphological approach to discovery, invention, research and construction. In A. G. Wilson (Ed.), *New Methods of Thought and Procedure* (pp. 273–297). Springer.

2. How Established Organizations Adapt to MaaS: Business Model Innovation Pathways

Building on Chapter 1's mapping of what MaaS provider configurations are currently observable in practice, Chapter 2 shifts attention to how such configurations emerge by examining the adaptive response of established organisations operating in the mobility ecosystem. In line with the overarching thesis question, this chapter addresses the ecosystem-level transformation component by focusing on incumbent-driven transformation, and it directly answers RQ2: How does the introduction of MaaS trigger business model reconfiguration among incumbent actors, and which strategies do they adopt to reposition themselves within the mobility ecosystem?

The chapter presents the study “Embracing New Disruptions: Business Model Innovation in the Transition to Mobility as a Service (MaaS)”, which conceptualises business model innovation as a dynamic adaptation process within MaaS ecosystems. The study is guided by two more specific questions: (1) How have firms in the ecosystem changed their business models in response to the emergence of MaaS? and (2) What strategies and approaches can firms adopt to implement the MaaS concept and create, capture, and deliver new value?

Methodologically, it adopts an inductive, multiple-case and explicitly evolutionary/longitudinal perspective, analysing six established organisations spanning service providers and technology providers (including firms such as Uber, Lime, BVG, Mercedes-Benz Group, Masabi, and Siemens), and triangulating documentary/archival sources with interviews/surveys and expert validation. Using a value creation, capture, and delivery lens (Teece, 2010), the chapter reconstructs the main mechanisms through which these actors adapt to MaaS – showing, for example, how incumbents move toward integrated multimodal

propositions via partnerships and acquisitions, develop new platform and data capabilities, adopt new pricing, subscription and loyalty logics, experiment with revenue-sharing and data monetisation, and enable ecosystem-level connectivity through APIs and data-sharing arrangements. In doing so, the chapter clarifies the incumbent-side business model pathways and strategic moves that make certain MaaS configurations feasible (or contested) and that condition whether ecosystem alignment can emerge beyond pilot stages.

Embracing New Disruptions: Business Model Innovation in the Transition to Mobility as a Service (MaaS)

2.1 *Abstract and Keywords*

Abstract – *A decade ago, Mobility as a Service (MaaS) has emerged as a revolutionary concept destined to change the traditional transport paradigm. Indeed, MaaS envisions an integrated and on-demand transportation ecosystem where users have access to a variety of mobility options via a unified digital platform that centralizes information, ticketing, and payment systems for different service providers. Recognizing its disruptive potential, in this paper we examine the effects of MaaS introduction in the market, with a particular focus on businesses within the industry. Specifically, we aim at investigating the dynamic nature of business model innovation within the MaaS business ecosystem, thus capturing the changes, adaptations, and innovations that organizations have undergone, providing valuable insights into the new value creation, capture and delivery mechanisms that have emerged. To achieve these goals, we have employed an inductive, multiple case study approach, focusing on a total of six renowned organizations representing two key actor categories within MaaS ecosystems: service providers and technology providers. Our findings reveal that,*

despite their heterogeneity, both service and technology providers have adopted similar strategies in their transition to MaaS. Utilizing the value creation, capture, and delivery framework we developed distinct models for each of these categories. We have identified common firm-specific mechanisms which have been categorized into broader macro-level mechanisms of value creation, capture, and delivery, drawing from existing literature. The findings of this study contribute to the ongoing academic literature related to MaaS and to business model innovation. Furthermore, they offer valuable practical insights for managers and policymakers, providing a guidance for strategic decision-making aimed at fostering the development and sustainability of innovative MaaS systems.

Keywords— Mobility as a service (MaaS); MaaS impacts; MaaS business models; Business model innovation

2.2 Introduction

In the recent years, the mobility industry has been experiencing a fast-paced transformation driven by technological advancements, changing consumer preferences, and the growing focus on sustainability (ITF, 2021). The increasing urbanization and citizen demand for mobility are pushing policy makers, municipalities, and transport authorities to re-think cities and the extant infrastructures in response to the new challenges that have arisen (Jones, 2014). In this context, the terms Smart City and Smart Mobility have gained momentum for modern urban development and transportation planning. Indeed, by leveraging Information and Communication Technologies (ICT), Artificial Intelligence (AI), data-driven insights, and collaborative governance, city planners seek to develop smart solutions to enhance efficiency and efficacy of service provision to users, integrate and optimize infrastructures, as well as improve resource allocation and the overall quality of life for citizens (Butler et al., 2021;

Albino et al., 2015; Sharifi, 2019; Harrison et al., 2010; Nam and Pardo, 2011; Klein and Kaefer, 2008; Yigitcanlar et al., 2019). Within this framework, Mobility as a Service (MaaS) has recently emerged as a revolutionary concept. Aligning closely with the principles of the access, crowd, and sharing economy (Lee et al., 2018; Geissinger et al., 2020; Tseng and Chan, 2021), it envisions an integrated and on-demand transportation ecosystem where users have access to a variety of mobility options, ranging from public transit to shared mobility services, car rents and taxi, all managed through a unique digital platform (Kamargianni and Matyas, 2017; Kamargianni et al., 2018; Sochor et al., 2018; Heikkilä, 2014; Hensher et al., 2020; Giesecke et al., 2016). MaaS aims to enhance the overall travel experience of users and to emulate the flexibility provided by owning a personal car (Lyons et al., 2019; Kamargianni and Matyas, 2017; Hietanen, 2014; MaaS Alliance, 2017), as well to reduce congestion and optimize connection networks in cities by boosting the efficiency of extant infrastructures, improving accessibility for rural areas and for frail and disadvantaged people, and promoting sustainable, inter-modal or just multi-modal transport solutions (Eckhardt et al., 2020; MaaS Alliance, 2018; Kamargianni and Matyas, 2017; Hensher et al., 2020; Utriainen and Pöllänen, 2018; Ambrosino et al., 2016; König et al., 2016). In the literature, MaaS has been considered a disruptive “phenomenon” that transcends traditional transportation modes (Sochor et al., 2018; Merkert and Wong, 2020; Wilson and Mason, 2019; Giesecke et al., 2016). Indeed, from a user perspective, it simplifies the decision-making process and enhance the travel experience by integrating real-time information on transit schedules, traffic conditions, and vehicles positions with a unique booking and payment system for different transport providers. As a result, it provides a simple, flexible, and cost-effective service that disrupts the traditional fragmented paradigm (Lyons et al., 2019; Jittrapirom et al., 2017; Heikkilä, 2014; Pangbourne et al., 2020; Utriainen and Pöllänen, 2018). Instead, from a supplier perspective, the adoption of MaaS necessitates a shift towards a cus-

tomers-centric approach. Specifically, the focus is on providing personalized, on-demand transport solutions that cater to the unique needs and preferences of individual users (Jittrapirom et al., 2017; Hensher et al., 2020). Furthermore, its success relies on the collaboration among different stakeholders, the integration between previously separated entities. Thereby, new and innovative business models are created, transforming the traditional landscape of the transportation industry (Kamargianni and Matyas, 2017; Polydoropoulou et al., 2020; Wong et al., 2018; Hensher, 2017; Mukhtar-Landgren et al., 2016; König et al., 2016; Aapaoja et al., 2017a). Although almost ten years have passed since its introduction, there remains a scarcity of concrete ideas on how to effectively offer a MaaS service: while MaaS applications have been downloaded by millions of users, providers continue to face challenges in achieving profitability and breaking even (Krauss et al., 2022; van den Huevel et al., 2020). Newcomers and incumbent players in the transport sector, as well as governments around the world, have a growing interest in its development and implementation, but most of the times a MaaS service doesn't get through the prototype stages (Hensher et al., 2020; Karlsson et al., 2020). Hence, studying business models for MaaS is not only crucial but also highly beneficial for the successful realization of MaaS schemes (Polydoropoulou et al., 2020). Thus, the body of literature on MaaS business models is currently widening (see, for example, König et al., 2016; Holmberg et al., 2016; Sarasini et al., 2017; Ebrahimi et al., 2017; Polydoropoulou et al., 2020; Krauss et al., 2022), and previous studies predominantly focused on providing a static representation of the business model of MaaS providers, often utilizing frameworks like the Business Model Canvas (Osterwalder and Pigneur, 2010). These studies have typically explored how the governance structure (private, public, or public-private partnership) influences the design and operation of the MaaS business model (Aapaoja et al., 2017a; Narupiti, 2019; Smith et al., 2018; Wong et al., 2020; Zhang and Zhang, 2021). Instead, the present study aims at investigating the dynamic nature of business

model innovation (hereafter BMI) within the context of MaaS. In particular, by studying existing firms operating in the MaaS ecosystem, we aim at picturing and describing the impacts of MaaS introduction on businesses in order to capture the changes, adaptations, and innovations that occurred and gain insights on the new value creation, capture and delivery mechanisms that emerged. Hence, the following research questions will be addressed:

- *How have firms in the ecosystem changed their business models in response to the emergence of MaaS?*
- *What strategies and approaches can firms adopt to implement the MaaS concept and create, capture, and delivery new value?*

To do so, we adopt an inductive, multiple case study approach (Yin, 1994; Eisenhardt 1989; Eisenhardt and Graebner 2007). After defining the business ecosystem for MaaS, a longitudinal analysis has been conducted, focusing on a total of six specific organizations belonging to two types of actors: service providers and technology providers. These actors represent the core components of the MaaS ecosystem, as they enable the implementation of the service (Kamargianni and Matyas, 2017). As for the service providers, Uber Technologies Inc (mainly a ride-hailing company), Berliner Verkehrsbetriebe (also known as BVG, a public transport provider) and Neutron Holdings Inc (also known as Lime, a micro-mobility solutions provider) were selected and analysed, while for the technology providers the choice fell on Mercedes-Benz Group AG (a car manufacturer), Masabi Ltd (a digital payments and fare collection solutions provider), and Siemens AG (focusing on its mobility division). Our research process involved collecting and organizing data from these case studies, leveraging the value creation, capture, and delivery framework (Bocken et al., 2015; Lepak et al., 2007). This framework allows for an analysis of the BMI from the pre-MaaS to the post-MaaS eras. Indeed, the BMI concept is often defined as the process of creating, capturing, and delivering value in new ways that differ from existing

practices; it involves the re-configuration of existing business model or the design of new ones (Acciarini et al., 2023; Amit and Zott, 2012; Foss and Saebi, 2017; Teece, 2010). Therefore, by utilizing the introduction of MaaS as a cut-off point, we examine the main changes that have occurred in the value mechanisms employed by both service and technology providers. Our findings reveal that, despite their heterogeneity, companies belonging to these two categories have embraced analogous strategies for value creation, capture, and delivery within their respective domains during their transition to MaaS. Thus, we have formulated two different models by identifying common firm-specific mechanisms and subsequently categorizing them into broader macro-level mechanisms of value creation, capture, and delivery, as identified in existing literature.

The findings of this research bring contributions to the ongoing academic literature related to MaaS and to BMI. First, we extend the theoretical knowledge on MaaS business models by highlighting the different strategies that existing firms may adopt to naturally incorporate MaaS into their value propositions. Second, our examination reveals the MaaS influence and its impact on businesses within the mobility landscape. This theme has been widely discussed in the literature (see, for instance, Srivastava and Wong, 2023; Hensher, 2017; Mulley and Nelson, 2020), but our aim is to focus on business strategies, operational dynamics, and value creation and value appropriation mechanisms. This knowledge area needs a deeper exploration, as it may advances our understanding of BMI in dynamic environments like the mobility sector and provide useful managerial insights. By describing the evolution of the business models of service and technology providers we thereby shed new light on the BMI strategies adopted by firms in response to new phenomena (e.g. Sarasini and Linder, 2018; Cohen and Kietzmann, 2014; Turoń and Kubik, 2021).

Our research has also straightforward practical implications. It mainly informs managers and policymakers of the evolutionary trajectory of business

models within firms operating in MaaS ecosystems and highlights the value mechanisms used by them to navigate the challenges and opportunities presented by MaaS. Understanding their dynamics might guide the decision-making process and the implementation of strategic plans that foster innovation and the creation of new MaaS systems, while also ensuring their long-term success and sustainability.

The paper is structured as follows. The upcoming section provides a comprehensive overview of the theoretical background surrounding MaaS. Section 2.4 briefly describes the methodology adopted. Section 2.5 presents the results of the analysis. Section 2.6 concludes the paper by discussing the findings, the main implications for theory and practice, and possible avenues for further research.

2.3 Theoretical Background

2.3.1. The MaaS Concept

Since its introduction, MaaS has garnered significant attention from scholars, practitioners, and policy makers, due to its potential to change the way transportation is perceived and experienced, as well as in achieving sustainable and efficient goals (Hensher et al., 2020). There have been numerous attempts to define its boundaries and characteristics; however, a universally recognized definition of MaaS has yet to be established (Arias-Molinares and Garcia-Palomares, 2020; Maas, 2022). Indeed, MaaS may be considered as a new mobility paradigm based on the concepts of integration and interoperability (Giesecke et al., 2016; Sochor et al., 2018). It can be viewed as an evolutionary step from the idea of mobility management, which emerged in the early 1990s with the aim of enhancing the efficiency and accessibility of public transportation (Mulley, 2017; Lyons et al., 2019). Such idea has now become possible

due to several factors that characterize today's society, as the increasing urbanization, advancements in technologies and better penetration of smartphones, the proliferation of privately-owned shared mobility services (such as bike sharing, e-scooter sharing, car sharing, etc.), and a cultural shift driven by the preferences of new generations (Heikkila, 2014; Hensher and Xi, 2022). On its basis, MaaS is strictly connected and shares several conceptual and operational similarities with new economic paradigms such as crowd and sharing economy (Lee et al., 2018; Geissinger et al., 2020; Tseng and Chan, 2021). Indeed, by emphasizing access over ownership, MaaS enables users to access transportation services on-demand, rather than owning vehicles outright. Moreover, it offers viable and sustainable alternatives which emulate the flexibility of private car use for moving from point A to point B (Kamargianni et al., 2018; Fioreze et al., 2019; Lyons et al., 2019). It involves the integration and combination of different modes, facilitating the realization of intermodal travel and enabling a free, informed and convenient choice for consumers among the various existing mobility solutions (bus, cabs, metro, trains, sharing and on-demand services, even ferries, and a mix of these). In addition to mobility, MaaS offerings may also include mobility-related (e.g., parking, recharge stations, etc.) or other types of services (food delivery, logistics, television packages, retail discounts, and so on), forming a comprehensive and multimodal portfolio of services (Hensher et al., 2021; Hensher and Mulley, 2021; Kamargianni et al., 2016). Generally, MaaS schemes differ by the level of service integration in their value proposition; as the level of integration increases, there are different shades or “degree of MaaS-ness” (Hensher et al., 2021; Hensher et al., 2020; Sochor et al., 2018). The MaaS experience, as in many other sharing-labelled services, is offered through apps, which provide real-time information on timetables, routes prices, vehicles location and availability, traffic conditions, and centralize the booking and payment process (one-stop-shop principle) (Hensher et al., 2021; Hensher et al., 2020; Sochor et al., 2018; Kamargianni and Matyas, 2017). The app may also of-

fer additional features such as info on weather updates, synchronization with the personal activity calendar, trips history and ability to re-buy tickets, display of invoices, ability to issue feedbacks, etc (Jittrapirom et al., 2017; Cruz and Sarmiento, 2020; Esztergar-Kiss et al., 2020). The payment options can range from single trip purchases (pay-as-you-go) to monthly subscriptions that provide mobility bundles at potentially discounted prices (Reck et al., 2020; Ho et al., 2018; Ho et al., 2020). MaaS is intended to be a user-centric service: it focuses on users and their real needs; it seeks to provide a unique (or personalized) travel experience that is integrated, easily accessible, door-to-door, seamless, convenient, and of high-quality standards (Hensher et al., 2021; Jittrapirom et al., 2017; MaaS Alliance, 2019). Moreover, MaaS promotes a collaborative approach that fosters the creation of a single, cooperative and interconnected transportation market. In this model, all participating parties continuously interact and share data, hence creating a dynamic ecosystem where resources are efficiently utilized (Hietanen, 2014; Polydoropoulou et al., 2020; Kanda-naarachchi et al., 2022; Meurs et al., 2018). The smooth operation of MaaS is thus enabled by leveraging collective resources and expertise of all the stakeholders within the ecosystem (Kamargianni and Matyas, 2017; Karlsson et al., 2020; Zhang and Zhang, 2021).

2.3.2. MaaS expansion and open challenges

Currently, MaaS is undergoing a rapid expansion within the mobility sector, with its valuation surpassing \$120 billion in 2021 and projected to grow with a CAGR of 16.8% until 2030 (P&S Intelligence, 2022). This surge is characterized by the emergence of numerous start-ups, prompting the development of innovative platforms that offer consumers a diverse array of mobility options (Hensher et al., 2021). Additionally, incumbent firms are adapting their strategies to incorporate this new offering into their portfolios, while governments

worldwide are proactively supporting its development and implementation through a proliferation of government-led MaaS trials (Hensher et al., 2020; König et al., 2016; Polydoropoulou et al., 2020). Multiple factors are driving this phenomenon. On one hand, companies are willing to seize the economic opportunity represented by MaaS, to diversify their revenues and expand in new markets. On the other hand, policy makers are attracted by the potential benefits promised by this innovative service. Indeed, when correctly designed, MaaS can potentially shift consumer preferences toward more sustainable modes of transportation (Ho et al., 2018; Lyons et al., 2019). A drastic decline in private car use would result in reduced emissions and congestion, as well as the need for less parking space. In turn, such facilities could be redeveloped into green spaces, thus contributing to better city liveability and environmental sustainability (Kamargianni et al., 2018; Pangbourne et al., 2020; Audouin and Finger, 2018; Aapaoja et al., 2017b). MaaS systems can improve urban connectivity by providing first and last mile solutions and ensure greater accessibility to transportation services for rural areas and fragile people (Eckhardt et al., 2020; MaaS Alliance, 2017; Sarasini et al., 2017). Finally, MaaS has the potential to enhance efficiency by optimizing the utilization of existing infrastructures, filling gaps in the transportation network, offering alternative options and necessary redundancy during peak hours, and facilitating comprehensive planning of the entire transportation system (Kamargianni and Matyas, 2017; Wong et al., 2020; Butler et al., 2021). However, all these positive externalities are still uncertain, as there is still no evidence based on the MaaS trials conducted around the world (Hensher et al., 2020; Pangbourne et al., 2020; Arias-Molinares and Garcia-Palomares, 2020). This is because many MaaS initiatives remain stuck in the prototype stages, unable to progress to full-scale implementation (Hensher et al., 2020; Karlsson et al., 2020). Moreover, even when these initiatives manage to reach the commercialization stage, providers often encounter significant challenges in achieving financial sustainability and breaking even (Krauss et al.,

2022; van den Huevel et al., 2020; Harrison et al., 2020). In sum, MaaS faces various practical difficulties that hinder its widespread adoption. Firstly, integrating diverse transportation modes and service providers poses technical challenges, as it requires seamless data sharing, interoperability, and compatibility among different systems, as well as organizational challenges, as it necessitates the coordination and collaboration of the actors involved, which may have conflicting goals (Kamargianni and Matyas, 2017; Giesecke et al., 2016; Butler et al., 2021; Li and Voegelé, 2017; Zhang and Zhang, 2021). Secondly, regulatory frameworks and policies may not be adequately adapted to accommodate the unique characteristics of MaaS, creating legal and governance barriers (Karlsson et al., 2016; Mukhtar-Landgren et al., 2016). Additionally, MaaS requires a shift in user behaviour and a willingness to embrace alternative modes of transportation: resistance to change can significantly impact the penetration of MaaS and hinder the ability of firms to achieve profitability (Mukhtar-Landgren et al., 2016; Butler et al., 2021; Karlsson et al., 2020; Mulley, 2017). Table 2.1 provides a comprehensive synthesis of the factors that influence MaaS adoption, considering aspects related to the industry side, the demand side, and the government (or policy side).

2.3.3. MaaS Business Models

Given the complexity of implementing MaaS and the absence of a universally effective business strategy to ensure its success and sustainability, the importance of developing robust business models has become a focal point for both academics and practitioners (Polydoropoulou et al., 2020; Krauss et al., 2022). This interest is reflected by a notable increase in scholarly articles and industry analyses aimed at exploring this topic. However, many previous contributions have primarily focused on providing a static representation of the "prototype" business model for the MaaS provider, describing how it should func-

tion based on the principles of the MaaS concept, often using the Business Model Canvas framework (Osterwalder and Pigneur, 2010). Moreover, they acknowledge the influence of the governance model and the entity assuming the role of the MaaS provider in the value creation, delivery, and capture process (Sochor et al., 2018; see, for example, Smith et al., 2018; Narupiti, 2019; Wong et al., 2020; Zhang and Zhang, 2021). Holmberg et al. (2016) presented UbiGo's Business Model Canvas and described the potential role of public transport in a MaaS scheme. Within the "MAASiFiE" and "Rural-MaaS" projects, König et al. (2016), Aapaoja et al. (2017a) and Eckhardt et al. (2017) developed four models of MaaS provision, as reseller, integrator, public and public-private partnership (PPP). Their differences are based on which actors hold control over the integration of mobility services, and each specific model may be appropriate depending on whether they are developed in urban, suburban, national, or international areas. However, these four models are barely characterized in the aforementioned papers. In addition, König et al. (2016) proposed a very generic Business Model Canvas for MaaS. Instead, Polydoropoulou et al. (2020) developed a business model prototype with the Business Model Canvas' framework and investigated how this prototype can be characterized to successfully adapt in different operational contexts. Krauss et al. (2022) combined the morphological analysis (Zwicky, 1967) with Osterwalder and Pigneur' (2010) Business Model Canvas with the aim of structuring and characterizing a MaaS business model from the point of view of the service provider. The result is a framework that pinpoints all the considerable elements of a MaaS Business Model. Finally, Srivastava and Wong (2023), after performing a macro analysis of the current MaaS market in China, developed three new business models specifically tailored for automobile manufacturers which aim to address the opportunities and threats arising from the rapid development of MaaS.

Table 2.1 - Aspects influencing MaaS adoption (Sources: Authors' own rielaboration from Mukhtar-Landgren et al., 2016; Karlsson et al., 2020; Butler et al., 2021; Zhao et al., 2019; Matyas, 2020; Mulley and Kronsell, 2018; Zhang and Zhang, 2021)

<i>GENERAL TRENDS</i>		
• Growing Urbanization • Globalization • Sharing economy • Servitisation		• Social Changes triggered by Millennials • Technological advancements • Increased awareness of environmental, economic, social sustainability
<i>INDUSTRY SIDE</i>	<i>DEMAND SIDE</i>	<i>GOVERNMENT</i>
Uncertainties about: - the economic viability of the business - who should assume leadership - the distribution of profits - the prices to adopt - the services to include - the management of the brand	Willingness-to- MaaS services. It is influenced by: - Awareness of the added value provided by the service - Awareness of one's spending on mobility - Financial availability of individuals - Perception of a personalized service (match between need and service offered)	Legislative measures about: - Taxes, subsidies and allocation of financial resources for mobility - More flexible procurement and contracts on public transportation modes - Standardization of data - Protection of user privacy
Ability to create a shared vision and a roadmap for service implementation	Awareness of the existence of alternative modes of transportation and their costs	"Push measures": economic disincentives, taxing cars, increasing fuel and highway fares, reducing the number of parking lots, banning car traffic in city centers
Ability to measure performance and outcomes achieved	Social and cultural context	"Pull measures": subsidize investment in electric vehicles and reduce the cost of public transportation; economic incentives for companies that want to undertake a MaaS project
Resistance to change or Presence of an entrepreneurial mindset open to innovations	Emotional relationship of users with their private car	Proactive measures to foster cooperation between companies in the industry and regulate competition

Ability to provide an intuitive, easy-to-use app and ensure extensive service coverage	Travel habits	Ability to develop a shared vision and roadmap to drive change
Ability to ensure users' privacy adequately	Difficulties in using smartphones and new technologies (elderly)	Strong political will to make the transition, to rethink and redefine the concept of "public transportation"
Ability to establish collaboration and data/resource sharing		Economic incentives, grants and funding for new MaaS initiatives.

All these works tend to overlook the dynamicity of MaaS and its impact on established transportation businesses. In contrast, recognizing its transformative power, this paper delves into understanding the effects of MaaS on existing companies within the transportation sector. Our objective is to explore the innovation mechanisms and strategies employed by these enterprises to effectively seize the opportunities presented by MaaS and successfully integrate such a system in their business models. In other words, rather than focusing on business model prototypes for MaaS, this paper offers a distinct viewpoint by examining the strategies and mechanisms through which companies in the transportation sector integrate MaaS. Thereby, by focusing on these strategic approaches to MaaS adoption, our study contributes to a broader understanding of how MaaS has impacts the mobility sector.

2.4 *Methods*

In the present study, we adopt an inductive, multiple case study approach (Eisenhardt 1989; Eisenhardt and Graebner 2007; Yin, 1994) to explore and understand the dynamics of business model innovation in the context of MaaS. The selection of this research approach is driven by several key motivations and considerations. Firstly, as underlined in the previous section, there’s a

relative lack of investigation in the field of BMI for MaaS and more theory building is necessary in this emerging domain (Eisenhardt, 1989). Secondly, MaaS represents a complex and transforming concept, involving several stakeholders and intricate interdependencies (Kamargianni and Matyas, 2017; Hensher et al., 2020; Liimatainen and Mladenović, 2018). Hence, studying multiple rather than single cases can be more indicated, as it enables the exploration of diverse perspectives and variations, allowing us to compare and contrast different and independent examples in the MaaS industry, identifying common patterns and unique features that contribute to a more comprehensive understanding of the phenomenon (Eisenhardt and Graebner 2007). Furthermore, the utilization of multiple cases in our research design enhances the generalizability and robustness of our findings, offering stronger evidence compared to single-case studies (Davis et al., 2007). Overall, this methodology offers an opportunity to capture the multifaceted nature of the industry, generate insights, and contribute to both theoretical knowledge and practical implications. In the following sections, we provide an elaborate account of the research setting and the enacted methodological process.

2.4.1. Research Setting

We have chosen to study MaaS through the theoretical lens of Business Model Innovation (Amit and Zott, 2020; Foss and Saebi, 2017; Girotra and Netessine, 2014) for several compelling reasons. Firstly, as noted in the previous sections, MaaS is a relatively new concept that is continuously evolving (Sochor et al., 2018) and shaping its presence in the marketplace (Hensher et al., 2020; Harrison et al., 2020; van den Huevel et al., 2020). The dynamicity of MaaS calls for in-depth research to explore and understand the diverse business models that emerge to translate this concept into a viable and profitable business (Krauss et al., 2022). The scalability and sustainability of MaaS implementations

are critical factors in realizing its full potential (Mulley, 2017). Thereby, understanding the business models that enable scalability is vital for ensuring the growth of MaaS and the realization of all its externalities (Polydoropoulou et al., 2020; Krauss et al., 2022). Secondly, MaaS is a new and disruptive concept that is currently transforming the way firms operate within the mobility sector and how they deliver value to the customers (Jittrapirom et al., 2017; Giesecke et al., 2016). Its impact extends beyond the MaaS providers themselves and permeates throughout the entire ecosystem of companies involved in this domain (Garcia et al., 2019; Kamargianni and Matyas, 2017). As MaaS changes the traditional and fragmented transport paradigm, it prompts transportation providers, technology companies, and various service providers to reassess their roles and redefine how they create and capture value by embracing a more collaborative approach (Hensher, 2017; Wong et al., 2020; Pangbourne et al., 2020; Hensher et al., 2020). Therefore, the examination of the effects on the business models of firms in the MaaS business ecosystem is undoubtedly interesting and holds substantial implications for both theory and practice. Finally, MaaS is experiencing a rapid and steady growth in the transportation market. Since its introduction, a plethora of trials and start-ups emerged to explore and practically develop MaaS (Hensher et al., 2020; König et al., 2016; Polydoropoulou et al., 2020). Governments worldwide have taken proactive measures to foster its adoption, providing support for trials and recognizing its potential in addressing sustainability challenges within cities (Hensher et al., 2020; Pangbourne et al., 2020; Butler et al., 2021). Concurrently, new companies, such as MaaS Global, Citymapper, and Moovit, have recognized the profitability prospects associated with MaaS and have consequently developed innovative platforms to offer consumers a growing array of mobility options (Hensher et al., 2021). Furthermore, many incumbents in the mobility sector have actively sought to capitalize on the opportunities that this concept represents by evolving their operations and business strategies and developing their own MaaS service; this can be ob-

served in well-known examples in the field, such as Uber and Lyft (P&S Intelligence, 2022). Overall, the MaaS market has been valued over \$120 billion in 2021, and it is projected to grow with a CAGR of 16.8% until 2030 (P&S Intelligence, 2022). We can therefore expect that MaaS will become an integral part of everyday life, serving as a central component in the realm of transportation solutions. Within this dynamic landscape, our research findings may hold significant relevance for future studies that focus on analysing and understanding MaaS.

2.4.2. Research Sample

The research sample consists of six prominent organizations operating within the MaaS business ecosystem, all of which have adapted their business models in response to MaaS introduction. The selection of these organizations follows a theoretical sampling approach, aiming to identify cases that can either replicate or extend the emerging theory (Eisenhardt, 1989). The primary objective is to develop theory rather than solely test it. In order to illustrate the sampling process, it is essential to establish a preliminary definition of the MaaS business ecosystem. A comprehensive description has already been provided by Kamargianni and Matyas (2017), and we present a simplified representation in Figure 2.1. The MaaS provider operates within a collaborative network of key stakeholders spanning multiple sectors and playing a crucial role in shaping the service provision, as well as the dynamics of value creation and value appropriation (Kamargianni and Matyas, 2017). The ecosystem comprises four key entities, as service providers, technology providers, financial partners, and customers.

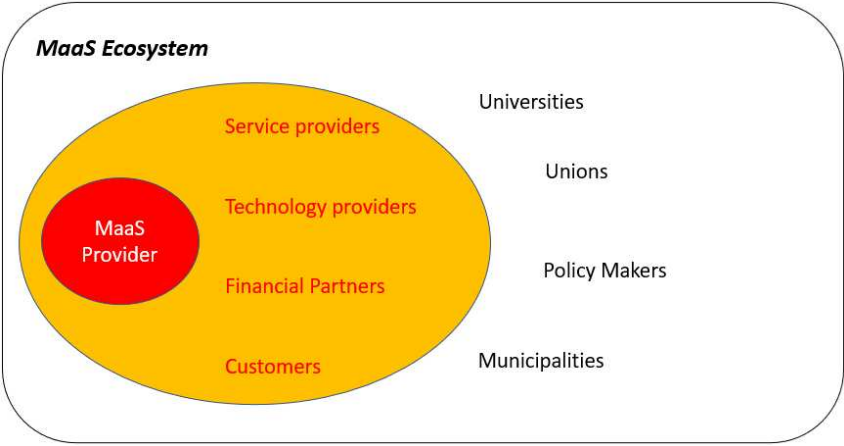


Figure 2.1 - A simplified representation of the MaaS Business Ecosystem according to Kamargianni and Matyas, 2017 and Garcia et al., 2019

To evaluate the effects of MaaS, we choose to analyse companies belonging to the categories of service and technology providers. Service providers constitute the core of MaaS, as they encompass a range of transportation, mobility, and mobility-related service operators. Instead, technology firms provide the backbone (software solutions, digital infrastructures, data management systems) that enables real-time information exchange, booking and payment processing, data analytics, and user-friendly interfaces (HaCon Company, 2022; Maas, 2022). Customers were excluded, as our primary emphasis is on the industry side. Furthermore, we have also opted to exclude financial partners (such as investors, funding organizations and insurance companies) from our research, acknowledging their distinct dynamics that differ from those of service providers and technology companies. In order to ensure both literal and theoretical replication, we employed four criteria to guide the sampling process for the multi-case study. The first criterion that guided our selection of companies was their status of established player in the industry. This decision was motivated by our aim to comprehensively study the evolution of their business

models in response to MaaS adoption. By focusing on well-established firms, we can gain valuable insights into how their business models have evolved over time, benefiting from their operational stability and experience. This approach allows us to capture the complexities and nuances associated with MaaS implementation and its impact on mature organizations, providing a robust foundation for our research. The second criterion identified was the company size, reputation, and ideally, their status as publicly traded organizations. This criterion was driven by the need for access to a wealth of information, particularly from both primary and secondary sources. By choosing well-known and larger companies, we could ensure a greater availability of information regarding the evolution of their business models over time. This facilitated tracking and analysing the changes and adaptations made by these companies in response to MaaS adoption. The third criterion was the heterogeneity of companies in terms of their core services within their respective categories. For instance, within the category of service providers, we selected a micro mobility, a public transport, and a ride-hailing company, while within the technology providers category, we chose a car manufacturer, a provider of ticketing and payment solutions, and a provider of software solutions and digital services. Heterogeneity allows for a broader exploration of the phenomenon under investigation. Different cases with diverse characteristics and contexts provide a more comprehensive understanding of the subject matter, capturing a range of perspectives, challenges, and outcomes (Eisenhardt, 1989). Moreover, heterogeneity promotes theoretical replication and extension and enhances the validity of the research findings (Eisenhardt and Graebner 2007; Yin, 1994). Finally, the last criterion was to include in the research companies that successfully adopted MaaS, regardless of their geographical location. Indeed, by focusing on companies that have demonstrated the ability to effectively integrate MaaS into their operations and achieve sustainable outcomes, we can gather meaningful data and draw robust conclusions about the implications and potential benefits of MaaS

adoption. After establishing the selection criteria, an initial search was conducted across various literature, industry reports, and news sources to identify notable companies operating within the MaaS ecosystem. This preliminary research yielded a list of potential candidates. Subsequently, each company on the list was evaluated based on the selection criteria, taking into account their suitability for the research objectives. For the service providers category, we identified Uber, a prominent ride-hailing service with a global presence, BVG, a well-established public transport company in Berlin, and Lime¹, a leading provider of bike and e-scooter sharing services. In the technology providers category, we included Mercedes-Benz Group AG, a renowned car manufacturer, Masabi, a provider of ticketing and payment solutions, and Siemens AG, a multinational company specializing in electrification, automation, and digitalization. In response to the introduction of MaaS, all these companies have innovated their business models. Some have transitioned to become MaaS providers or have joined existing MaaS systems, while others have evolved into MaaS-as-a-Service providers to expand their offerings. In Table 2.2, we present a brief overview of each selected case study.

2.4.3. Data Collection

The data collection process for this analysis consisted mainly in three sequential steps. First, we gathered data related to the case studies from various online sources, and then carefully summarized key information, pertinently to our research questions. Second, we focused on the validation of the knowledge we

¹ It is important to note that, while Uber does not directly own Lime, they are indeed financially intertwined. However, Lime maintained its operations independent. This strategic partnership reflects a common tendency among service providers that will be further discussed in the next sections.

gathered in the previous step by asking for interviews or the completion of an online survey to the managerial personnel of the selected companies. Third, we engaged discussions with industry experts, employing them as key informants, to enrich our understanding of the research theme and to gather additional insights on the organizations under analysis. We iterated through the first three steps as needed, incorporating feedback into our research. We analyse multiple sources of information to allow triangulation for more accurate findings (Eisenhardt, 1989). Therefore, our data sources encompassed two main categories, namely archival records and documentary information, as well as individual interviews and survey.

Archival records and documentary information

The preponderant source of information was retrieved from secondary sources. In particular, we began by consulting industry reports, research articles, and newspaper articles in order to gain an initial understanding of the organizations under analysis and to retrieve primary insights. Subsequently, we carefully examined their annual reports, websites, and press releases to obtain specific and up-to-date details. Given the characteristics of the transportation market and the ongoing evolution of MaaS (ITF, 2021; Hensher et al., 2020), we focused on the most recent data available. While some of the selected companies have a long history and have undergone various business model transformations over time, the study placed particular emphasis on investigating their current strategies and approaches in relation to the emergence of MaaS.

Individual interviews and survey

Information from primary sources served to validate our findings retrieved online. Specifically, we asked various managerial personnel from the selected organizations to conduct an interview, offering the option of either face-to-face meetings or asynchronous interviews via email exchanges.

Table 2.2 - Overview of the six selected cases

Company name	Type	Year of found.	HQ Location	Core Business	Size
Uber Technologies Inc.	Service provider	2009	San Francisco, California, USA	Ride-hailing	Available in 10.5K cities; Employees: 10K+ Revenue: \$31.88 billion (2022); Market cap: appr. \$85 billion
Berliner Verkehrsbetriebe (BVG)	Service provider	1928	Berlin, Germany	Public Transport	Revenue: €1.34 billion (2022) Employees: 10K+
Neutron Holdings, Inc. (Lime)	Service provider	2017	San Francisco, California, USA	Bike-sharing and e-scooter sharing	Available in more than 2K cities; Employees: 1.001-5.000 Revenue: \$10 - \$100 million
Mercedes-Benz Group AG	Technology provider	1926	Stuttgart, Germany	Car manufacturer	Revenue: €150 billion (2022); Market cap: appr. €87.5 billion Employees: 10K+
Masabi Ltd	Technology provider	2001	London, UK	Ticketing and payment solutions	Revenue: €37.8 million (2022) Employees: 201-500
Siemens AG	Technology provider	1847	Munich, Germany	Digital solutions, automation, energy	Revenue: €62 billion (2022); Market cap: appr. €125 billion; Employees: 10K+

The interview structure encompassed three key sections of questions. Informants were prompted to reflect on (i) their company's business model before the emergence of MaaS, (ii) their current one, and (iii) what are the most significant changes that occurred in the transition between the pre-MaaS and post-MaaS era. We used BMI theory as a foundational framework to formulate the questions (Amit and Zott, 2020; Foss and Saebi, 2017). Additionally, to provide them greater flexibility, we designed an online survey, the structure of which is detailed in Table 2.3. Therefore, informants could choose to participate either with an interview or by completing the online survey. The main difference is that the survey was designed with a predefined structure comprising multiple-choice questions, which facilitated responses based on the insights gathered from our prior research of secondary sources. Finally, face-to-face meetings or asynchronous interviews via email exchanges were conducted with industry experts to further validate our findings. We conducted interviews with at least one member from each company, in addition to consulting with nine industry experts. This resulted in a total of fifteen interviews.

2.4.4 Data Analysis

Following the recommended approach by Strauss and Corbin (1990), the data analysis process involved iterative steps. Once the case selection was over, we applied the value creation, capture, and delivery framework (Bocken et al., 2015; Lepak et al., 2007) to each company based on the initially gathered information from secondary sources. Drawing from literature highlighting that BMI involves changes in the architecture of value creation, capture, and delivery of a firm (Teece, 2010; Amit and Zott, 2012; Foss and Saebi, 2017; Acciarini et al., 2023), we identified this framework as the most appropriate for our analysis. We applied it both before and after the adoption of MaaS for each case. To enhance the organization and interpretation of data, we compiled the infor-

mation into tables that provided a comprehensive overview of the business model innovation mechanisms employed by each company and the resulting transformations in their business models. Furthermore, primary data sources were utilized to enrich the information precedingly retrieved. In order to derive theoretical insights from the qualitative nature of the data (Glaser and Strauss, 1967), an intra-case and cross-case analysis was conducted (Eisenhardt, 1989; Yin, 1994). This analysis aimed to identify potential patterns of BMI within each category (service and technology providers) and to discern differences between the two categories. As previously mentioned, to ensure the integrity of the data and enhance the reliability of our findings, we employed a triangulation approach by utilizing multiple sources of information. Additionally, we conducted independent reviews and analyses of the collected information, engaging in collaborative discussions and meetings to exchange and challenge ideas. In cases where disagreements arose, we gathered additional sources of information and conducted comparative analyses. These measures were taken to establish a robust foundation for our results, grounded both empirically and theoretically.

2.2 Findings

MaaS is more than just a new mobility trend. Indeed, it can be seen as a new and disruptive concept that is transforming the mobility landscape (Hensher et al., 2020; Sochor et al., 2018). MaaS represents a paradigm shift in how individuals perceive and access transportation options, as well as in how mobility is provided to users (Jittrapirom et al., 2017; Lyons et al., 2019; Polydoropoulou et al., 2020). Giving more emphasis to the supply side, the primary aim of this research is to assess how the introduction of MaaS has influenced the organizations operating within the MaaS ecosystem.

Table 2.3 – Survey structure

Section	Motivation	References
Introduction	This section serves as an introduction, where participants are provided with a clear context for the research that is being carried out. Key terms and concepts are here defined. The section begins by requesting basic details, such as the name of the respondent's organization. Additionally, it seeks to determine whether the respondent's organization predominantly functions as a service provider or a technology provider	Braun et al., 2021
Pre-MaaS business model	The second section of the survey aims at gathering information regarding the business models that organizations employed before the emergence of MaaS in the market. We delve into the strategies and value mechanisms that these organizations utilized in the pre-MaaS era. We asked for their value proposition, customer segments, key partnerships and resources. Furthermore, we asked what were in their opinion the main value creation, capture and delivery mechanism they employed. The questions in this section were mainly designed as multiple-choice, providing respondents with structured options.	Osterwalder and Pigneur, 2010; Amit and Zott, 2001; Lepak et al., 2007
Post-MaaS business model	The third section delves in the current state of respondents' organizations business models and explores the changes that occurred after the introduction of MaaS. We asked specifically what the main shifts in their value mechanisms are and on what aspects or business areas MaaS had the most significant impact.	Osterwalder and Pigneur 2010; Lepak et al., 2007
BMI Process	The final section delves into the "how" behind these changes and explores the motivations. Respondents were asked about the key strategies they employed to introduce MaaS solutions, which partners they engaged, and the critical steps taken during this process.	Amit and Zott, 2020; Foss and Saebi, 2017; Teece, 2010

In particular, our focus is to analyse the subsequent evolution of their business models and shed new light on the mechanisms and strategies adopted by firms. Figure 2.2 illustrates a timeline showcasing the primary initiatives undertaken by the companies under analysis. Our findings reveal that, despite their heterogeneity, companies in the service provider and technology provider categories have embraced analogous strategies for value creation, capture, and delivery within their respective domains during their transition to MaaS. Thus, we created different models for the two categories by discerning common firm-specific mechanisms and subsequently grouping them into broader macro-level mechanisms of value creation, capture, and delivery as identified in existing literature. Results are shown in Table 2.4 and Table 2.5. The following sections describe our contribution in detail.

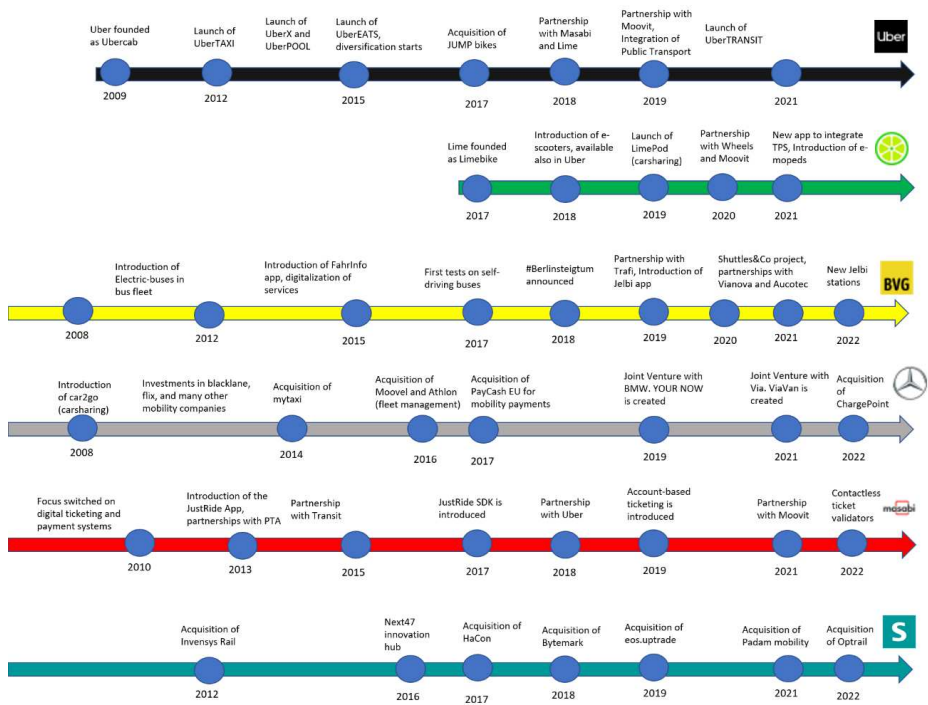


Figure 2.2 - Key Initiatives towards MaaS by Uber, Lime, BVG, Mercedes-Benz, Masabi, Siemens Mobility

Table 2.4 - Value creation, capture, and delivery framework applied to Service Providers

	PRE-MAAS MECHANISMS		POST-MAAS MECHANISMS	
	Macro-Level	Micro-Level	Macro-Level	Micro-Level
Value Creation	[Transport] Product and Service provision	Core transportation service offering (Sharing mobility, ride-hailing, PT)	New Products and Services	- Integrated mobility solutions (creation of a multimodal portfolio) - Ticket interoperability, real-time information, and unique payment system for multiple services - Real-time traffic monitoring and Route Optimization - Inclusion of other mobility-related products and services
	Product Differentiation	- Wide range of product alternatives based on customer needs - Integration of mobility-related services in the product portfolio - More flexibility, convenience, and accessibility for mobility needs - Sustainable initiatives and incentives - Quality and security focus	R&D	Investments in new technologies (AI, Machine Learning, AV, EV, app algorithms, Smart Mobility solutions)
	Innovation and improvements	- Investments in new technologies (digitalization of services, EV, AV) - Investments in new infrastructures and fleets (Improvements in the connection network in cities)	Efficiency	- Data analytics and insights - Process Optimization
	Market Development – Expansion in new segments	Expansion in new cities		
Value Capture	Traditional Revenue Streams	- Commissions and Fees/Fares - Subscriptions - Advertising (in-app/posters) - Sponsorships - Pricing Strategies - Data monetization - Government subsidies - Vouchers/Discounts	New Revenue Streams	- New pricing strategy - New subscription offers and memberships revenue - Revenue sharing with partners
			Networking and Partnerships	- Strategic Alliances - Increased visibility and reduced costs of customer acquisition - Co-Promotion and Marketing
			Lock-In	- Loyalty Programs - Brand reputation
Value Delivery	Digital Platforms and Technology	- App/Platform - Website - Customer support and assistance	Improvements to Digital and physical infrastructures	- New and improved Apps - Side platforms - API and integrated platform with partners - Data sharing - New stations and routes
	Physical Infrastructure and assets	- Stations and routes - Vehicles		

2.5.1. Service Providers

Value Creation

As previously mentioned, service providers in our study constitute a diverse spectrum of entities engaged in delivering transportation, mobility, and related services. Thereby, during the pre-MaaS era, their priority revolved around providing specific transportation services – their core business – to users. For instance, Uber focus on its ride-hailing service, Lime on micro mobility, while BVG offers essential public transport services. Additionally, to distinguish themselves in the competitive landscape, service providers implemented product differentiation strategies. This strategic approach encompassed, in the first place, the introduction of a wide range of transportation options tailored to the specific needs of users. For example, Uber not only provided various car choices for riders but also expanded its service portfolio by integrating mobility-related services such as food delivery and logistics.² Similarly, BVG offered an array of transportation modes including trains, metro, trams, buses, and ferry³, while Lime concentrated on e-scooter and e-bike sharing⁴. This strategy of incorporating different alternatives aimed at enhancing the attractiveness of their overall value proposition and the customer satisfaction. Secondly, their main objective

² Uber Technologies Inc., 2019. “Uber Announces Results for Fourth Quarter and Full Year 2019”. Available at: <https://investor.uber.com/news-events/news/press-release-details/2020/Uber-Announces-Results-for-Fourth-Quarter-and-Full-Year-2019/> (Accessed 28 May 2023)

See also Uber: “Our offerings”. At: https://www.uber.com/it/en/about/uber-offerings/?uclid_id=2e5c484d-0670-4789-8cb1-556495b95e71 (Accessed 28 May 2023)

³ BVG, 2020. “Annual Report 2020”. Available at: <https://unternehmen.bvg.de/media-downloads/> (Accessed 10 June 2023)

See also BVG: “Our company”. Available at: <https://unternehmen.bvg.de/profile/> (Accessed 9 June 2023)

⁴ Neutron Holdings Inc.: About page. Available at: <https://www.li.me/about> (Accessed 4 June 2023)

laid in enhancing flexibility, convenience, and accessibility for users.^{5,6} Certainly, both Uber and Lime have developed a service model that allows users to book a private taxi or access bikes and e-scooters effortlessly, regardless of their location.^{7,8} Moreover, this process is facilitated through intuitive and user-friendly mobile applications. These applications not only streamline the booking and payment processes but also provide real-time updates on vehicle availability, estimated arrival times, and route navigation. On the other hand, BVG, as a public transport provider, focuses on delivering extensive coverage and well-defined timetables, ensuring that a significant portion of the urban area is effectively connected.⁹ Another common concern for service providers is the commitment to offering a secure and reliable experience during transport. Notably, Uber and Lime faced certain challenges in this aspect. In the case of Uber, concerns over passenger safety and incidents involving drivers prompted the company to implement stringent background checks and safety protocols, such as in-app emergency buttons and real-time location sharing, in order to create more confidence among their users.¹⁰ Similarly, Lime has reinforced safety guidelines, provided supplied helmets, and promoted awareness campaigns to ensure the well-being of both riders and pedestrians.¹¹ Instead, BVG installed

⁵ Uber Technologies Inc., 2020. "2020 Investor Presentation". Uploaded in February 6, 2020. Available at: https://s23.q4cdn.com/407969754/files/doc_financials/2019/q4/InvestorPresentation_2020_Feb13.pdf (Accessed 29 May 2023)

⁶ Neutron Holdings Inc., "Our core principles". Available at: <https://www.li.me/> (Accessed 4 June 2023)

⁷ Uber, website Homepage. Available at: <https://www.uber.com/it/en/> (Accessed 28 May 2023)

⁸ Neutron Holdings Inc., "Why Lime". Available at: <https://www.li.me/why> (Accessed 4 June 2023)

⁹ BVG, 2020. "Annual Report 2020". Also, BVG, 2021. "Annual Report 2021"- Available at: <https://unternehmen.bvg.de/media-downloads/> (Accessed 10 June 2023)

¹⁰ Uber Technologies Inc., "Our Commitment to safety" – Available at: <https://www.uber.com/us/en/safety/> (Accessed 30 May 2023)

¹¹ Neutron Holdings Inc., "Rider Community" – Available at: <https://www.li.me/blog/category/rider-community> (Accessed 4 June 2023)

CCTV cameras across its network of buses, trams, and subway stations to enhance the overall security of its transit network. Furthermore, it has introduced a real-time monitoring system that allows for the swift response to any incidents or disruptions.¹² Finally, sustainability and environmental initiatives not only align with their strategic goals but also serve as a distinct element of product differentiation in their value proposition. This approach has been adopted to distinguish themselves in the competitive market by appealing to environmentally conscious consumers. Uber, for instance, launched its "Uber Green" option, enabling riders to opt for hybrid or electric vehicles, reducing carbon emissions from their trips.¹³ This initiative is part of Uber's broader commitment to becoming a zero-emission platform by 2040.¹⁴ Lime's emphasis on micro mobility naturally fosters sustainability by promoting cleaner and more eco-friendly transportation options. Moreover, Lime's commitment to accessibility and community welfare is demonstrated through initiatives like Lime Access and Lime Able.¹⁵ In a similar vein, BVG has incorporated electric buses into its fleet and implemented route optimization strategies to enhance energy efficiency.¹⁶ Another pivotal mechanism of value creation employed by this category of firms involves continuous innovation and enhancement of their services. Uber, Lime, and BVG have all strategically pursued advancements through in-

¹² BVG, 2020. "Safety in numbers" – Available at: https://unternehmen.bvg.de/wp-content/uploads/2023/08/BVG_Sicherheit-in-Zahlen-2022.pdf

¹³ Uber Technologies Inc., "Uber Green" – Available at: <https://www.uber.com/it/it/ride/ubergreen/> (Accessed 30 May 2023)

¹⁴ Uber Technologies Inc., "Your city, our commitment" – Available at: https://www.uber.com/us/en/about/sustainability/?uclid_id=23f8fd9e-24d4-4318-9a97-32095c7ff45e

¹⁵ Neutron Holdings Inc., "Community – Lime Access" – Available at: <https://www.li.me/why/community/lime-access>
See also "How Lime leveraged sustainability to achieve profitability" – Available at: <https://www.li.me/blog/how-lime-leveraged-sustainability-to-achieve-profitability> (Accessed 5 June, 2023)

¹⁶ BVG, 2020. "Annual Report 2020" – Available at: <https://unternehmen.bvg.de/media-downloads/> (Accessed 10 June 2023)

vestments in new technologies.^{17,18,19} For instance, Uber heavily invested in financial services and refining its already sophisticated algorithms to minimize waiting times and optimise routing.²⁰ Lime invested in IoT technology to track, manage, and optimize the utilization of its vehicles, which are central to its dockless mobility service, while BVG invested in digitalizing its ticketing system and providing real-time information on schedules and delays. Another dimension of their innovation strategy involves investments in new infrastructures and fleets.^{21,22} This approach resonates with their commitment to improving the overall mobility experience within urban environments. Sometimes, these investments are intertwined with the imperative to expand into different cities and explore novel market segments. In particular, both Uber and Lime have established their services across various cities and regions worldwide, amplifying their brand presence and diversifying their revenues.²³

Building upon the aforementioned points, MaaS adds novelty to the value proposition of service providers. It represents more than a mere extension of existing offerings; rather, it brings about a fundamental transformation in the way services are bundled, presented, and delivered. The companies under examination are now strategically positioned to offer users a holistic and integrat-

¹⁷ Neutron Holdings Inc., “Why Lime – Innovation” Available at: <https://www.li.me/why/innovation> (Accessed 5 June, 2023)

¹⁸ Uber Technologies Inc., 2020. “2020 Investor Presentation”.

¹⁹ BVG, 2020. “Annual Report 2020”.

²⁰ Uber Technologies Inc., 2020. “2020 Investor Presentation”.

²¹ Uber Technologies Inc., 2020. “2020 Investor Presentation”.

²² BVG, 2020. “Annual Report 2020”.

²³ See Neutron Holdings Inc., “Location” – Available at: <https://www.li.me/locations> (Accessed 5 June, 2023)

And Uber Technologies Inc., “Cities” – Available at: <https://www.uber.com/global/en/cities/?uclid=2e5c484d-0670-4789-8cb1-556495b95e71> (Accessed 30 May 2023)

ed solution that encompasses multiple modes of transportation, curating a comprehensive multimodal portfolio. This positioning has been achieved through various means, including partnerships with other service providers or technology providers and through direct investments or acquisitions. For instance, Uber has expanded its MaaS capabilities by partnering with Moovit, a start-up leader in multimodal trip planning, which allowed Uber to integrate real-time public transit data from over 7000 agencies directly within the Uber app. Moreover, Uber has acquired Routematch and invested in micro-mobility companies like JUMP Bikes to offer a diversified range of transportation options.²⁴ Uber and Lime partnered to offer Lime Scooters through the Uber's app.²⁵ BVG partnered with Trafi,²⁶ a start-up specialized in white-label solutions that enable cities and transport companies to develop their own customized MaaS systems. These strategies focused on leveraging and sometimes developing key resources and competences internally to support their new business. Partnership management, contract negotiation, project management, and technology-related skills were considered crucial in the transition. With a new and enhanced platform, service providers offer a unique ticket and payment system for all the mobility options available. Moreover, real-time information dissemination empowers users with timely updates on routes, schedules, and potential disruptions, fostering an enhanced sense of control and reducing the uncertainties associated with travel. They heavily leverage on data analytics to optimize the process and enhance their efficiency. Uber has built the Gairos platform, which optimizes data ingestion and querying to sup-

²⁴ Lyko, M2050, "Is Uber a MaaS app?" – Available at: <https://m2050.media/en/uber-on-its-way-to-becoming-a-maas-player/>

²⁵ See Neutron Holdings Inc., Help center – Available at: <https://help.li.me/hc/en-us/articles/1260805266589-How-does-renting-a-scooter-through-Uber-work>

²⁶ BVG, 2021. "Annual Report 2021". See also BVG website: "Jelbi" – Available at <https://www.jelbi.de/en>

port dynamic pricing and trip forecasting. Lime handles vast data streams using AWS and Amazon Kinesis, to monitor millions of trips and ensure that its vehicles are charged and available, enhancing the user experience. These mechanisms play a pivotal role in tailoring services to meet changing demands, while also allowing them to allocate resources strategically and streamline their operations.^{27,28} In the quest for continuous innovation and staying at the forefront of the mobility landscape, service providers are increasingly investing in RandD. Uber allocates annually approximately 10% of its revenue in RandD, entailing the exploration of cutting-edge technologies as AI, machine learning and autonomous vehicles (AV) to enhance the efficiency, safety, and sustainability of their services. BVG has also started pilot projects deploying driverless vehicles with on-board attendants and other AI-based systems for connected mobility.²⁹

Value Capture

In terms of value capture, pre-MaaS service providers relied on traditional revenue streams commonly associated with the transportation sector. Mobility platforms like Uber and Lime typically charge commissions and fees on transactions made through their apps, based on the effective usage of their service.³⁰ BVG, instead, collects ride fares at capped prices, supplemented by government subsidies, to maintain its financial sustainability while ensuring acces-

²⁷ BVG, 2022. "Annual Report 2022". Available at : <https://unternehmen.bvg.de/media-downloads/> (Accessed 11 June 2023)

²⁸ Uber Technologies Inc., 2022. "Annual Report 2022". Available at: https://s23.g4cdn.com/407969754/files/doc_financials/2023/ar/2022-annual-report.pdf (Accessed 1 June 2023)

²⁹ Uber Technologies Inc., 2022. "Annual Report 2022". BVG, 2022. "Annual Report 2022". See also: BVG, "Smart Cities" – Available at: <https://unternehmen.bvg.de/smartcity/> (Accessed 12 June 2023)

³⁰ Neutron Holdings Inc., "User Agreements" – Available at: <https://www.li.me/user-agreement> (Accessed 7 June, 2023). Also Uber Technologies Inc., 2019. "Uber Announces Results for Fourth Quarter and Full Year 2019".

sibility for a diverse population.³¹ Most of the times, subscription models are used to provide a predictable revenue stream and promote user loyalty by offering benefits such as reduced prices, priority service, or access to exclusive features. This category of firms also offers vouchers and discounts as a means to attract new customers, retain existing ones, and encourage increased usage of their services. In addition, platforms like Uber adopt particular dynamic and personalized pricing strategies to adapt their prices based on real-time demand and supply conditions, in order to optimize revenue generation.³² Finally, other value capture mechanisms adopted are data monetization, advertising and sponsorships.

The advent of MaaS opened up new revenue streams for service providers. This transformation is underscored by the integration of new pricing strategies, the introduction of innovative subscription offers, and the implementation of loyalty programs, all of which contribute to lock-in users and promote retention. For instance, Uber launched Uber Rewards to offer benefits across different tiers, including discounts on rides, priority support, and flexible cancellation policies. Moreover, Uber One has been introduced to provide discounts and exclusive experiences across both rides and delivery.³³ Instead, Lime launched Limepass, which provides unlimited free scouter unlocks for a week, and LimePrime, a monthly subscription program offering unlimited free unlocks and discounts on rides.³⁴ Partnership and network strategies have emerged as key

³¹ BVG, 2020. "Annual Report 2020".

³² Uber Technologies Inc., "Dynamic pricing" – Available at: <https://www.uber.com/en-GB/blog/uber-dynamic-pricing/> (Accessed 2 June 2023)

³³ Uber Technologies Inc., "Uber Introduces Uber One: A New Membership Program Bringing Together the Best of Uber" – Available at: <https://investor.uber.com/news-events/news/press-release-details/2021/Uber-Introduces-Uber-One-A-New-Membership-Program-Bringing-Together-the-Best-of-Uber/default.aspx>

³⁴ Neutron Holdings Inc., Newsroom: <https://www.li.me/en-gb/blog/lime-introduces-lime-prime-just-in-time-for-summer>

mechanisms for value appropriation, involving revenue sharing models, co-promotion, and increased brand recognition to all the participants.³⁵ For instance, Uber has extended its delivery network by setting strategic partnerships with existing restaurants and retail locations. By taking a fee for every order, Uber helps local businesses gain recognition among its vast user-base. Additionally, Uber has partnered with public transport and micro-mobility providers to enhance its mobility offer and diversify its revenues. Finally, Uber's adopted co-promotion strategies with companies from various sectors (e.g. Spotify) to extend its market reach and brand presence. With Jelbi, BVG opened to new shared revenue streams with the transportation services included in its offering. Businesses that link to the MaaS provider, as Lime did, have experienced a greater visibility of their brand and the access to other's customer bases.

Value Delivery

In terms of value delivery, service providers in the pre-MaaS era relied on both digital platforms and physical assets to grant transportation to users and enhance their overall experience. Leveraging intuitive mobile applications, they allowed users to make bookings, request rides, access vehicles, plan routes, get assistance in every moment. Furthermore, comprehensive fleets of vehicles and maintained well-defined routes for public transport, ensured that users could access transportation options across urban landscapes.³⁶

In the Post-MaaS era, new value delivery mechanisms emerged to contribute to a more seamless and integrated mobility experience for users. One of these mechanisms involves data sharing, which underscores the significance of

³⁵ Uber Technologies Inc., "Transit" – Available at: <https://www.uber.com/it/it/transit/> (Accessed 2 June 2023). Also Uber Technologies Inc., 2022. "Annual Report 2022".

³⁶ Uber, Lime, and BVG websites.

collaboration and interconnectedness among various stakeholders in the MaaS ecosystem. This is made possible through the integration of Application Programming Interfaces (APIs) and the creation of integrated platforms.^{37,38} These enable service providers to connect their offerings with those of complementary partners, allowing users to access a multitude of services through a single interface. Furthermore, the establishment of new stations and routes serves as a tangible manifestation of service providers' commitment to expanding their reach and accessibility.

2.5.2. Technology Providers

Value Creation

Moving to the technology provider category, these firms contribute through the provision of software solutions, digital infrastructures, data management systems, and other technological enablers that facilitate the creation of MaaS systems. Before the introduction of MaaS, technology providers were distinctively engaged in delivering specific technological solutions that catered to various aspects of the transportation and mobility landscape. For instance, Mercedes-Benz, renowned for its expertise in luxury car manufacturing and production of vans, trucks, and buses, ventured into the realm of mobility with car sharing, like car2go, and fleet management solutions.³⁹

³⁷Neutron Holdings Inc, API guide, Available at: <https://docs.lime-crm.com/integration/rest-apis/start#:~:text=Limetype%20API.%20Used%20to%20discover%20and%20retrieve%20metadata,to%20binary%20file%20data%20stored%20in%20Lime%20CRM>.

³⁸Uber Technologies Inc, “Riders API References” – Available at: <https://developer.uber.com/docs/riders/references/api>

³⁹Mercedes-Benz Group AG, 2015. “Annual Report 2015”. Available at: <https://group.mercedes-benz.com/investors/reports-news/annual-reports/download/>

Table 2.5 - Value creation, capture, and delivery framework applied to Technology Providers

	PRE-MAAS MECHANISMS			POST-MAAS MECHANISMS	
	Macro-Level	Micro-Level		Macro-Level	Micro-Level
Value Creation	[IT and Transport-related] Products and Services provision	- Software and digital solutions - Vehicle manufacturing and transport infrastructure solutions - Consulting and digital transformation services - Customized and tailored products and customer services		New Products and Services	- New Digital Solutions for quick innovation, cost reduction, increase in operational efficiency, easy integration with third-party apps and services - Development of Mobility Management solutions (fleet management systems, White label MaaS apps, parking and lot management, recharging systems) - Mobility data analytics and insights (Mobility data platforms) - Mobility consulting and advisory services
	Complementarities	- After sales services (Maintenance, technical support, training, updates) - Financial and mobility services - Sustainability and ESG initiatives			
	R&D	- Investments in EV and AV - Investments in new technologies (smart mobility, digitalization, AI)			
	Market Development – Expansion in new segments	- Investments in new Production Plants (emerging economies) - Expansion of customer base			
Value Capture	Product and service sales and revenues	- Direct sales and service implementation fees - Financial services revenues - Intellectual property and licensing revenues		New Revenue Streams	- Subscriptions to digital and connected services - New software licensing and implementation fees - Data monetization - Partnership agreements and revenue sharing - Premium prices for extra features and upgrades
	Lock-In	- Brand Reputation - Cross-selling and up-selling			
		Networking and Partnerships	- Collaborative R&D - Suppliers and distribution Partnerships - Advertising and Sponsorship		Tangible and Intangible resources acquisition
Value Delivery	Digital Platforms and Technology	- Mobile Apps - Website - Customer service		Improvements to Digital and physical infrastructures	- Integrated mobility platforms (white label) - APIs and data integration tools - Improved digital and mobile apps - Updates and innovations - Cloud-based support services
	Physical Infrastructure and assets	Sales and Dealership network			
	Knowledge Transfer	- Training and knowledge transfer - System integration and Project Management			

Masabi, on the other hand, carved its niche in the realm of e-ticketing and related validation systems. It directed its efforts towards developing comprehensive back-end solutions that ensured secure payments, efficient ticket management, robust customer service, detailed reporting, and real-time analytics. Through these solutions, Masabi contributed to enhancing the efficiency and convenience of public transportation systems, facilitating streamlined fare collection and management.⁴⁰ Siemens Mobility offer a wide range of solutions, from locomotive manufacturing and rail electrification systems, rail automation and digital solutions as signalling systems, traffic management systems, tolling systems, to electric vehicle charging solutions, and intelligent parking systems for mobility.⁴¹ In the more recent years leading up to the advent of MaaS, technology providers pivoted their focus towards digital transformation solutions designed to increase the operational efficiency of their clients. Leveraging their deep-rooted knowledge in technology, they began to provide them valuable insights and strategic guidance. In addition to consulting services, a central part of their value proposition is the creation of customized and tailored products to integrate their solutions into existing frameworks while accommodating client's requirements. Indeed, Masabi and Siemens strongly collaborate with their clients to understand their needs and propose the right solution that fits the case.⁴² Mercedes-Benz's commitment to customization is demonstrated through its practice of allowing customers to personalize their vehicles by se-

⁴⁰ Masabi Ltd., "Products: Justride" Available at: <https://www.masabi.com/justride-mobile-ticketing/> (Accessed 20 June 2023)

⁴¹ Siemens AG, 2019. "Annual Report 2019". Available at: <https://www.siemens.com/global/en/company/investor-relations/events-publications-ad-hoc/annualreports.html>

⁴² Siemens AG, 2020. "Annual Report 2020". Available at: <https://www.siemens.com/global/en/company/investor-relations/events-publications-ad-hoc/annualreports.html>

Also Masabi Ltd., "Customers". Available at: <https://www.masabi.com/agencies-and-operators-using-justride/> (Accessed 20 June 2023)

lecting specific features and options based on their preferences.⁴³ The concept of complementary services emerges as a fundamental value creation mechanism within technology providers. Cross-selling and up-selling enabled technology providers to offer their clients enhanced functionalities or expanded capabilities that aligned with their existing needs. They usually offer their products and services in packages encompassing software, assets, infrastructures, support, and after sales services such as maintenance, training, updates, and even financial services.⁴⁴ To remain at the forefront of their respective industries and maintain a competitive edge, technology providers consistently channel substantial investments into the development of emerging technologies and RandD efforts. By dedicating resources to the development of smart mobility solutions, digitalization, AI, AV, and EV technologies, these types of companies try to build up patents while also contributing to the evolution of their industries and the advancement of sustainable and efficient mobility solutions.⁴⁵ Finally, a pivotal element in the value creation strategy of technology providers is the expansion of their market reach, seeking to broaden their influence across various regions and customer segments. This expansion manifests through two primary avenues: investments in new production plants, particularly in emerging economies (in Mercedes-Benz and Siemens cases), and the enlargement of their customer base, solidifying their market presence and harnessing previously unexplored revenue streams.

⁴³ Mercedes-Benz Group AG, "Passenger cars" – Available at: <https://www.mercedes-benz.it/passengercars.html?group=allandsubgroup=see-allandview=BODYTYPE> (Accessed 2 July 2023)

⁴⁴ Siemens AG, 2019. "Annual Report 2019". Also Mercedes-Benz Group AG, 2018. "Annual Report 2018". Available at: <https://group.mercedes-benz.com/investors/reports-news/annual-reports/download/>

⁴⁵ Siemens AG, 2019. "Annual Report 2019"; Mercedes-Benz Group AG, 2017. "Annual Report 2017". Available at: <https://group.mercedes-benz.com/investors/reports-news/annual-reports/download/>; Masabi Ltd., masabi.com website homepage, at: <https://www.masabi.com/> (Accessed 20 June 2023)

With the advent of MaaS, technology providers went beyond being suppliers of software and digital infrastructure and have evolved into strategic partners that contribute to the holistic development of the urban mobility ecosystem. MaaS prompted them to reimagine their role and expand their horizons, resulting in the emergence of novel products and services. To incorporate MaaS into their services, these companies have adopted various strategic measures including establishing partnerships, conducting mergers and acquisitions, and initiating joint ventures. This approach serves as a means to access both tangible and intangible resources that are essential for the development and deployment of advanced mobility solutions. New skills and competences belonging to the technology realm were considered crucial for the transition. For instance, a big company like Siemens opted to acquire smaller IT companies as HaCon, eos.uptrade, Padam, and Bytemark to extend its influence in the mobility realm and to provide a comprehensive portfolio of services, from fare collection systems to MaaS solutions.⁴⁶ Mercedes-Benz acquired the ride-hailing company mytaxi and then ventured jointly with BMW to provide a new wide-ranging mobility service called Your-Now, giving birth to the Free Now (ride-hailing), Reach Now (MaaS), Share Now (car-sharing), Park Now (parking solutions) and Charge Now (electric vehicle charging solutions) brands.⁴⁷ Instead, Masabi partnered with Transit, Trapeze, TransLoc, and other journey planning and MaaS apps to provide a comprehensive service to its customers, ranging from digital payment systems to mobility planning and scheduling, business intelligence, workforce management, and white label MaaS solutions.⁴⁸ Overall,

⁴⁶ Siemens AG, Press Releases 2019, 2020, 2021. Available at: https://press.siemens.com/global/en/press-search?f%5B0%5D=business%3A5andf%5B1%5D=content_type%3Ac2_ct_press_release (Accessed 15 and 16 July, 2023)

⁴⁷ Mercedes-Benz Group AG, 2017. "Annual Report 2017".

⁴⁸ Masabi Ltd., Press Releases 2015, 2017, 2019. Available at: <https://www.masabi.com/press-releases/> (Accessed 25 June 2023)

new mobility management solutions are now developed and sold from technology providers: fleet management systems, white-label MaaS applications, parking and lot management solutions, and recharging systems have become integral offerings. In the realm of mobility data analytics, technology providers now provide comprehensive data platforms that leverage advanced analytics to offer real-time insights into mobility patterns, user behaviour, and operational performance. For instance, Siemens developed the TPS.integrate and HAFAS platforms to integrate, exchange, and analyse an extensive amount of data from various transport providers to predict the overall mobility demand based on travellers' behaviour.⁴⁹ Masabi further enhanced their Justride platform to better manage data from the mobility services connected in a MaaS system, including a comprehensive data analytics solution to improve services and operations.⁵⁰ Leveraging new technologies, companies offer solutions that streamline processes, integrate seamlessly with third-party applications and services, and drive digital transformation for a quick innovation and reduction of costs for their clients.⁵¹

Value Capture

In terms of value capture, technology providers generate revenues mainly by selling their products and services to their customers. This encompasses a range of income streams, including direct sales and service implementation fees, along with the provision of financial services, intellectual property

⁴⁹ Siemens Mobility, "Data Management and Analytics" – Available at: <https://www.mobility.siemens.com/global/en/portfolio/digital-solutions-software/mobility-as-a-service/data-management-analytics.html>

⁵⁰ Masabi, "Ticketing for Public Transport" – Available at: <https://www.masabi.com/>

⁵¹ Mercedes-Benz Group AG, 2022. "Annual Report 2022". Available at: <https://group.mercedes-benz.com/investors/reports-news/annual-reports/download/>; Siemens AG, 2022. "Annual Report 2022".

and licensing revenues to monetize their proprietary innovations.⁵² Intellectual property serves also as a Lock-In effect that protects innovative solutions and make it harder for customers to switch to other alternatives in the market. Contribute to the Lock-In also the brand reputation and the cross-selling and up-selling strategies described before. Partnerships and network collaborations are also a crucial value capture mechanism for technology providers. In particular, they often recur to Collaborative RandD ventures, which bring together the expertise, resources, and knowledge of multiple stakeholders to undertake ambitious and complex innovation projects. Moreover, technology providers often rely on a diverse set of suppliers for components, materials, and specialized technologies.⁵³

The emergence of the MaaS market segment has opened new avenues for technology providers to diversify their revenue streams. As they develop new software solutions, the potential for licensing and implementation fees expands. Subscriptions to their SaaS models provide also a steady stream of revenue while fostering a deeper engagement with customers. For instance, Masabi employs a Fare Payment-as-a-Service (FPaaS) approach, offering transit agencies comprehensive solutions for mobile ticketing, contactless payments, and seamless integration with existing infrastructures, in exchange for a fee. Siemens adopted a similar approach with the acquisition of Bytemark. Additionally, the vast pool of data generated by MaaS systems presents an opportunity for data monetization, creating a source of revenue that capitalizes on valuable insights drawn from user behaviour and trends. Other revenue sources for tech-

⁵² Siemens AG, 2020. "Annual Report 2020"; Mercedes-Benz Group AG, 2019. "Annual Report 2019"; Masabi Ltd., "Customers". Available at: <https://www.masabi.com/agencies-and-operators-using-justride/> (Accessed 20 June 2023)

⁵³ Siemens AG, 2018 Press releases. Available at: https://press.siemens.com/global/en/press-search?f%5B0%5D=business%3A5andf%5B1%5D=content_type%3Ac2_ct_press_release (Accessed 15 July, 2023)

Mercedes-Benz Group AG, 2017 Press releases. Available at: <https://media.mercedes-benz.com/> (Accessed 5 July, 2023)

nology providers are revenue-sharing deriving from collaboration agreements and the introduction of premium-prices for new features and upgrades of their services.⁵⁴

Value Delivery

In the pre-MaaS era technology providers delivered value mainly through their digital platforms, as mobile apps and websites, used as gateways for clients to explore the product offerings, access information, and initiate interactions. Some companies, above all Mercedes-Benz, established a robust network of sales outlets and dealerships to provide localized support, test drives, and vehicle servicing.⁵⁵ Technology providers build up on robust customer service departments, ready to address inquiries, resolve issues, and provide technical assistance to their customers. They offered comprehensive project management services, ensuring a seamless integration process of their technology within existing frameworks.⁵⁶ Finally, recognizing that the adoption of their technologies often required specialized know-how, technology providers organized training sessions and knowledge transfer initiatives with their clients to get them accustomed to the use of their products.⁵⁷

In the post-MaaS era new value delivery mechanisms have emerged. By leveraging the power of cloud technology, providers offer robust support systems that enhance reliability, accessibility, and scalability. These services enable efficient troubleshooting, quick updates, and seamless integration for their cli-

⁵⁴ Siemens AG, 2022. "Annual Report 2022"; Mercedes-Benz Group AG, 2022. "Annual Report 2022"; Masabi Ltd. "Customers".

⁵⁵ Mercedes-Benz Group AG, 2015. "Annual Report 2015".

⁵⁶ Siemens AG, 2019. "Annual Report 2019"; Masabi Ltd. "Products: Justride".

⁵⁷ Siemens AG, 2020. "Annual Report 2020"

ents. Through regular updates and innovations, technology providers ensure that their solutions remain relevant, efficient, and capable of addressing the changing needs of their clients.⁵⁸ Finally, technology providers have also improved their applications and provide complete platforms that seamlessly integrates diverse mobility services into a unified interface.

2.3 Discussion and Conclusion

This article aims at providing a dynamic and evolutionary perspective in the MaaS business models domain. It delves into the impact of the MaaS impact on organizations operating within the MaaS ecosystem, and how it has influenced their strategies and operations. Specifically, we investigate how service and technology providers have evolved their business models over time in response to MaaS introduction in the mobility market, by adopting the value creation, capture, and delivery framework. Our results reveal that MaaS had a significant effect on the organizations under examination.

In particular, our research reveals that MaaS adds novelty in the way both service and technology providers create, capture, and distribute value to their customers (Amit and Zott, 2001). Service providers have primarily directed their efforts towards delivering integrated and multi-modal solutions, while prioritizing the enhancement of their operations through the use of data, user convenience, safety, and overall travel experience. These companies continue to invest in elevating service quality and sustainability as key drivers of differentiation (Ioannou and Serafeim, 2019). Additionally, they are actively expanding their services into new market segments, further solidifying their reach and aiming for more profits. As for value capture, MaaS introduced a shift in their

⁵⁸ Mercedes-Benz Group AG, 2022. "Annual Report 2022". Siemens AG, 2022. "Annual Report 2022".

traditional scheme for revenue generation. This transformation is evident through the integration of new pricing strategies, the introduction of innovative subscription offers, and the establishment of loyalty programs. These strategies not only lock-in users but also promote user retention (Amit and Zott, 2001). Moreover, partnership and network strategies have emerged as pivotal mechanisms for value appropriation, encompassing revenue-sharing models, co-promotion, and increased brand recognition among all participants. Finally, MaaS has brought changes also in the way new value is delivered to users. A prominent mechanism that has emerged is data sharing, highlighting the importance of collaboration and interconnectedness within the MaaS ecosystem. This collaboration is facilitated by the integration of Application Programming Interfaces (APIs) and the development of integrated platforms, which allows the connectivity among complementary service partners. The increasing digitization of processes and enhancements in the physical network and routes stand out as the most significant changes that occurred as for value delivery.

Instead, technology providers have directed their efforts in adapting their products and services to the evolving market conditions. They focused on providing digital solutions that enable real-time data sharing, seamless transactions, and the integration of mobility planning. Additionally, they have developed an array of mobility management solutions, including white-label MaaS applications, fleet management systems, parking systems, recharging infrastructure, and mobility data platforms. These solutions have broadened their product portfolio and complemented their existing offerings. After embracing MaaS, technology providers have embraced new value capture mechanisms. Notably, they have engaged in partnerships, joint ventures, or mergers and acquisitions, to access essential resources for developing advanced mobility solutions. Collaborative agreements also have led to revenue-sharing opportunities. Moreover, MaaS opened new revenue streams. Their new software solutions expanded the potential for licensing and implementation fees. They have shift-

ed their focus on providing subscription-based Software as a Service (SaaS) models, thus ensuring consistent revenues and, at the same time, fostering deeper engagements with customers. Finally, new value delivery mechanisms have emerged. Leveraging on cloud technology, they have introduced robust systems that facilitate troubleshooting, software updates, and integration with clients. Through regular updates and ongoing innovations, technology providers ensure that their solutions remain pertinent, efficient, and capable of adapting to the evolving needs of their clients. They still rely on project management, training, and knowledge transfer as pivotal mechanisms for value delivery. This is because project management ensures the perfect integration of their technology products within the clients' existing systems, while training empowers clients to effectively utilize these products and thus maximize their benefits.

Although service and technology providers have specific differences depending on the sector they primarily belong to, it is possible to state that there have been some commonalities in their responses to MaaS introduction. First, they strategically relied on partnerships and collaborations as main mechanism not only to expand and enrich their service offerings, but also to enter into new markets, secure key resources and foster knowledge sharing and capabilities development (Dyer et al., 2018). This has been widely recognized by the literature as key mechanism that can enable MaaS ecosystems (Kamargianni and Matyas, 2017; MaaS Alliance, 2017; Polydoropoulou et al., 2020; Kandanaarachchi et al., 2022) and our study confirms this tendency among established organizations in the mobility realm. Certainly, service providers frequently engage with technology providers to advance their digitalization efforts and create innovative solutions, including the development of MaaS applications, aiming at enhancing the customer experience, while at the same time they often establish partnerships with other service providers to enable their MaaS service or to access new markets. On the other hand, technology providers typically form alliances with other technology firms to leverage their knowledge and expertise

for research and development endeavours or to extend their product lines, as well as with service providers to reach a broader audience for their products and services. Second, the adoption of technology-based solutions and digitalization has been a fundamental shift for both categories. They heavily invested in emerging technologies such as AI, machine learning, and EVs, to align their services with the evolving mobility landscape. Third, both service and technology providers have adopted customer-centric approaches when developing of their products and services. Service providers have concentrated their efforts on enhancing the overall travel experience of users. They achieve this by developing integrated mobility services, creating user-friendly interfaces that facilitate the decision-making and the selection process, and improving the reliability and accessibility of their transportation offerings. On the other hand, technology providers relied on personalization of services, enhancing their software solutions, and emphasizing project management, to ensure a perfect implementation of their technology into their clients' systems. Finally, both service and technology providers view the advent of MaaS as a strategic opportunity to expand their market reach, increase their customer base and diversify their revenue streams. They instinctively incorporate MaaS in their value proposition, demonstrating their commitment to quickly follow the prevailing market trends, strengthen their competitive position, and capture new market shares.

2.6.1. Implications for theory

The findings of this research bring contributions to the ongoing academic literature related to MaaS and to BMI. On the one hand, we extend the theoretical knowledge on MaaS business models (e.g. Polydoropoulou et al., 2020; Krauss et al., 2022; Aapaoja et al., 2017a; Konig et al., 2016). Indeed, our study sheds new light on the main macro and micro-level mechanisms that firms belonging to the service and technology providers categories may employ to create, capture, and deliver new value by incorporating MaaS into their value

proposition, with some variations between these two organization types. Therefore, it enriches the previous knowledge, which predominantly revolved around conceptualizing MaaS providers ideal business models, by highlighting the different strategies that existing firms may adopt to naturally develop MaaS systems. Additionally, our study delves into MaaS emphasizing its transformative potential and studying its impacts mainly related to the organizations belonging to MaaS ecosystems (e.g. Srivastava and Wong, 2023; Hensher, 2017; Mulley and Nelson, 2020). We thus contribute to the analysis of the effects of MaaS by particularly uncovering and deepening its influence on business strategies, operational dynamics, and value creation and value appropriation mechanisms for different actors within the service providers (as ride-hailing, public transport, and micro-mobility companies) and the technology providers (as car manufacturers and digital solutions providers) domain. On the other hand, our contributions extend to and enrich the broader topic of BMI within the mobility sector in response to new phenomena (e.g. Sarasini and Linder, 2018; Cohen and Kietzmann, 2014; Turoń and Kubik, 2021). Specifically, we describe the evolution of the business models of the actors under analysis after the emergence of a disruptive concept like MaaS. By applying the value creation, capture, and delivery framework (Bocken et al., 2015; Lepak et al., 2007) we provide new insights on the main strategies and value mechanisms adopted by service and technology providers in their transition process toward MaaS. The paper advances theoretical understanding by acknowledging that some patterns and common themes exist between categories, although the micro-level strategies adopted are contingent on the nature of the organization and its core competencies.

2.6.2. Implications for practice

Our research holds straightforward implications for practitioners and policymakers. It mainly informs about the evolutionary trajectory of business

models within firms operating in MaaS ecosystems and highlights the strategies and value mechanisms used by them to navigate the challenges and opportunities presented by MaaS. Hence, understanding their dynamics can be crucial for managers, as it can guide the decision-making process and the implementation of strategic plans that align with evolving market conditions. Indeed, our findings may help them allocate resources effectively, prioritizing investments in key areas such as technology development, partnerships, or customer experience to stay competitive or, in some cases, gain significant competitive advantage. Finally, policymakers responsible for urban planning, transportation regulation, and sustainable mobility initiatives can draw upon our research to design policies that foster innovation, emphasizing digitalization and cross-sector collaboration among firms. Our research underscores the critical role of digitalization and data in enhancing mobility services. Companies extensively engage in sharing, storing, and analysing data across various transport modes. Yet, the establishment of comprehensive data sharing and interoperability standards remains pending. With MaaS companies operating on a global scale, there is a pressing need for international standards to facilitate the integration and widespread adoption of MaaS. Finally, given the crucial importance of partnerships and collaboration, policy makers can foster them by offering tax incentives or grants to ensure economic convenience. Policies could include mechanisms for shared revenue or cost-saving opportunities for collaborative projects, encouraging companies to work together towards common goals in the mobility ecosystem.

2.6.3. Limitations and Future Research Directions

This work presents some limitations that may provide an opportunity for further research. First, our study primarily employs a macro perspective, focusing on overarching strategies and outcomes of companies transitioning towards MaaS. This approach may not delve into the detailed, micro-level dynamics such

as decision-making processes, internal challenges, and the step-by-step evolution of business model innovations within these firms. This gap suggests a valuable direction for future research, emphasizing a more detailed, within-the-firm analysis that explores the nuances of implementing MaaS, including the obstacles, uncertainties, and strategic decisions faced by companies. Further research could benefit from a qualitative approach, examining case studies or conducting interviews with decision-makers to “look inside of the box” and how MaaS actually influenced the companies within the mobility sector.

Second, the generalizability of our findings may be constrained by the case study approach. Our inductive and qualitative insights can be enriched through the collection of quantitative data. Quantitative analysis allows for a more comprehensive evaluation of the impact of MaaS on businesses. This could be achieved by monitoring some key performance indicators (KPIs) such as, for instance, market share, revenue growth, customer retention rates, and profitability of the organizations under analysis before and after MaaS introduction. Furthermore, other metrics could be created ad hoc to track other significant aspects of MaaS impacts for businesses, such as the financial implications, the operational efficiency, the stakeholder relations, or the innovation process.

Third, the research sample comprises a total of six companies. These were divided into three firms belonging to the service providers category and three to the technology providers category. Hence, we derived our insights from a relatively small group of companies, and we may have not fully captured the diversity of responses to MaaS introduction. Further research could expand the samples size to provide and explore whether similar patterns emerge across a broader spectrum of organizations and regions, therefore adding more generalizability and robustness to the findings.

Fourth, we selected in our research sample only full established players in the industry, which successfully implemented MaaS in their value proposi-

tion. This might introduce a bias in our results, as we did not account for smaller firms or new entrants in the market which may face different challenges and respond differently to MaaS adoption. Further research could conduct separate studies mainly focused on start-ups or small and medium-sized enterprises and compare their responses and strategies with those of incumbents. This comparative analysis would provide a more comprehensive view of how different organizations navigate into MaaS.

Fifth, we recognize that our study is certainly limited in scope. We mainly analysed the evolution of service and technology providers' business models in response to MaaS introduction. However, it is essential to acknowledge that the MaaS ecosystem comprises a broader range of stakeholders, such as regulators, infrastructure providers, investors, whose dynamics are undoubtedly impacted by MaaS. Therefore, to address this limitation and offer a holistic view of MaaS impacts on organizations, future research can expand the scope and include different types of firms within the ecosystem.

Finally, it is important to underscore that MaaS is still an evolving concept, and market dynamics are quickly changing over time. As it progresses, new and more refined business models will continue to emerge, designed to maximize the long-term sustainability and profitability. Accordingly, business strategies will adapt to remain aligned with the changing market conditions. By adopting a longitudinal analysis, future research might keep track of MaaS evolutions and delve into how organizations strategize to position themselves in the market and try to gain competitive advantage.

2.4 References

Aapaoja A., Eckhardt J., Nykanen L. (2017a). "Business Models for MaaS". 1st International Conference on Mobility as a Service (ICOMaaS), Tampere, Finland.

Aapaoja A., Eckhardt J., Sochor J. (2017b). "MaaS service combinations for different geographical areas". 24th World Congress on Intelligent Transportation Systems, Montreal.

Acciarini, C., Cappa, F., Boccardelli, P., Oriani, R. (2023). "How Can Organizations Leverage Big Data to Innovate Their Business Models? A Systematic Literature Review". *Technovation*, 123, 102713.

Albino, V., Berardi, U., and Dangelico, R. M. (2015). "Smart Cities: Definitions, Dimensions, Performance, and Initiatives". *Journal of Urban Technology*, 22(1), 3–21.

Ambrosino, G., Nelson, J. D., Boero, M., and Pettinelli, I. (2016). "Enabling intermodal urban transport through complementary services: From flexible mobility services to the shared use mobility agency. Workshop 4. Developing inter-modal transport systems". *Research in Transportation Economics*, 59, 179–184.

Amit, R., Zott, C. (2001). Value creation in E-business. *Strategic Management Journal*, 22(6/7), 493-520.

Amit R., Zott C. (2012). "Creating Value through Business Model Innovation". *MIT Sloan Management Review*.

Amit R., Zott C. (2020). "Business Model Innovation Strategy: Transformational Concepts and Tools for Entrepreneurial Leaders". John Wiley and Sons.

Arias-Molinares D., Garcia-Palomares J.C. (2020). "The Ws of MaaS: Understanding mobility as a service from a literature review". *IATSS Research*, 44(3), pp.253-263.

Audouin M., Finger M. (2018). "The development of Mobility-as-a-Service in the Helsinki metropolitan area: A multilevel governance analysis". *Research in Transportation Business and Management*, Volume 27, Pages 24-35.

Bocken N.M.P., Rana P., Short S.W. (2015). "Value mapping for sustainable business thinking", *Journal of Industrial and Production Engineering*, 32:1, 67-81.

Braun V., Clarke V., Boulton E., Davey L., McEvoy C. (2021). "The online survey as a qualitative research tool". *International Journal of Social Research Methodology*, 24:6, 641-654.

Butler L., Yigitcanlar T., Paz A. (2021). "Barriers and risks of Mobility-as-a-Service (MaaS) adoption in cities: A systematic review of the literature". *Cities*, Volume 109, 103036.

Cohen B., Kietzmann J. (2014). "Ride On! Mobility Business Models for the Sharing Economy". *Organization and Environment*, 27(3), 279–296.

Cruz C.O., Sarmento J.M. (2020). "'Mobility as a Service' platforms: a critical path towards increasing the sustainability of transportation systems". *Sustainability* 12 (16), 6368.

Davis, Jason P., Eisenhardt, Kathleen M., Bingham, Christopher B., (2007). "Developing theory through simulation methods". *Acad. Manag. Rev.* 32 (2), 480–499.

Dyer J.H., Singh H., Hesterly W.S. (2018). "The relational view revisited: A dynamic perspective on value creation and value capture". *Strategic Management Journal*. Volume39, Issue12, Pages 3140-3162.

Ebrahimi S., Meurs H., Sharmeen F. (2018). "Innovative Business Architectures (BAs) for MaaS – exploration, assessment and categorization using operational MaaS cases", *Transportation Research Board 97th Annual Meeting*, Washington DC, United States.

Eckhardt J., Aapaoja A., Nykänen L., Sochor J. (2017). "Mobility as a Service business and operator models". *12th ITS European Congress*. Strasbourg, France.

Eckhardt J., Lauhkonen A., Aapaoja A. (2020). "Impact assessment of rural PPP MaaS pilots". *European Transport Research Review*, 12(1), 49.

Eisenhardt K.M. (1989). "Building Theories from Case Study Research". *The Academy of Management Review*, Vol. 14, No. 4, pp. 532-550.

Eisenhardt, K. M., and Graebner, M. E. (2007). "Theory building from cases: Opportunities and challenges". *Academy of Management Journal*, 50(1), 25–32.

Esztergár-Kiss D., Kerényi T., Mátrai T., Aba A. (2020). "Exploring the MaaS market with systematic analysis". *European Transport Research Review*, 12, Article number: 67.

Fioreze T., de Gruijter M., Geurs K. (2019). "On the likelihood of using mobility-as-a-service: a case study on innovative mobility services among residents in Netherlands". *Case Study on Transport policy*, Volume 7, Issue 4, Pages 790-801.

Foss, N.J., Saebi, T., (2017). "Fifteen years of research on business model innovation: how far have we come, and where should we go?". *J. Manag.* 43 (1), 200–227.

García R.J.R., Lenz G., Haveman S.P., Bonnema G.M. (2020). "State of the Art of Mobility as a Service (MaaS) Ecosystems and Architectures—An Overview of, and a Definition, Ecosystem and System Architecture for Electric Mobility as a Service (eMaaS)". *World Electric Vehicle Journal* 11, no. 1: 7.

Geissinger, A., Laurell, C., Sandström, C. (2020). "Digital Disruption beyond Uber and Airbnb—Tracking the long tail of the sharing economy". *Technological Forecasting and Social Change*, 155, 119323. <https://doi.org/10.1016/j.techfore.2018.06.012>

Giesecke, R.; Surakka, T.; Hakonen, M. (2016). "Conceptualising Mobility as a Service". In *Proceedings of the Eleventh International Conference on Ecological Vehicles and Renewable Energies (EVER)*, Monte Carlo, Monaco; pp. 1–11.

Girotra K., Netessine S. (2014). "Four Paths to Business Model Innovation". *Harvard Business Review*.

Glaser B.G., Strauss A.L. (1967). "The Discovery of Grounded Theory: Strategies for Qualitative Research". Aldine Transaction.

HaCon Company. (2022). "MaaS Business Models – Lessons Learned". Available at: https://www.youtube.com/watch?v=gvaX6hODxVsandab_channel=HaconCompany

Harrison C., Eckman B., Hamilton R., Hartswick P., Kalagnanam J., Paraszczak J., Williams P. (2010). "Foundations for Smarter Cities". *IBM Journal of Research and Development* 54: 4, pp.1–16.

Heikkilä S. (2014), "Mobility as a Service—A Proposal for Action for the Public Administration, Case Helsinki". (Master of Science in Technology) Helsinki: Aalto University.

Hensher D.A. (2017). "Future bus transport contracts under a mobility as a service (MaaS) regime in the digital age: are they likely to change?". *Transp. Res. A Policy Prac.*;98:86-96.

Hensher D.A., Ho C.Q., Mulley C., Nelson J.D., Smith G., Wong Y.Z. (2020). "Understanding Mobility as a Service (MaaS): Past, Present and Future". Elsevier Ed.

Hensher D.A., Mulley C. (2021). "Mobility bundling and cultural tribalism - Might passenger mobility plans through MaaS remain niche or are they truly scalable?". *Transport Policy*, Volume 100, Pages 172-175.

Hensher D.A., Ho C.Q., Reck D.J., Smith G. (2021). "The Sydney Mobility as a Service (MaaS) Trial Design, Implementation, Lessons and the Future". iMove project final report.

Hensher D.A., Xi H. (2022) "Mobility as a service (MaaS): are effort and seamlessness the keys to MaaS uptake?", *Transport Reviews*, 42:3, 269-272.

Hietanen S. (2014). "'Mobility as a Service' – The new transport model?". *Eurotransport*, 12(2), pp.2-4.

Ho C.Q., Hensher D.A., Mulley C., Wong Y.Z. (2018). "Potential uptake and willingness-to-pay for Mobility as a Service (MaaS): A stated choice study". *Transportation Research Part A: Policy and Practice*. Volume 117, Pages 302-318.

Ho C.Q., Mulley C., Hensher D.A. (2020). "Public preferences for mobility as a service: Insights from stated preference surveys". *Transportation Research Part A: Policy and Practice*. Volume 131, Pages 70-90.

Holmberg, P.E., Collado, M., Sarasini, S., Willander, M. (2016). "MaaS framework". Final Report of MaaSsterplan project (Vinnova).

van den Heuvel, C., Kao, P.-J., and Matyas, M. (2020). "Factors driving and hindering business model innovations for mobility sector start-ups". *Research in Transportation Business and Management*, 37, 100568.

Ioannou I., Serafeim G. (2019). "Corporate Sustainability: A Strategy?". Harvard Business School Accounting and Management Unit Working Paper No. 19-065, Available at SSRN: <https://ssrn.com/abstract=3312191>

ITF, (2021). "The Innovative Mobility Landscape: The Case of Mobility as a Service". International Transport Forum Policy Papers, No. 92, OECD Publishing, Paris.

Jittrapirom P., Caiati V., Feneri A.-M., Ebrahimi S., González M.J.A., Narayan J. (2017). "Mobility as a service: a critical review of definitions, assessments of schemes, and key challenges". *Urban Plan*, 2(2), 13-25.

Jones P. (2014). "The evolution of urban mobility: the interplay of academic and policy perspectives". *IATSS Research*, Volume 38, Issue 1, pp. 7-13.

Kamargianni M., Li W., Matyas M., Schäfer A. (2016). "A Critical Review of New Mobility Services for Urban Transport". *Transportation Research Procedia*, 14, pp.3294-3303.

Kamargianni M., Matyas M. (2017). "The business ecosystem of mobility-as-a-service". In: Paper Presented at the 96th Transportation Research Board (TRB) Annual Meeting, Washington, DC.

Kamargianni, M., Matyas, M., Li, W., Muscat, J., Yfantis, L. (2018). "The MaaS Dictionary". MaaS Lab, Energy Institute, University College London.

Kandanaarachchi, T., Nelson, J., and Ho, C. (2022). "Building Trust and Collaboration Among the Stakeholders in a Mobility as a Service Ecosystem—Insights from Two MaaS Case Studies". Available at SSRN 4253442.

Karlsson I.C.M., Sochor J., Strömberg H. (2016). "Developing the 'Service' in Mobility as a Service: experiences from a field trial of an innovative travel brokerage". *Transp. Res. Proc.*, 14 (2016), pp. 3265-3273.

Karlsson I.C.M., Mukhtar-Landgren D., Smith G., Koglin T., Kronsell A., Lund E., Sarasini S., Sochor J. (2020). "Development and implementation of Mobility-as-a-Service –A qualitative study of barriers and enabling factors". *Transportation Research Part A*, Volume 131, Pages 283-295.

Klein C., Kaefer G. (2008). "From Smart Homes to Smart Cities: Opportunities and Challenges from an Industrial Perspective". *Proc. of the 8th Interna-*

tional Conference, NEW2AN and 1st Russian Conference on Smart Spaces, SMART 2008, St. Petersburg, Russia.

König D., Eckhardt J., Aapaoja A., Sochor J., Karlsson M. (2016). "Deliverable 3 –Business and operator models for MaaS". MaaSIFIE Project funded by CEDR.

Krauss K., Moll C., Kohler J., Axhausen K. W. (2022). "Designing mobility-as-a-service business models using morphological analysis". *Transportation Business and Management*, Volume 45, Part C, 100857.

Lee, Z.W.Y., Chan, T.K.H., Balaji, M.S., Chong, A.Y.L. (2018). "Why people participate in the sharing economy: an empirical investigation of Uber". *Internet Research*, 28, 1-34. <https://doi.org/10.1108/IntR-01-2017-0037>

Lepak D. P., Smith K. G., Taylor M. S. (2007). "Value Creation and Value Capture: A Multilevel Perspective". *Academy of Management Review*, Vol. 32, No. 1

Li Y., Voegelé T. (2017). "Mobility as a Service (MaaS): Challenges of Implementation and Policy Required". *International Transport Forum at OECD*, Paris, France.

Liimatainen, H., Mladenović, M. N. (2018). "Understanding the complexity of mobility as a service". *Research in Transportation Business and Management*, 27, 1-2.

Lyons G., Hammond P., Mackay K. (2019). "The importance of user perspective in the evolution of MaaS". In: Hensher D.A., Mulley C., eds. *Transportation Research Part A: Policy and Practice*. 22–36. Special Issue on Developments in Mobility as a Service (MaaS) and Intelligent Mobility; vol. 121.

MaaS Alliance (2017). "Guidelines and Recommendations to Create the Foundations for Thriving MaaS Ecosystem". White Papers.

MaaS Alliance (2018). "Data makes MaaS happen – MaaS Alliance Vision Paper on Data". White Papers.

MaaS Alliance (2019). "MaaS Alliance Study: Challenges associated with MaaS and Approaches for overcoming them". White Papers.

Maas B., (2022). "Literature Review of Mobility as a Service," *Sustainability*, MDPI, vol. 14(14), pages 1-28.

Matyas M. (2020). "Opportunities and barriers to multimodal cities: lessons learned from in-depth interviews about attitudes towards mobility as a service". *European Transport Research Review*, 12, Article 7.

Merkert R., Wong Y.Z. (2020). "Workshop 3: Emerging business models and implications for the transport ecosystem". *Research in Transportation Economics*, Volume 83, 100911.

Meurs H., Sharmeen F., Marchau V., van der Heijden R. (2018). "Organizing integrated services in mobility-as-a-service systems: Principles of alliance formation applied to a MaaS-pilot in the Netherlands". *Transportation Research Part A: Policy and Practice*, Volume 131, Pages 178-195.

Mukhtar-Landgren D., Karlsson M., Konglin T., Kronsell A., Lund E., Sarasini S., Smith G., Sochor J., Wendle B. (2016). "Institutional conditions for integrated mobility services (IMS): towards a framework for analysis". *K2 Working Papers* 2016:16.

Mulley C. (2017). "Mobility as a Service (MaaS) - does it have critical mass?". *Transp. Rev.*;37(3):247–251.

Mulley C., Kronsell A. (2018). "Workshop 7 report: The "uberisation" of public transport and mobility as a service (MaaS): Implications for future mainstream public transport". *Research in Transportation Economics*, Volume 69, Pages 568-572.

Mulley, C., Nelson J. (2020). "How Mobility as a Service Impacts Public Transport Business Models", *International Transport Forum Discussion Papers*, No. 2020/17, OECD Publishing, Paris, <https://doi.org/10.1787/df75f80e-en>.

Nam T., Pardo T.A. (2011). "Conceptualizing smart city with dimensions of technology, people, and institutions". *Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times*, ACM (2011), pp. 282-291.

Narupiti S. (2019). "Exploring the possibility of MaaS service in Thailand, implications from the existing conditions and experts' opinions on "Who should be the MaaS provider in Bangkok?"". *IATSS Research*, Volume 43, Issue 4, Pages 226-234.

Osterwalder, A., Pigneur, Y. (2010). "Business Model Generation: A handbook for visionaries, game changers and challengers". Book, John Wiley and Sons Ed.

Pangbourne K., Mladenović M.N., Stead D., Milakis D. (2020). "Questioning mobility as a service: Unanticipated implications for society and governance". *Transportation Research Part A: Policy and Practice*, vol.131, pp.35-49.

Polydoropoulou A., Pagoni I., Tsirimpa A., Roumboutsos A., Kamargianni M., Tsouros I. (2020). "Prototype business models for Mobility-as-a-Service". *Transp. Research Part A*, vol. 131, issue C, 149-162.

Prescient and Strategic Intelligence (P&S Intelligence). (2022). "Global Mobility as a Service (MaaS) Market". Report from psmarketresearch.com.

Reck D.J., Hensher D.A., Ho C.Q. (2020). "MaaS bundle design". *Transportation Research Part A*, 141, 485–501.

Sarasini, S., Sochor, J., Arby, J. (2017). "What characterises a sustainable MaaS business model?" 1st International Conference on Mobility as a Service, 28–29. Tampere, Finland.

Sarasini, S., Linder, M. (2018). "Integrating a business model perspective into transition theory: The example of new mobility services". *Environmental Innovation and Societal Transitions*, 27, 16-31.

Sharifi A. (2019). "A critical review of selected smart city assessment tools and indicator sets". *Journal of Cleaner Production*, Volume 233, pp. 1269-1283.

Smith G., Sochor J., Karlsson I.C.M. (2018). "Mobility as a Service: Development scenarios and implications for public transport", *Research in Transportation Economics*, Volume 69, Pages 592-599.

Sochor J., Arby H., Karlsson I.C.M., Sarasini S. (2018). "A topological approach to mobility as a service: a proposed tool for understanding requirements and effects, and for aiding the integration of societal goals". *Res. Transp. Bus. Manag.*;27:3–14.

Srivastava M., Wong Y.H. (2023). "The Development of Mobility as a Service in China and its Impact on Automobile Manufacturers: A Business Model

Innovation". *Journal of Innovation Economics and Management*, Volume 40, Issue 1, Pages 225 – 263.

Strauss, A., Corbin, J. M. (1990). "Basics of qualitative research: Grounded theory procedures and techniques". Sage Publications, Inc.

Teece, D.J. (2010). "Business Models, Business Strategy and Innovation". *Long Range Planning*. Volume 43, Issues 2–3, Pages 172-194.

Tseng, Y.C., Chan, C.L. (2021). "When the Sharing Economy Meets Established Institutions: Uber and Airbnb in Taiwan". *IEEE Transactions on Engineering Management*, In press. <https://doi.org/10.1109/TEM.2019.2934520>

Turoń K., Kubik A. (2021). "Business Innovations in the New Mobility Market during the COVID-19 with the Possibility of Open Business Model Innovation". *Journal of Open Innovation Technology Market and Complexity*, 7(3):195.

Utriainen R., Pöllänen M. (2018). "Review on mobility as a service in scientific publications". *Research in Transportation Business and Management*, Volume 27, pp. 15-23.

Wilson A., Mason M. (2019). "The coming disruption – The rise of mobility as a service and the implications for government". *Research in Transportation Economics*, 83, 100898.

Wong Y.Z., Hensher D.A., Mulley C. (2018). "Stated preference design for mobility as a service (MaaS) broker/aggregator contracts". *ATRF 2018 - Australasian Transport Research Forum 2018, Proceedings*.

Wong Y.Z., Hensher D., Mulley C. (2020). "Mobility as a Service (Maas): Charting a future context". *Transportation Research Part A*, Volume 131, Pages 5-19.

Yigitcanlar T., Kamruzzaman M., Foth M., Sabatini-Marques J., Da Costa E., Ioppolo G. (2019). "Can cities become smart without being sustainable?" *Sustainable Cities and Society*, 45, pp. 348-365.

Yin R.K. (1994). "Case Study Research: Design and Methods". SAGE Publications.

Zhang Z., Zhang N. (2021). “Novel development scheme of mobility as a service: Can it provide a sustainable environment for China?”. *Sustainability* (Switzerland), 13(8), 4233.

Zhao X., Vaddadi B., Sjöman M., Hesselgren M., Pernestål A. (2020). “Key barriers in MaaS development and implementation: Lessons learned from testing Corporate MaaS (CMaaS)”. *Transportation Research Interdisciplinary Perspectives*, Volume 8, 100227.

Zwicky, F (1967). “The morphological approach to discovery, invention, research and construction”. In F. Zwicky, and A. G. Wilson (Eds.), *New methods of thought and procedure* (pp. 273–297). Berlin, Heidelberg: Springer.

3. Entrepreneurial Role Formation in MaaS Ecosystems: Start-ups' Adaptive Trajectories

Chapter 3 shifts the focus to entrepreneurial entrants and examines MaaS transformation from a new venture creation perspective. In line with the overarching thesis question, the chapter addresses the ecosystem-level transformation component by explaining how start-ups contribute to MaaS ecosystem formation through role-specific business model evolution. It directly answers RQ3: How do MaaS start-ups contribute to MaaS ecosystem formation through role-based business model evolution?

This chapter presents the study “Driving Mobility Innovations: Examining Mobility as a Service (MaaS) Start-ups Evolution from a Resource-Based View”, which investigates how MaaS start-ups leverage, develop, and recombine resources and competences to evolve their business models across the stages of the new venture creation (NVC) process. The study is guided by the research question: How do start-ups leverage and develop their resources and competences to evolve their business models throughout the different stages of the NVC process?

To answer this question, the study conceptualises MaaS start-ups as playing different functional roles in the ecosystem—orchestrator, enabler, and component—and investigates how each role is associated with distinct business model trajectories and capability-building needs. Methodologically, the paper adopts a longitudinal multiple-case study design: it first identifies and classifies MaaS start-ups (building an industry dataset) and then selects three representative cases – MaaS Global (orchestrator), SkedGo (enabler), and RideMovi (component) –, analysed through archival data and CEO interviews, across three NVC stages (Idea Generation/Inception, Development, and Scaling). The chapter

shows that MaaS start-ups do not scale by “executing a fixed plan”; rather, they continuously reconfigure their business models and resource endowments as they progress through stages, with role-specific patterns (e.g., orchestrators strengthening ecosystem-building, integration and subscription logic; enablers modularizing technology and pivoting toward B2B SaaS models; components scaling through operational efficiency, asset and supply-chain capabilities). Overall, this chapter explains *how* MaaS reshapes the ecosystem by illuminating the micro-level adaptation mechanisms through which new ventures (in different roles) build the resources, competences, and partnerships required to survive and scale, thereby actively contributing to the formation of the MaaS ecosystem and to the variety of configurations observed in practice.

Driving Mobility Innovations: Examining Mobility as a Service (MaaS) Start-ups Evolution from a Resource-Based View

3.1. Abstract and Keywords

Abstract – *This study explores the dynamic evolution of business models and resource endowment during the new venture creation (NVC) process within the rapidly growing Mobility as a Service (MaaS) industry. We categorize start-ups in the MaaS sector into three macro-categories: orchestrator, enabler, and component. Using a longitudinal case study approach, we analyze three representative start-ups: MaaS Global (orchestrator), SkedGo (enabler), and Ride-Movi (component). We uncover how these companies navigate their growth journeys by continuously adapting their business models and strategically acquiring and developing crucial resources and competencies. Our findings reveal that each start-up undergoes significant business model transformations and*

proactively secures new resources and competencies tailored to their specific business model needs throughout each phase of their development process. Our research contributes to the business model and NVC literature by offering a nuanced understanding of how start-ups leverage and develop resources and competencies to evolve their business models. This study also provides practical insights for entrepreneurs and practitioners in the MaaS sector, highlighting strategies for growth and innovation. Policymakers can benefit from these insights to create supportive regulatory environments.

Keywords— Mobility as a Service (MaaS); start-ups; business model evolution; new venture creation; resource-based theory

3.2. Introduction

The journey from an embryonic business idea to a fully-fledged enterprise is a complex and sometimes long process involving several iterative steps for development (Davidsson and Gruenhagen, 2021; Vogel, 2017). This evolutionary path is not just about the survival of the fittest idea or the most innovative product; it hinges significantly on a start-up's ability to adapt, change, and continually innovate its business model as well as align its internal resources accordingly (Teece, 2018). Indeed, a business model can be defined as a particular configuration of both internal and external assets as well as activities delineated and managed by a focal company orchestrating its partnerships network to achieve specific goals (Zott and Amit, 2010; Amit and Zott, 2020). The initial configuration exists as little more than a rudimentary vision within the entrepreneur's mind, characterized by an outline of the key elements but lacking in detail (Vogel, 2017). As the new venture transitions from concept to concrete operation, a process of growth and continuous refinement is witnessed, entailing the proactive acquisition of new resources and the development of competences through different cycles of experimentation and market feedback (Sosna

et al., 2010; Ries, 2011; Marcon and Ribeiro, 2021). Thereby, as the complexity of the organizational structure and the overall architecture needed to commercialize the product or service increases, the business model not only becomes more sophisticated and clearly articulated but may also undergo innovation, pivoting from its original design (Morris et al., 2005; Sosna et al., 2010; Zott and Amit, 2007, 2010; Amit and Zott, 2015).

The objective of this paper is to investigate the co-evolution of business model and resources endowment during the new venture creation (hereafter NVC) process. It is commonly recognized in the business model literature that the theoretical foundations of business models are deeply rooted in the resource-based view (hereafter RBV) of the firm (see, for example, Amit and Zott, 2001; George and Bock, 2011; Demil and Lecocq, 2010; DaSilva and Trkman, 2014). In fact, a business model can be seen as a translation of a firm's resources and capabilities into a viable economic and operational architecture to create, deliver, and capture value (Teece, 2010). The mere possession of valuable, rare, inimitable, and non-substitutable (VRIN) resources as the RBV posits (Barney, 1991; Barney, 1995; Ireland et al., 2003; Sirmon et al., 2007) does not guarantee success. Indeed, it necessitates a well-designed and functional business model to harness and deploy them effectively and secure competitive advantage (Teece, 2018; Birkinshaw and Ansari, 2015). Furthermore, to sustain or evolve their business models, firms must proactively acquire new resources, highlighting the dynamic nature of this process (Hamel, 1999). Thus, the business model acts simultaneously as an enabler and a constraint in the firm's process of accumulating and deploying resources (George and Bock, 2011), suggesting a bidirectional relationship between the business model and the firm's resource base (Amit and Zott, 2001; Garnsey et al., 2008; Mahadevan, 2000; Morris et al., 2005; Tracey and Jarvis, 2007).

While prior studies have explored the interplay between resources, capabilities, and business models, they often adopt a static approach, focusing on

specific moments within the venture's life (e.g., Raff, 2000; Mangematin et al., 2003; Willemstein et al., 2007). However, a longitudinal analysis could significantly deepen our understanding of this relationship by tracing its evolution over time. In this vein, the NVC process provides novel and dynamic lens to explore these interactions, especially considering the mechanisms that facilitate the evolution of business models from one phase to another. Start-ups, with their lean structure, are inherently agile and flexible, can pivot swiftly, and thus showcase better the interdependence of strategy, resources endowment, and business models. Additionally, the NVC process perspective can illustrate how initial strategic choices and resource configurations may influence long-term development paths, highlighting the path dependence in business models evolution (Lovins et al., 1999; Mahadevan, 2000; Tracey and Jarvis, 2007; Willemstein et al., 2007; Garnsey et al., 2008).

In line with these considerations, in this paper we aim at addressing the following research question:

- *How do start-ups leverage and develop their resources and competences to evolve their business models throughout the different stages of the new venture creation process?*

To answer this question, we choose the Mobility as a Service (MaaS hereafter) industry as our setting. MaaS is an innovative mobility concept that challenges conventional transportation systems by integrating various mobility services onto a single digital platform (Kamargianni et al., 2018; Kamargianni and Matyas, 2017; Sochor et al., 2018). Its industry is constantly expanding. Indeed, despite a brief slowdown during the COVID-19 pandemic, it has demonstrated remarkable growth, with a global valuation surpassing \$120 billion in 2021 and an anticipated CAGR of 16.8% through 2030 (P&S Intelligence, 2022). Start-ups have been crucial to the sector's development, pioneering the initial MaaS business models and continually innovating to address evolving market

needs. The novelty of the product, the rapidly evolving landscape, and the abundance of start-ups dominating the field makes MaaS an ideal setting for our investigation.

For our analysis we adopted a case study approach (Yin, 1994; Eisenhardt 1989; Eisenhardt and Graebner 2007). The methodology involved several sequential steps. First, we set the boundaries of our research by defining clearly what a MaaS start-up is. Second, we conducted a systematic search using platforms such as Crunchbase to identify start-ups that fit our predefined criteria. Third, we categorized the identified start-ups into three macro-groups based on their functional role in the industry: orchestrator, enabler, and component. Finally, we selected three distinct start-ups representing each of these categories. Our choice fell on MaaS Global, a renowned orchestrator within the MaaS domain; SkedGo, a pioneering player primarily functioning as a MaaS enabler; and RideMovi, positioned as a component within the MaaS ecosystem. Data collection involved gathering archival and documentary information, complemented by interviews with company CEOs. By decomposing the new venture creation process in three main steps, namely Idea Generation, Development, and Scaling (Davidsson and Gruenhagen, 2021; Marcon and Ribeiro, 2021; Vogel, 2017), we present the resources, competences, and business models that characterize each phase and their implications for the evolution of each start-up under analysis.

Our results show that the three distinct macro-categories of start-ups within the MaaS industry have each undergone significant changes and growth in their business models throughout the process. They have proactively secured new resources to facilitate these transformations. Moreover, while there are overlapping competencies and resources among them, the specific resources and competencies leveraged vary significantly depending on the business model.

Our findings hold significance for both theory and practice. Specifically, for theory, our research contributes to both the business model and new venture creation (NVC) fields. We present a novel perspective on the interplay between strategy, business models, and resource endowment, examining how these relationships evolve over time (Teece, 2018; Demil and Lecocq, 2010). By focusing on the development and leveraging of key resources and competencies, we provide insights into how firms navigate their growth trajectories and may establish path dependencies (George and Bock, 2010; Hamel 1999; Willemstein et al., 2007). In the NVC field, we use business models and the resource-based view (RBV) to highlight the critical role of resources and competencies throughout a start-up's lifecycle (Davidsson and Gruenhagen, 2021; Marcon and Ribeiro, 2021; Vogel, 2017). Our findings detail how new ventures adapt their strategies, business models, and resource allocations in response to dynamic market conditions and internal growth demands (Teece, 2018; Morgan et al., 2020; Lim et al., 2020).

In practical terms, we provide an overview of the current MaaS market, delineating main business models and offering practical guidance for entrepreneurs and practitioners. We illustrate the evolution of these models and detail the resources and competencies MaaS companies develop to grow, innovate, and deliver services. Lastly, we showcase how firms can transition between business models by strategically acquiring and leveraging new resources and competencies. These insights guide investment strategies and business decisions for entrepreneurs and practitioners in the mobility sector and help policymakers create supportive regulatory frameworks for the sector's development.

The paper is structured as follows. In the next section, an overview of the theoretical background concerning NVC, the business model concept and its ties with broader strategy concepts as RBV and Positioning theory will be pro-

vided. Section 3.4 will describe in detail the setting and the methodology adopted in this work. Section 3.5 presents the results of the analysis. Section 3.6 concludes the paper by discussing the main findings, implications for theory and practice, and possible avenues for further research.

3.3. Theoretical Background

3.3.1. The Business Model concept

The term 'Business Model' gained prominence at the beginning of the 21st century when significant shifts in global economies—driven by the digital revolution, globalization of markets, and regulatory harmonization—led to the creation of novel business practices not fully explained by traditional strategic theories (Climent and Haftor, 2021; DaSilva and Trkman, 2014). Intuitively, a business model describes how an organization functions to achieve its goals (Massa et al., 2017). It encapsulates the mechanisms or processes through which a company creates value for its customers, organizes itself to deliver this value, and captures a portion of the value as profit (Teece, 2010). This intuitive understanding, while clear in its essence, lacks a universally accepted definition due to the fragmented nature of the business model literature (Massa et al., 2017; Zott et al., 2011). Several authors in the past attempted to delineate the concept and its core components (e.g., Zott and Amit, 2010; Osterwalder and Pigneur, 2010; Casadeus-Masanell and Ricart, 2010; Johnson et al., 2008). However, most of the conceptualizations address specific objectives of researchers, leading to wide variety of interpretations (Zott et al., 2011). Massa et al. (2017) identified three main perspectives concerning business models within management studies: (i) business models as inherent attributes of firms; (ii) business models as cognitive or linguistic schemas (e.g., Martins et al., 2015; Baden-Fuller and Mangematin, 2013; Kaplan, 2011); and (iii) business models as formal

conceptual representations of how a business functions (Osterwalder et al., 2005).

From the first perspective, business models are seen as empirical properties of real companies directly impacting their performance. This view emphasizes the role of a firm's activities and their outcomes in driving performance differences among competitors, often through innovative activity configurations (Afuah, 2004; Zott and Amit, 2010). The latter two perspectives treat business models as mere tools that aid in strategic decision-making and effectively communicate the firm's objectives to its members (Massa et al., 2017).

Despite this ambiguity, the literature converges on several core themes. First, the business model is recognized as a novel unit of analysis placed in an intermediary position between a firm and its external network. Indeed, while a business model is often delineated from the perspective of a focal company, it fundamentally describes how the company interacts and engages with the wider network of partners, suppliers, and customers to achieve its goals (Zott et al., 2011; Amit and Zott, 2020). Second, the business model construct describes simultaneously how a firm captures value from its competitive environment and also how value is created and delivered to all the stakeholders involved. Thus, in contrast to traditional strategic theories, it poses a dual emphasis on both value creation and value appropriation. (Massa et al., 2017). It describes the mechanisms a company employs to create, deliver, and capture value along with the functional relations among these mechanisms (Foss and Saebi, 2017). As such, the business model emerges as a boundary-spanning and holistic theoretical construct that provides an integrated perspective on a firm's entire value architecture (Zott and Amit, 2010; Teece, 2010). Third, business models – i.e., the value architecture – may be characterized as particular configurations of activities carried out by a company along with its partners. These configurations necessitate distinct resources for a successful implementation (Zott and Amit,

2010; McGrath, 2010; Teece, 2010). Finally, business models are not static but inherently dynamic constructs (Demil and Lecocq, 2010; Voelpel et al., 2004; Cavalcante et al., 2011) that can impact firm performance (Zott and Amit, 2007; Teece, 2010; Morris et al., 2005). While business models might be susceptible to imitations, it is imperative for firms to continuously refine and adapt their models in response to competitive pressures and changes within the external environment. Therefore, their innovation is crucial for sustaining market relevance and securing a competitive advantage (Teece, 2010).

Any refinement or innovation requires coherence with the organization's strategic objectives and capabilities (Teece, 2018). Firms must manage their resources and competences, acquiring necessary assets or divesting from existing ones to support the evolution of their business models (Hamel, 1999). The following section will explore from a theoretical point of view this dynamic interaction between business models and resources.

3.3.2. Business Models and the Resource-Based View

Originating from the seminal works of Penrose (1959) and further developed by scholars like Barney (1991) and Peteraf (1993), the RBV has become a cornerstone of strategic management theory (Liu et al., 2009). From its perspective, organizations can be seen as an idiosyncratic bundle of tangible and intangible resources. These resources are accumulated over a company's history. They can be internally developed, purchased, or leased, and once integrated into the company's operations acquire a unique value shaped by their synergic combination with pre-existing assets. Firms aim to leverage on valuable, rare, inimitable, and non-substitutable (VRIN) resources to secure a competitive advantage (Barney, 1991; Ireland et al., 2003; Sirmon et al., 2007). However, resources per se do not bring any value to customers. It is the strategic integration and utilization of these resources within an effective and well-conceived

value architecture that unlocks their true potential (Teece, 2018; Birkinshaw and Ansari, 2015). In this vein, the business model acts as the framework through which a firm's resources and competencies are organized and applied, illustrating how the firm leverages them to create, deliver, and capture value (Teece, 2010). The decision to develop, purchase, or lease resources is driven by the firm's strategic vision as defined and operationalized within its business model. These choices are in turn influenced by the specific resource's potential to enhance the firm's capabilities in both creating and capturing value (Garnsey et al., 2008; George and Bock, 2011). For instance, a company may invest in cutting-edge technology not just for the sake of ownership or because it could be useful in the future, but because its business model relies on technological innovation to deliver new products and services, enhance customer experience, or improve operations efficiency (Amit and Zott, 2001). Furthermore, adjusting or transforming a business model necessitates a re-evaluation and potentially a restructuring of the existing resource allocation. Firms may need to reallocate, divest, or acquire new resources proactively to support the transition towards the new model (Teece, 2010; Hamel, 1999). Thus, the business model acts simultaneously as an enabler and a constraint in the firm's process of accumulating and deploying resources (George and Bock, 2011). Conversely, the available or acquired resources can also prompt a rethinking or reshaping of the business model itself (Demil and Lecocq, 2010; Zott and Amit, 2010).

We find this dynamic and bidirectional relationship underexamined in the literature, despite its recognition in previous works conceptualizing the business model construct (e.g., Demil and Lecocq, 2010; Johnson et al., 2008; Osterwalder and Pigneur, 2010; Zott and Amit, 2010). Raff (2000) analyzes the evolution of book superstores, particularly focusing on Borders and Barnes and Noble, to highlight how different strategic focuses on assortment and price required distinct capabilities. Mangematin et al. (2003) developed a typology of business models in the French biotech sector, identifying the crucial role of fi-

nancial, human, and social capital resources in shaping organizational forms. Willemstein et al. (2007) explore the dynamics of business models within the Dutch medical biotechnology sector, emphasizing the role of business model shifts post-founding and the trend toward hybrid business models that combine product development with other activities. The study underscores the significance of management's ambition, technological readiness, and the need for short-term revenue in driving business model transformations. Other works put more emphasis on high-order (or dynamic) capabilities and their critical role in fostering business model evolution (e.g., Bocken and Geradts, 2020; Cavalcante et al., 2011; DaSilva and Trkman, 2014; Teece, 2016, 2017, 2018; Warner and Wager, 2019). In this study, our aim is to delve deeper into the relationship between business model evolution and resources. We seek to investigate how firms leverage and develop their resources and competencies to evolve their business models. Additionally, we aim to identify the resources required for these transitions and examine how initial strategic choices and resource configurations may influence long-term development paths and pivots. To do so, we employ an original approach and setting, as explained in the following sections.

3.3.3. New Ventures Creation process

The focus of our analysis is on new ventures, as they offer a particularly insightful and interesting perspective for two main reasons. First, the creation of a start-up is a dynamic process that entails different and iterative steps to transform an initial, innovative business idea into a commercially viable business (Davidsson and Gruenhagen, 2021; McMullen and Dimov, 2013). During this process, new ventures engage in diverse activities requiring proactive acquisition of different typologies of resources and producing outcomes that can change the initial expectations (Vogel, 2017; Marcon and Ribeiro, 2021; Huang et al., 2012). In order to achieve a product-market fit, experimentations and ad-

justments in both the business model and resource allocation are inevitable and reflect the evolving goals of the start-up (Sosna et al., 2010; Reymen et al. 2015, Bojovic et al., 2017). The second reason is that new ventures typically operate with limited resources and capabilities, and this constraint compels them to strategically focus more on resource allocation and utilization compared to established firms (Marcon and Ribeiro, 2021). They tend to prioritize resources deemed as 'core' while leveraging external resources within their ecosystem to support and execute their business model effectively (Priem et al., 2013; Adner and Karpoor, 2010; Sirmon et al., 2011; Fukugawa, 2018). Moreover, their lean structure, combined with their inherently strong dynamic capabilities, facilitates transformations, hence enabling them to re-engineer the extant set-up in a simpler and relatively faster way (Teece, 2018). In other words, new ventures are agile and innovative, can pivot swiftly, and thus showcase better the interdependence of strategy, resources endowment, and business models.

The NVC process has been defined in different ways by the extant literature (König et al., 2019), but it fundamentally is a new venture's growth lifecycle involving three main phases, namely: inception (or creation), development, and scaling (or exploitation or market scale) (Davidsson and Gruenhagen, 2021; Paschen, 2017; Fukugawa, 2018). The boundaries between each phase are often not clearly defined, as start-ups do not progress linearly; instead, they may cyclically revisit phases to refine both their product and business (Picken, 2017; Peralta, 2020; Vogel, 2017). The process typically starts with the recognition of a business opportunity and the entrepreneur's willingness to act (Davidsson and Gruenhagen, 2021; Vogel, 2017). In the inception stage, the business opportunity is in its infancy, with only a rudimentary vision and a few elements of the business outlined, primarily based on the entrepreneur's intuition and insights (Brush et al., 2001). During this phase, a preliminary business model takes shape with just a vague understanding of the customers, their needs, and the resources and competences needed to address them (Abell, 1980; Vogel, 2017).

Entrepreneurial efforts in this stage focus on refining the business idea (Bird, 1988), gathering information and resources to assess its potential (Marcon and Ribeiro, 2021) and validating the business concept (Paschen, 2017). The resources available to new ventures are typically limited to those possessed by the entrepreneurs themselves (Aspelund et al., 2005), and activities typically require minimal financial investment (Bakker and Shepherd, 2017; Von Briel et al., 2018).

In the development stage, entrepreneurs focus on refining their business through a series of iterative experiments and evaluations (Vogel, 2017). Specifically, based on the outcomes they receive, entrepreneurs will eventually decide whether to proceed with bringing the solution to market (Vogel, 2017), conduct further experimentation (Chen, 2021; Cohen et al., 2019; Mansoori et al., 2019), pivot their approach (Kirtley and O'Mahony, 2020), or halt the creation process altogether (Vogel, 2017). In this phase, the business model begins to take form, as key elements such as customer segments, value-creating activities, and partnerships are defined (Vogel, 2017), offering a clearer understanding of the organization as well as the resources required to realize the vision of the new venture (Marcon and Ribeiro, 2021; Huang et al., 2012).

Finally, the exploitation or scaling phase begins after entrepreneurs consolidate their business (Vogel, 2017), leading to the implementation of efficient, large-scale operations for production, marketing, and value capture (Choi et al., 2008; Eisenmann, 2021; Furr and Ahlstrom, 2011). The objectives of this phase include building a robust customer base, establishing and expanding market presence, and enhancing organizational capacity (Picken, 2017) to increase sales and achieve profitability (Paschen, 2017; Karami et al., 2022). The business model is well-defined, providing a clear blueprint for the operations of the new venture (Vogel, 2017; Rothaermel and Deeds, 2004). This final phase marks the pivotal moment for successful start-ups. They either transition into established

companies, continuing independently or being acquired by major players, while others may unfortunately falter and fail in the process (Paschen, 2017).

By integrating the NVC process framework, this work aims at examining how does the venture concept evolve over time and identifying critical resources and strategic decisions that facilitate successful transitions from one stage to another.

3.4. *Methods*

In our study, we employ an inductive, multiple case study approach (Eisenhardt 1989; Eisenhardt and Graebner 2007; Yin, 1994) to investigate how start-ups develop and leverage on their resources and competences to evolve their business models throughout the different stages of the NVC process. This approach is motivated by two main reasons. First, the evolution of a business model is a complex and dynamic process that involves multiple aspects of a firm, from its organizational structure to resource allocation and strategic decisions (i.e., procurement, partnerships, etc.) (Demil and Lecocq, 2010; Cavalcante et al., 2011). Furthermore, start-ups evolve rapidly and continuously adapt throughout their growth lifecycle. A case study approach is hence ideal for examining this process, especially if combined with a longitudinal analysis (Perren and Ram, 2004). Indeed, it allows for a holistic examination and provide a rich empirical foundation with granular details. Second, both the NVC and business model evolution research streams are relatively new, thus calling for more theory building (Foss and Saebi, 2017; Davidsson and Gruenhagen, 2021). The case study approach allows for the development of theories from case observations (Eisenhardt, 1989). Moreover, the utilization of multiple cases and cross-case comparisons enhance the generalizability and robustness of the findings, offering stronger evidence compared to single-case studies (Davis et al., 2007).

Overall, this methodology is particularly well-suited to address our research question, generate insights, and enhance both theoretical understanding and practical applications. In the subsequent sections, we will detail our research setting and describe the steps employed.

3.4.1. Research Setting

MaaS is an innovative mobility concept introduced over a decade ago, representing an evolutionary step from the idea of mobility management enabled by new technologies (Mulley, 2017; Lyons et al., 2019). It is based on the integration of various forms of transport and transport-related services into a single, comprehensive, and on-demand mobility service accessible through a digital platform (MaaS Alliance, 2022; Kamargianni et al., 2018; Giesecke et al., 2016). This platform centralizes the information, booking, and payment system across the various services, providing users with a unique interface to seamlessly plan their journeys and satisfy their mobility needs (Sochor et al., 2018; Jit-trapirom et al., 2017; Enoch and Potter, 2023). Its primary aim is to offer users the convenience of personal cars while promoting the adoption of sustainable travel options (MaaS Alliance, 2017; Lyons et al., 2019; Kamargianni and Matyas, 2017). Thereby, the MaaS concept is disrupting the traditional transportation paradigm, as it promotes a collaborative approach that fosters the creation of a single, cooperative and interconnected mobility market. In this model, all involved parties engage in continuous interactions and data sharing, hence creating a dynamic ecosystem where resources are utilized efficiently (Hietanen, 2014; Meurs et al., 2020).

We decided to set our research in the MaaS industry for several compelling reasons. Firstly, the sector is still in its infancy and is populated by a high number of start-ups. These start-ups have played a crucial role in commercializing the idea of MaaS and in shaping its development up until now. They are the

true pioneers and launchers of the initial prototypes of MaaS business models (Audouin and Finger, 2018) and are continuously innovating to meet new market needs. Moreover, new ventures keep emerging, each focusing on specific aspects of MaaS, underscoring the overall attractiveness and dynamism of the sector (P&S Intelligence, 2022).

Secondly, the industry has a high potential for growth and development. Despite the temporary slowdown due to the COVID-19 pandemic, the MaaS sector has kept growing, reaching a valuation of over \$120 billion globally in 2021 and projected to grow with a CAGR of 16.8% until 2030 (P&S Intelligence, 2022). Policy makers worldwide are actively promoting the implementation of MaaS in urban areas, thereby alimending the growth of the market (Hensher et al., 2020). Moreover, most incumbent players in the mobility sector are adapting their strategies to incorporate this new offering into their portfolios. In this context, start-ups are forced to maximize efficiency, pivot, or innovate their business model to face competition and maintain a strong presence in the market. This rapidly evolving market provides thus an ideal context for investigating the dynamics we aim to explore.

Finally, to our knowledge, there is still no contribution in the existing literature regarding the specific examination of start-ups within the MaaS domain. While discussions on MaaS recognize the importance of business models to effectively deliver the service and emphasize that ‘MaaS is not a mere platform’ (Hensher et al., 2020; Polydoropoulou et al., 2020; König et al., 2016), there remains a notable gap in the research literature towards the entrepreneurial ventures shaping innovation within this sector and the resources and competences that are crucial for bringing these innovations to market. Moreover, there is limited exploration into the strategies employed by start-ups and how they are pivoting to face competition and survive.

Within this context, our research findings may hold significant relevance for practitioners belonging in the MaaS domain.

3.4.2. Research Sample

The selection of the research sample involved several sequential steps. Initially, we set the boundaries of our research by defining clearly what a MaaS start-up is. In our view, a MaaS start-up is “a new venture that, in whole or part, is dedicated to providing MaaS services”. These services involve “the integration of different transport and transport-related services (e.g., car parking, EV recharge, etc.) into a single digital platform – either through a smartphone app or a website”. Companies that provide white-label solutions for MaaS are also included in our definition. Overall, we adopted Hensher et al. (2021) perspective, which suggests that a MaaS service does not need to integrate every possible transport solution, but it should serve as a platform for delivering a diverse range of multi-modal mobility services. The second step entailed conducting a systematic search through start-up directories and platforms to identify ventures that matched our definition of MaaS start-up. We chose Crunchbase as our primary data source for its comprehensive coverage and up-to-date information on start-ups globally. Using the advanced search feature, we entered the terms “Mobility as a Service,” “Mobility-as-a-Service,” and “MaaS.” This search generated a list of 248 companies. We refined this initial list by applying industry filters such as “Transportation”, “Mobile Apps”, and “Mobile Payments”, which align closely with our definition and with the core characteristics of MaaS. This filtering process narrowed our focus to 90 start-ups. To ensure comprehensiveness and accuracy, we supplemented this search with insights from specific industry reports, which corroborated and expanded the total number of start-ups identified to 102. Next, we created an Excel database to systematically gather and analyse essential information about each company.

This included various details such as the legal name, website, year of foundation, headquarters location, market value, funding raised, number of employees, and a description of their business model, focusing on their value creation and value capture mechanisms (Lepak et al., 2007). The purpose of creating this database was twofold. First, it allowed us to study the market more comprehensively and gain a better understanding of the prevailing business models employed by start-ups in the sector. Second, it facilitated the classification of these start-ups into three main categories, distinguishing their roles within the industry based on their business models. We labelled these groups as orchestrators, enablers, and components. Orchestrators are companies that directly manage the integration of various mobility services and provide it to the users via their platform. Instead, enablers mainly offer necessary technology and white-label platforms that facilitate the implementation and running of MaaS systems. Their value proposition is generally targeted towards other businesses and public administrations. Finally, components are firms that provide specific services or functionalities that are integrated into broader mobility solutions (e.g., in an orchestrator's value proposition).

We deem this division crucial to our analysis, as it enables a detailed examination of how various business models function within the same industry and how these models potentially prioritize distinct resources and competencies to operate.

Finally, we selected three distinct ventures for our sample, comprising one orchestrator, one enabler, and one component. We adopted a theoretical sampling approach, purposefully selecting three firms that exemplify each category and that could provide significant insights for our research inquiry (Eisenhardt and Graebner, 2007). Our choice fell on MaaS Global as for the orchestrator category; SkedGo, a renowned pioneering player primarily functioning as an

enabler; and RideMovi, a company that integrates all the micro-mobility, as a component. An overview of these three companies is provided in Table 3.1.

3.4.3. Data Collection

The data collection process for our analysis consisted in two main steps. Initially, we collected data related to MaaS start-ups, focusing specifically on the ones under study, from various online sources. The aim was to build a primary understanding about the business models, resources, and competences of each firm. We reviewed industry reports to gain a macro-level view of the MaaS sector, including market trends, key players, and strategic developments in recent years. For up-to-date information and current industry insights, we consulted articles from leading digital news platforms such as TechCrunch, Forbes, and Bloomberg. Additionally, specific details about the companies under analysis were sourced directly from their official websites. We explored their history and blog posts to trace their evolution over time and we gathered information about their current service offerings, strategic partnerships, and other pertinent details to our research question. However, due to the specificity of our inquiry, we relied predominantly on primary sources to derive our insights. We conducted semi-structured, face-to-face interviews with the CEOs of the companies under study (see Table 3.2 for reference). Initially, we asked them to narrate the story of their company's formation, focusing on the resources and capabilities that were considered crucial to start. Further, we delved into how their start-ups have progressed over time, requesting them to outline the key milestones in their journey and explain how they adapted their resources, capabilities, and business model through various development stages. Finally, we discussed the main challenges and opportunities they encountered in the scaling process and the strategies implemented to overcome or capitalize on these situations. The details of the interview questions are provided in Appendix A.

Table 3.1 – Case Studies Overview

Legal name	MaaS Global Ltd	SkedGo Pty Ltd	RideMovi S.p.A.
HQ Location	Helsinki (Finland)	Sydney (Australia)	Milan (Italy)
Date of foundation	2015	2009	2017
Employees	100+	11-50	50-100
Turnover	4.000.000€ (approx..)	5.000.000€ (approx.)	14.000.000€ (approx.)
Main products/services	MaaS application (Whim)	Planning platform (TripGo) and MaaS-as-a-Service	Micro-mobility platform with 3 different modes (bikes, e-bikes, e-scooters)
Cities Served	Few cities in Europe (Helsinki, Birmingham, Vienna, Antwerp)	Available in 500+ cities and regions worldwide	Less than 100 cities in Italy and Europe
Website	http://www.maas.global	http://www.skedgo.com	http://www.ridemovi.com/

Table 3.2 – List of Interviewees

Name	Role	Date of interview
Sampo Hietanen	CEO of MaaS Global	1st February, 2024
John Nuutinen	CEO of SkedGo	14th December, 2023
Alessandro Felici	CEO of RideMovi	19th December, 2023

3.4.4. Data Analysis

Adhering to the methodology suggested by Strauss and Corbin (1990), the data analysis was conducted through a series of iterative steps. Initially, we arranged the data collected from secondary sources into a 3x3 matrix, with columns representing the stages of the NVC process—Inception, Development, and Scaling—and rows categorized by enterprise type: Orchestrator, Enabler, and Component. For each combination of enterprise type and NVC stage, we detailed the corresponding business models, resources, and competencies. Once data from primary sources became available, we updated the matrix to include this new information. We hence employed a triangulation approach by utilizing multiple sources of information, to ensure the integrity of data and enhance the reliability of our findings. In order to derive theoretical insights from the qualitative nature of the data (Glaser and Strauss, 1967), an intra-case and cross-case analysis was conducted (Eisenhardt, 1989; Yin, 1994). We identified critical resources and competences essential for supporting the evolution of the business model across various phases for each company, highlighting both differences and commonalities. Data analysis involved several collaborative discussion and meetings to exchange and challenge ideas, ensuring our results were robustly founded both empirically and theoretically.

3.5. Results

The aim of our research is to explore the dynamic interplay between the evolution of business models and the corresponding resource allocations to support these transformations (George and Bock, 2011; Demil and Lecocq, 2010). Start-ups exemplify better this relationship due to their continuous experimentations and refinements throughout their creation process (Vogel, 2017; Sosna et al., 2010). By analysing the evolution of three distinct macro-categories of start-ups within the MaaS industry—orchestrators, enablers, and components—our findings show that each category (i) has demonstrated considerable changes and growth in its business model throughout the process; (ii) proactively secured new resources to facilitate and enhance their business model transformations; and (iii) while there are some overlapping competencies and resources among them in each phase, the types of resources and competences leveraged vary significantly depending on the specific business model. Table 3.3 offers a detailed overview of the business models, resources, and competences for each case study across the different phases of their NVC process. It emphasizes the relationship between these elements and how it has evolved over time, demonstrating the progression of each company from inception to scaling. In the following sections, we will present a detailed within-case analysis for each considered start-up, as well as a cross-case analysis.

Table 3.3 - Overview of resources, competences, and business model evolution for MaaS Global, SkedGo, and RideMovi

	Inception	Development	Scaling
MaaS Global			
Business Model	<u>Value Creation</u> : An all-encompassing mobility subscription service integrating all transport modes into a single app. Initially served only one city (Helsinki) <u>Value Capture</u> : Subscription-based model (one subscription), PAYG	<u>Value Creation</u> : Personalization of the offering <u>Value Capture</u> : Expanded service offerings through tiered subscription models that ranged from low-end to premium	<u>Value Creation</u> : Expanded the service internationally, adapted the MaaS app to regional preferences <u>Value Capture</u> : Diversified revenue streams with B2B offerings (selling mobility solutions to companies), and licensing of technology.
Resources	Initial funding, initial tech infrastructure (app, cloud, back-end), initial partnerships	Increased investments to enhance existing technological infrastructure, data analytics tools, data protection systems.	Investments to scale up technological infrastructure globally, Development and integration of SDKs and APIs, big data platforms, local staff
Competences	leadership and entrepreneurial background, app design and software development, bargaining skills (contracts negotiation), communication skills	Data analytics skills, product design (subscriptions), pricing and market segmentation skills, management of suppliers and partnerships, customer care, financial management	Business development skills, market analysis skills, partnership management, compliance and regulatory affairs expertise, recruiting and managerial skills
SkedGo			
Business Model	<u>Value Creation</u> : Developed TripGo, the world's first preference-based journey planner app targeting the B2C market. <u>Value Capture</u> : Freemium model	<u>Value Creation</u> : Enhanced TripGo app functionalities (MaaS app) and pivoted to a B2B SaaS model (end-to-end implementations) <u>Value Capture</u> : Service implementations and usage fees, consultancy, white labels	<u>Value Creation</u> : Shifted focus to core service of journey planning, integrating with partners for delivering end-to-end solutions (for PA and businesses) <u>Value Capture</u> : partnership agreements, new API usage plans
Resources	Initial Capital, Initial technological infrastructure (app, cloud, back-end, localization tech, data storages)	Technological hubs, investments in new technologies (booking and payment systems, API, SDKs, data analytics tools)	Recruitment of additional staff to manage expanded operations, new technological investments

	Inception	Development	Scaling
SkedGo			
Competences	Leadership and entrepreneurial background, technical competences in algorithms, front & back-end development, and app design	Technical competences in various areas from planning to payments and rewards, data analytics, business development and digital marketing skills, project management	Partnership management skills, recruiting and managerial skills, compliance and regulatory affairs expertise
RideMovi			
Business Model	<u>Value Creation</u> : dockless bike-sharing service operating in a few cities across Italy and Spain. <u>Value Capture</u> : Usage fees of users	<u>Value Creation</u> : Expanded product offerings to include electric bikes and scooters, focus on operation efficiency <u>Value Capture</u> : Diversified revenue streams through new vehicles, co-design with suppliers	<u>Value Creation</u> : Expanded operations to new cities across Europe, focus on operation efficiency <u>Value Capture</u> : Leveraged scalable business model to grow user base and increase utilization rates in new markets.
Resources	Initial capital, existing assets from Mobike, including bicycles, technology infrastructure, and initial software, HR (pick-up and repositioning of bicycles)	Purchase of new vehicles, investments in software upgrades	Investments in software scalability, additional vehicles, new local organizational structures
Competences	Leadership and entrepreneurial background, technological skills (software, app development), hardware expertise (for vehicles and maintenance)	Product design skills, suppliers' management, algorithm expertise for fleet management and routing, customer support, digital marketing skills, AI skills, business development skills	Market analysis skills, recruiting and managerial skills, compliance and regulatory affairs expertise

3.5.1. MaaS Global (Orchestrator)

MaaS Global was the first company to operationalize the MaaS concept into a business. Its journey began in 2015, from a concerted effort involving academics, the Finnish government, and various industry stakeholders including Siemens, Ericsson, Uber, and local transport entities. In the inception phase, after securing the initial funds, MaaS Global concentrated on building the necessary technological infrastructure to support its operations. As highlighted in the interview with its CEO, Sampo Hietanen, this phase involved procuring essential hardware and recruiting software developers to handle app design and backend development.

“[...] the first thing I did after securing some of the key guys was to have a CTO, and of course it's a crucial one. We got quite lucky with it, since I'm not technical enough. [...] We found a good one that could really even code himself, build the architecture, be the tech leader, be even speaking in front of investors.” (Interview, 14th December 2023).

Meanwhile, Hietanen leveraged his communication skills and leadership experience in start-ups to focus on negotiating contracts with key transport providers in Helsinki, laying the core infrastructure for the service. As discussed during the interview, the initial aim was to offer a seamlessly integrated mobility service accessible via its Whim app, where users could plan, book, and pay for various modes of transport. Additionally, the company introduced an all-inclusive subscription model priced at €499 per month, allowing unlimited access to all mobility services within the city. This approach served to test the market and gather valuable insights on how to effectively deliver such a service.

In its development phase, MaaS Global experienced rapid growth. As emerged during the interview, the company made substantial investments in its technological infrastructure, focusing on enhancing backend integration capabilities, implementing data security measures, and refining the user experience

design. According to Hietanen, designing the user experience is the hardest and most important part.

“You think that once they are here just like that, then people will love using it, but you'll have to spend a lot of money for the convenience of the UX. The design of the UX, how it works, how it functions, how it looks, how it's designed. I mean, if you set your target that you're supposed to be as good as owning a car, just imagine how much design do they put in cars.” (Interview, 14th December 2023).

The app's range of features expanded, hence enhancing its overall appeal to users. To support its growth, the company secured several rounds of funding, attracting significant investments from BP Ventures, Mitsui Fudosan, Mitsubishi Corporation, and Nordic Ninja, which collectively contributed around €30 million. The company also began to diversify its subscription offerings, introducing several tiers ranging from low-end (such as Whim benefits) to all-inclusive mobility bundles. This segmentation strategy enabled MaaS Global to address the diverse needs of different customer segments, ranging from casual users to those willing for more comprehensive mobility solutions. The primary goal was to retain regular customers, attract new users, and encourage them to buy subscriptions.

“First, you have to onboard them with this pay-as-you-go or what we call low-end subscriptions. And then you can start moving them across the field” (Interview, 14th December 2023).

To effectively design and manage these diverse subscriptions and introduce more personalized offerings, the company enhanced its competencies in several key areas, such as product design and pricing, data analytics, and customer care. It also concentrated on managing suppliers and forging strategic partnerships, essential for incorporating a wider variety of transportation services into its platform and enhancing its technological capabilities.

In the scaling phase, after establishing a strong base in Helsinki, MaaS Global began its expansion into additional cities including Turku in Finland, Birmingham in the UK, Vienna in Austria, Antwerp in the Netherlands, and Tokyo in Japan. The international expansion required replicating the organizational structure in new locations, which necessitated hiring skilled local staff to manage operations. During the interview emerged that this phase called for significant enhancements in technological infrastructure and the development of capabilities in business development, market analysis, and partnership management. These competencies were crucial for identifying potential new markets, navigating diverse regulatory landscapes, and forging collaborations with local transportation providers. Thereby, recruiting and managerial competencies played critical roles in effectively managing the process. To support this growth, MaaS Global also acquired the Spanish competitor, Wondo. The company expanded its subscription offerings through its app, introducing mobility bundles tailored to regional preferences.

“It's all about just how the model mix looks like, maybe a bit less of public transport more of taxi-like services, maybe on-demand buses, car shares, things like that. If we go into rural areas, you may add into the mix pulled rides, using p2p car share, using all of this. So, it's simple if you go from consumer perspective [...]”. (Interview, 14th December 2023).

Then, the company acquired the Brazilian start-up Quicko to improve the service with enhanced route suggestions. Additionally, it offered customization options and introduced various user benefits, while also adapting its offerings to corporate clients to meet the specific mobility needs of businesses and their employees. As discussed during the interview, in response to the challenges posed by the COVID-19 pandemic, MaaS Global began licensing its technology to other companies, thus enabling them to embed mobility solutions into their value propositions.

3.5.2. *SkedGo (Enabler)*

SkedGo was founded in 2009, pioneering the MaaS industry with its TripGo app, the world's first preference-based journey planner. As emerged during the interview with the company's CEO, John Nuutinen, the inception phase was marked by the acquisition of technical expertise to develop and support the founders' business concept.

"We're not developers. So, we came up with a concept, we came up with a business model, but then we had to find the talent. And the talent was very much technical talent. We got ourselves a technical expert in algorithms to basically develop the solution to the spec that we had designed. And then we had to find ourselves, Android and iOS developers. We started with a small nucleus of people." (Interview, 19th December 2023).

With a relatively small initial investment, they built the technological infrastructure required to launch their service into the market. As highlighted during the interview, this infrastructure included the development of the app, backend systems, localization capabilities, and data storages.

Initially, the service was active only in the Sydney regional area. During the development phase, SkedGo enhanced their TripGo app by developing booking and payment systems. According to Nuutinen, the establishment of a technological hub in Vallecas, Argentina, was crucial in this phase, as it provided access to skilled technical talent to support the technological advancements of the company and keep costs competitive. Initially, SkedGo focused on integrating public transport into their MaaS app, subsequently expanding to include private services across Australia, coupled with incentives and rewards for users, targeting the B2C market. However, recognizing the challenging revenue models and competitive landscape of the consumer market, SkedGo swiftly shifted its focus on their B2B SaaS model.

“We got to a point in 2016 where we decided to pivot as a business. What we realized was that when we look at the consumer market, it was a red ocean. There was no ability to make money out of mobility as a service. [...] So we started to modularize our technology, and we sold it to, or licensed it to other businesses that wanted to use the core capabilities to introduce mobility as a service to their customers.” (Interview, 19th December 2023).

Hence, SkedGo decided to capitalize on their platform's capabilities, offering tailored solutions for companies and public administrations seeking to implement MaaS solutions. The company had an active role in various MaaS trials in Australia. As part of this strategic shift, SkedGo invested significantly in developing APIs and SDKs to enhance the platform's interoperability and flexibility as well as to facilitate third-party integrations. As emerged during the interview, skills in data analytics, business development, digital marketing, and project management were essential for analysing market demands, managing system integrations, and cultivating business relationships, all critical for successfully implementing and scaling their B2B model.

In the scaling phase, SkedGo concentrated on enhancing its core service of journey planning while expanding internationally. The company significantly invested in upgrading its technological infrastructure and formed strategic partnerships with other tech providers.

“[Later on] we made the decision to become a focused differentiator in the market. So, we wanted to do one thing very well. And so we focused on planning. That was our differentiation at the very beginning. And what it forced us to do was to collaborate with other businesses. [...] This has become very much a collaborative industry” (Interview, 19th December 2023).

This allowed SkedGo to expand its service offerings, which now include advanced APIs, improved front-end interfaces, white-label solutions, and data integration capabilities enriched with AI. Furthermore, as SkedGo expanded,

the need for a more structured organizational scheme became evident. As highlighted during the interview, the company transitioned to a hierarchical management structure to effectively handle its expanding workforce, which included a growing number of local employees and specialized talent required to manage increased demand and operational complexities.

3.5.3. RideMovi (Component)

RideMovi was established through the acquisition of the business operations of Chinese company Mobike in 2019. Starting as a dock-less bike-sharing service, RideMovi initially operated in a few cities across Italy and Spain. The founders injected additional financial resources into the company by increasing its capital. During the interview with the CEO, Alessandro Felici, emerged that in the inception phase, the company leveraged the existing assets of Mobike, including bicycles, supplier relationships, software development teams, and technology infrastructure, and continued the business under the new brand. Starting with these resources, RideMovi used the business development skills and leadership of its founders to strategically expand its product offerings. Indeed, in the development phase, the company progressively incorporated electric bikes and scooters into its value proposition. According to Felici, this expansion required significant investments in new vehicles and software upgrades to enhance service offerings and user experience. Emphasizing differentiation and cost efficiency, the company invested in product design to develop user-friendly vehicles and an application that could communicate efficiently with the hardware components, while also providing users with an intuitive interface.

“30% of the profitability depends on how well the hardware works. It needs to be comfortable for the user and very reliable. Having hardware that breaks down less and lasts longer, is pleasant for the end-user, and is integrated into the operational flows is crucial. Another important factor, accounting for

another 30%, is operational capabilities, which include the cost of operating the fleet and how efficiently the fleet is managed to meet user demand.” (Interview, 1st February 2024, adapted from Italian)

As Felici explained us, the designs for the vehicles were passed to suppliers that manufactured them on a custom-order basis. Hence, effective supplier management was critical, ensuring that the quality and reliability of new vehicles met the company's standards. Moreover, algorithm experts were pivotal in optimizing fleet management, essential for maintaining service efficiency, and developing AI tools to further enhance operational capabilities. Finally, customer support and digital marketing skills were enhanced to better engage with users and manage the growing customer base effectively (Interview, 2024).

In the scaling phase, RideMovi focused on expanding its presence across Europe, emphasizing operational efficiency and strategic city selection to maximize profitability and growth.

“The basic infrastructure required for operating in one city or 100 cities is about 70% the same and increases linearly. In this phase, strategic and business development activities are crucial: when deciding whether to enter a city, we look at the demand and vandalism rates.” (Interview, 1st February 2024, adapted from Italian).

As highlighted in the interview, the company made substantial investments in software scalability and procured additional vehicles for a better service coverage. The company also developed new local organizational structures to manage the operations closely. Additionally, recruiting skills were prioritized to attract and retain the talent necessary to support and sustain the company's expansion.

3.5.4. Cross-case analysis

The within-case analysis showcased before demonstrates that each company under study has significantly revised and evolved its initial business model throughout its creation process to meet evolving customer demands, explore new revenue streams, and leverage market opportunities. Furthermore, to support their transitions, each of the companies proactively secured new resources and competencies crucial for their transformation and growth in each phase. For instance, MaaS Global adapted its business model over time by focusing on market segmentation and diversifying its subscription offerings to cater to both individual consumers and corporate clients. Consequently, it developed competencies in data analytics, marketing, and product design while also enhancing the coverage and features of its platform. To ensure a comprehensive offering, MaaS Global actively promoted cooperation and engagement with mobility service providers included in the platform.

SkedGo pivoted its business model two times during its journey. Indeed, initially conceived as a B2C journey planner, it quickly transitioned to a B2B model, increasingly enhancing its technical capabilities to provide customized mobility solutions through APIs and SDKs to businesses. Subsequently, the company narrowed its focus to specialize in journey planning while relying on tech partners to deliver complete and customized services to clients. This shift involved continuous development of cutting-edge technologies and project management skills, as well as an increased focus on cultivating strong partnership management capabilities.

Instead, RideMovi evolved its initial bike-sharing scheme to include electric bikes and scooters while continually expanding into new cities. This required substantial financial investments and business development skills. The company focused on differentiating its offerings through the design of their products, thus enhancing customer experience through product design and

software development skills. To boost operational efficiency, RideMovi enhanced its capabilities in supplier management, algorithm-based fleet management and routing, and AI in all the development phases of its journey.

The cross-case analysis reveals that each company tailored its core competences and resources to best serve its specific strategic objectives and business model needs. However, commonalities in the resources and competencies developed by them exist, reflecting their involvement in the same sector. All three companies heavily invested in technology, whether to enhance app functionalities, improve service integration, or extend service offerings. Moreover, they focused on building strong relationships with their partners and suppliers to enhance their value proposition, with different degrees purposes depending on the model adopted. In addition, they also relied on business development, recruiting and managerial skills to manage the scaling process effectively, replicating existing competences across new locations.

3.6. Discussion and Conclusion

The theoretical framework in Figure 3.1 synthesises and generalizes our findings. It illustrates the evolution of the three categories of MaaS start-ups – orchestrator, enabler, and component– each represented in different rows. These categories progress through the stages of the NVC process, with their development displayed horizontally from left to right, thus reflecting the chronological sequence of their business model evolution. For each phase, the framework lists specific resources and competences as well as the business model characterizing each category. Distinctive resources and competences for each category are highlighted in italics.

Figure 3.1 - Theoretical Framework for Business Model Evolution in MaaS Start-Ups (distinctive resources and competences for each category are marked in *italics*)

	INCEPTION	DEVELOPMENT	SCALING
ORCHESTRATOR	BM Focus: Novelty Resources: - Financial Resources - Social Resources - Technology Competences: - Entrepreneurship background - Product Design <i>Network Development</i> <i>Communication</i>	BM Focus: Novelty, Lock-In Resources: - Innovation Resources - Human Resources - Technology Competences: - UX Design and Development - Brand Building - Marketing and Sales <i>Ecosystem Building</i> <i>Product Development</i>	BM Focus: Lock-In, Efficiency Resources: - Financial Resources - Organizational Resources - Technology Competences: - Staff Recruiting - Commercial Development <i>Operation Management</i> <i>Knowledge of Regulations</i>
ENABLER	BM Focus: Novelty Resources: - Financial Resources - Social Resources - Technology <i>Innovation Resources</i> Competences: - Entrepreneurship background - Product Design	BM Focus: Novelty, Lock-In Resources: - Innovation Resources - Human Resources - Technology Competences: - UX Design and Development - Brand Building - Marketing and Sales <i>Project Management</i> <i>Network Development</i>	BM Focus: Novelty, Complementarities Resources: - Financial Resources - Organizational Resources - Technology <i>Innovation Resources</i> Competences: - Staff Recruiting - Commercial Development <i>Partnership Management</i> <i>Product Development</i>
COMPONENT	BM Focus: Novelty Resources: - Financial Resources - Social Resources - Technology <i>Physical Resources</i> Competences: - Entrepreneurship background - Product Design <i>Hardware Maintenance</i>	BM Focus: Novelty, Efficiency Resources: - Innovation Resources - Human Resources - Technology <i>Physical Resources</i> Competences: - UX Design and Development - Brand Building - Marketing and Sales <i>Supply Chain Management</i> <i>Operation Management</i>	BM Focus: Efficiency Resources: - Financial Resources - Organizational Resources - Technology <i>Physical Resources</i> <i>Human Resources</i> Competences: - Staff Recruiting - Commercial Development <i>Knowledge of Regulations</i>

3.6.1. Inception Phase

In the inception phase, all three categories emphasize novelty in their business models (Amit and Zott, 2001), aiming to introduce innovative solutions or differentiate themselves from competitors. This phase is characterized by a strong focus on product design to develop their value proposition and the utilization of entrepreneurial backgrounds to navigate the initial complexities of a new venture. A shared characteristic among these categories is the strategic use of social resources and the formation of initial partnerships (Fukugawa, 2018), which are critical for developing their offerings and gaining a foothold in the market (Marcon and Ribeiro, 2021; Kamargianni and Matyas, 2017). Furthermore, reliance on technology is a notable commonality, hence reflecting the tech-intensive nature of the MaaS sector (Jittrapirom et al., 2017). During this stage, each category begins to show signs of distinct strategic paths through their unique sets of resources and competences. Orchestrators, for instance, might focus on building a broad network and developing communication strategies that align with their role aiming to integrate various services. Enablers, by contrast, emphasize innovation resources (Sok and O’Cass, 2011), positioning themselves as pivotal in delivering cutting-edge technological solutions. Finally, components focus on leveraging physical resources essential for the hardware-dependent aspects of their services, such as vehicle fleets or other physical assets.

3.6.2. Development Phase

As the three categories progress into the development phase, their business models begin to diverge more distinctly, each leveraging unique resources and competences tailored to their specific strategic needs. Orchestrators emphasize ecosystem building and product development to support their model. They focus on diversifying their subscriptions and offerings through data

analytics, personalization, customization, and well-designed customer care to lock in clients (Amit and Zott, 2001). Enablers, on the other hand, concentrate on developing advanced technologies, APIs, and SDKs to enhance the interoperability and flexibility of their services. This strategy creates dependencies, effectively locking in clients who rely on these integrated systems for their operations. Key competences for enablers include project management to successfully implement and support their B2B SaaS model and network development to integrate a wide range of service providers and clients into their platform. Instead, components prioritize efficiency (Amit and Zott, 2001), concentrating their efforts on optimizing supply chain management and operational processes. This focus is crucial for maintaining the reliability and availability of their services, as well as minimizing costs.

Despite these differences, all three categories share several commonalities in the development phase. They all demonstrate a strong commitment to enhancing user experience, as MaaS is inherently a user-centric service (Lyons et al., 2019). Consequently, the apps and features provided by these companies, as well as vehicles in the case of components, must be functional and convenient for users (Esztergár-Kiss et al., 2020). Novelty remains a core focus of their business models, with each company leveraging innovation resources such as proprietary algorithms, patented technologies, data analytics tools, and software upgrades to expand service offerings, develop unique services, and differentiate from competitors. Marketing activities are also emphasized to effectively communicate their offerings, segment the market, and target the most profitable market segments. Brand building is another key focus, helping to establish a strong market presence and foster user trust and loyalty. Lastly, human resources (Fukugawa, 2018; Barney, 1991) play a critical role, as the talent acquired during this phase is essential for developing advanced service offerings.

3.6.3. Scaling Phase

During the scaling phase, all three categories of MaaS companies focus on internationalization and expanding their services into new cities. This phase requires substantial financial and organizational resources (Barney, 1991) to replicate the necessary operational competences and thus expand the workforce in new locations as well as establish a well-defined organizational structure. Key competencies in this phase include staff recruiting to attract and retain skilled talent, commercial development to select new markets for entry and grow revenue, and knowledge of transport regulations in targeted regions to ensure compliance and smooth operations. In this phase, the three categories further differentiate and consolidate their business models. Orchestrators tend to emphasize lock-in and efficiency by adding tailored subscription models based on regional needs and focusing on operation management to lower operational costs. Additionally, forging new partnerships with local transport providers is crucial for their model.

Enablers continue to enhance their service offerings and provide novelty to their clients. They rely heavily on partnerships with other tech companies and grow their collaboration network to further enhance their model by adding new features and complementarities (Amit and Zott, 2001) to their product with the help of partners. They continue leveraging innovation resources and product development to provide cutting-edge technological products.

Finally, components continue focusing on efficiency and targeted market entries to secure more income and increase their margins, leveraging skilled human resources particularly in logistics and operation management.

3.6.4. Implications for theory

Our research contributes to both the business model and NVC fields. In the business model domain, our study presents a novel theoretical perspective on the interplay between strategy, business models, and resources and competences endowment (Teece, 2018). We conducted a longitudinal analysis of different types of start-ups to understand how these relationships evolve over time (Demil and Lecocq, 2010). By examining practical instances of business model evolution – focusing specifically on the development and leveraging of key resources and competences – we provide insights into the mechanisms through which firms navigate their growth trajectories (Sosna et al., 2010; Marcon and Ribeiro, 2021; George and Bock, 2011). Additionally, our approach illustrates how possible path dependences are established in new ventures and underscores the role of business models in explaining this phenomenon (Hamel, 1999; Tracey and Jarvis, 2007; Willemstein et al., 2007; Garnsey et al., 2008).

As for the NVC field, our study offers a nuanced perspective of the NVC process by adopting business models and RBV as theoretical lenses (Davidsson and Gruenhagen, 2021; Marcon and Ribeiro, 2021; Vogel, 2017). We shed new light on the critical role of resources and competences at each phase of a start-up's lifecycle and their importance in enabling successful transitions between these phases (Marcon and Ribeiro, 2021; McMullen and Dimov, 2013). Our findings offer detailed insights into how new ventures adapt their strategies, business models, and resource allocations in response to dynamic market conditions and internal growth demands throughout the process (Teece, 2018; Morgan et al., 2020; Lim et al., 2020).

3.6.5. Implications for practice

Our research holds significant practical contributions. First, it provides an overview of the current MaaS market, delineating the main business models in operation. This offers practical guidance for entrepreneurs and practitioners looking to develop a MaaS service. It illustrates how these business models have originated and evolved, capturing the dynamic nature of the sector. Second, it details the resources and competences that MaaS companies develop to grow, innovate, and deliver their services. We reveal that MaaS enterprises are not just platforms; they are firms that utilize specific sets of resources and competencies to offer their products to users, with technology serving as a channel rather than the sole focus. This insight offers a clearer understanding of the essential resources and competencies required for delivering MaaS services, highlighting those that are critical for achieving specific business models. Finally, our findings illustrate how firms can transition from one business model to another by strategically acquiring and leveraging new resources and competencies. For instance, an orchestrator can transform into an enabler, or a component into an orchestrator and vice versa, through strategic resource and competence realignment. These insights are invaluable for entrepreneurs and practitioners within the mobility sector, guiding investment strategies and business decisions. Moreover, a deeper understanding of the business models and growth strategies of MaaS providers can assist policymakers in creating supportive regulatory frameworks and fostering the right environment for the sector's development.

3.6.6. Limitations and further research avenues

This study has some limitations that could serve as avenues for future research.

First, our categorization of start-ups into three distinct macro-groups was a theoretical decision aimed at simplifying the analysis and facilitating comparisons and discussions. We acknowledge that this approach may oversimplify the nature of the sector and possibly introduce biases in our research. Additionally, the study's reliance on a limited number of companies could affect the generalizability of the results. Future studies could consider expanding the sample size and provide a more nuanced categorization to enhance the overall robustness of the findings.

Second, the proposed framework is specifically tailored to knowledge and technology-intensive start-ups within sectors akin to MaaS. Future research could broaden the applicability of this framework by exploring its relevance and adaptability to other sectors. This expansion would not only test the robustness of the framework across different contexts but also potentially uncover unique industry-specific dynamics and insights.

Finally, our study utilizes a longitudinal perspective to illustrate the co-evolution of business models alongside the development of resources and competences across three distinct phases of the NVC process. However, a more detailed examination of the decision-making processes within a single phase could provide deeper insights into strategic choices, resource allocation, and competence development. Exploring the rationale behind key strategic decisions – such as pivots in business models or targeted investments in certain resources – could offer a clearer understanding of the internal and external factors that influence business model innovation in the MaaS industry.

3.7. *References*

Abell, D.F. (1980). "Defining the business: The starting point of strategic planning". Englewood Cliffs, NJ:Prentice-Hall.

Adner, R., Kapoor, R., (2010). "Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations". *Strateg. Manag. J.* 31, 306–333.

Afuah, A., (2004). "Business Models: A Strategic Management Approach". McGraw-Hill/Irwin, New York.

Amit, R., Zott, C. (2001). Value creation in e-business. *Strategic Management Journal*, 22(6–7), 493–520.

Amit R., Zott C. (2015). *Crafting Business Architecture: The Antecedents of Business Model Design*. *Strat. Entrepreneurship J.*, 9: 331–350

Amit R., Zott C. (2020). "Business Model Innovation Strategy: Transformational Concepts and Tools for Entrepreneurial Leaders". John Wiley and Sons Ed.

Aspelund, A., Berg-Utby, T., and Skjevdal, R. (2005). "Initial resources' influence on new venture survival: a longitudinal study of new technology-based firms". *Technovation*, 25(11), 1337-1347.

Audouin M., Finger M. (2018). "The development of Mobility-as-a-Service in the Helsinki metropolitan area: A multilevel governance analysis". *Research in Transportation Business and Management*, Volume 27, Pages 24-35

Baden-Fuller, C. and Mangematin, V. (2013). 'Business models: A challenging agenda'. *Strategic Organization*, 11, 418–27.

Bakker, R. M., and Shepherd, D. A. (2017). "Pull the Plug or Take the Plunge: Multiple Opportunities and the Speed of Venturing Decisions in the Australian Mining Industry". *Academy of management journal*, 60(1), 130-155.

Barney, J. B. (1991) "Firm resources and sustained competitive advantage", *Journal of Management*, 17(1), pp. 99–120.

Barney, J. B. (1995) "Looking inside for competitive advantage", *The Academy of Management Executive*, 9, pp. 49–61.

Bird, B. (1988). "Implementing Entrepreneurial Ideas: The Case for Intention". *The Academy of Management Review*, 13(3), 442-453.

Birkinshaw, J., Ansari, S., (2015). "Understanding management models: going beyond "what" and "why" to "how" work gets done in organizations". In:

Foss, N.J., Saebi, T. (Eds.), *Business Model Innovation: the Organizational Dimension*. Oxford University Press, Oxford, pp. 85e103.

Bocken N.M.P., Geradts T.H.J. (2020). "Barriers and drivers to sustainable business model innovation: Organization design and dynamic capabilities". *Long Range Planning*, Volume 53, Issue 4, 101950.

Bojovic N., Genet C., Sabatier V. (2017). "Learning, signaling, and convincing: The role of experimentation in the business modeling process". *Long Range Planning*, pp. 1-17.

Brush, C. G., Patricia, G. G., Myra, M. H., and Harold, S. H. (2001). "From Initial Idea to Unique Advantage: The Entrepreneurial Challenge of Constructing a Resource Base [and Executive Commentary]". *The Academy of Management Executive* (1993-2005), 15(1), 64-80.

Casadesus-Masanell, R., Ricart, J. E. (2010). 'From strategy to business models and onto tactics'. *Long Range Planning*, 43, 195–215.

Cavalcante, S., Kesting, P., Ulhøi, J., (2011). "Business Model Dynamics and Innovation: (Re)establishing the Missing Linkages". *Management Decision* 49 (8), 1327e1342.

Chen, A. (2021). "The Cold Start Problem: How to Start and Scale Network Effects". HarperCollins.

Choi, Y. R., Lévesque, M., and Shepherd, D. (2008). "When Should Entrepreneurs Expedite or Delay Opportunity Exploitation?" *Journal of business venturing*, 23, 333-355.

Climent R.C., Haftor D.M. (2021). "Value creation through the evolution of business model themes". *Journal of Business Research*. Volume 122, Pages 353-361.

Cohen, S. L., Bingham, C. B., and Hallen, B. L. (2019). "The role of accelerator designs in mitigating bounded rationality in new ventures". *Administrative Science Quarterly*, 64(4), 810-854.

DaSilva C.M., Trkman P. (2014). "Business Model: What It Is and What It Is Not". *Long Range Planning*, 47: 379-389

Davidsson, P., Gruenhagen, J. H. (2021). "Fulfilling the process promise: A review and agenda for new venture creation process research". *Entrepreneurship theory and practice*, 45(5), 1083-1118.

Davis, Jason P., Eisenhardt, Kathleen M., Bingham, Christopher B., (2007). "Developing theory through simulation methods". *Acad. Manag. Rev.* 32 (2), 480–499.

Demil, B., Lecocq, X. (2010). "Business model evolution: In search of dynamic consistency". *Long Range Planning*, 43: 227-246

Eisenhardt K.M. (1989). "Building Theories from Case Study Research". *The Academy of Management Review*, Vol. 14, No. 4, pp. 532-550

Eisenhardt, K.M., Graebner, M.E., (2007). Theory building from cases: opportunities and challenges diverse. *Acad. Manag. J.* 50, 25–32.

Eisenmann, T. R. (2021). "Why startups fail". Random House Audio.

Enoch M., Potter S. (2023). "MaaS (Mobility as a Service) market futures explored". *Transport Policy*. Volume 134, Pages 31-40

Foss, N. J., Saebi, T. (2017). "Fifteen years of research on business model innovation: How far have we come, and where should we go?" *Journal of Management*, 43(1), 200–227.

Fukugawa, N., (2018). "Is the impact of incubator's ability on incubation performance contingent on technologies and life cycle stages of startups?: evidence from Japan". *Int. Entrep. Manag. J.* 14, 457–478.

Furr, N., and Ahlstrom, P. (2011). "Nail it then scale it: the entrepreneur's guide to creating and managing breakthrough innovation". NISI Institute.

Garnsey, E., Lorenzoni, G., Ferriani, S. (2008). Speciation through entrepreneurial spin-off: The AcornARM story. *Research Policy*, 37(2), 210–224.

George, G., Bock, A.J., (2011). The business model in practice and its implications for entrepreneurship research. *Entrepreneurship Theory and Practice* 35 (1), 83–111.

Giesecke, R.; Surakka, T.; Hakonen, M. (2016). "Conceptualising Mobility as a Service". In *Proceedings of the Eleventh International Conference on Ecological Vehicles and Renewable Energies (EVER)*, Monte Carlo, Monaco; pp. 1–11.

Glaser B.G., Strauss A.L. (1967). "The Discovery of Grounded Theory: Strategies for Qualitative Research". Aldine Transaction.

Hamel, G. (1999). Bringing Silicon Valley inside. *Harvard Business Review*, 77(5), 70–84.

Hensher D.A., Ho C.Q., Mulley C., Nelson J.D., Smith G., Wong Y.Z. (2020). "Understanding Mobility as a Service (MaaS): Past, Present and Future". Book, Elsevier Ed.

Hensher D.A., Ho C.Q., Reck D.J., Smith G. (2021). "The Sydney Mobility as a Service (MaaS) Trial Design, Implementation, Lessons and the Future". iMove project final report.

Hietanen S. (2014). "'Mobility as a Service' – The new transport model?". *Eurotransport*, 12(2), pp.2-4

Huang, H.C., Lai, M.C., Lo, K.W. (2012). "Do founders' own resources matter? The influence of business networks on start-up innovation and performance". *Technovation*. Vol.32(5), pp.316-327

Ireland, R.D., Hitt, M.A., Sirmon, D.G., 2003. A model of strategic entrepreneurship: the construct and its dimensions. *J. Manage.* 29, 963–989.

Jittrapirom P., Caiati V., Feneri A.-M., Ebrahimi S., González M.J.A., Narayan J. (2017). "Mobility as a service: a critical review of definitions, assessments of schemes, and key challenges". *Urban Plan*, 2(2), 13-25

Johnson, M. W., Christensen, C. M. and Kagermann, H. (2008). 'Reinventing your business model'. *Harvard Business Review*, 86, 57–68.

Kamargianni M., Matyas M. (2017). "The business ecosystem of mobility-as-a-service". In: Paper Presented at the 96th Transportation Research Board (TRB) Annual Meeting, Washington, DC.

Kamargianni, M., Matyas, M., Li, W., Muscat, J., Yfantis, L. (2018). "The MaaS Dictionary". MaaS Lab, Energy Institute, University College London.

Kaplan, S. (2011). "Research in cognition and strategy: Reflections on two decades of progress and a look to the future". *Journal of Management Studies*, 48(3), 665-695.

Karami, M., Baber, W. W., Ojala A. (2022). "The effectual process of business model innovation for seizing opportunities in frontier markets". *Technovation*. Vol.117, 102595

Kirtley, J., and O'Mahony, S. (2020). "What is a pivot? Explaining when and how entrepreneurial firms decide to make strategic change and pivot". *Strategic management journal*.

König D., Eckhardt J., Aapaoja A., Sochor J., Karlsson M. (2016). "Deliverable 3 –Business and operator models for MaaS". MaaSIFIE Project funded by CEDR

König, M., Ungerer, C., Baltes, G., Terzidis, O., (2019). Different patterns in the evolution of digital and non-digital ventures' business models. *Technol. Forecast. Soc. Chang.* 146, 844–852.

Ireland, R.D., Hitt, M.A., Sirmon, D.G., (2003). "A model of strategic entrepreneurship: the construct and its dimensions". *J. Manage.* 29, 963–989.

Lepak D. P., Smith K. G., Taylor M. S. (2007). "Value Creation and Value Capture: A Multilevel Perspective". *Academy of Management Review*, Vol. 32, No. 1

Lim D.S.K., Morse E.A., Yu N. (2020). "The impact of the global crisis on the growth of SMEs: A resource system perspective". *International Small Business Journal*, Volume 38 (6).

Liu, J., Baskaran, A., Li, S. (2009). "Building Technological-Innovation-Based Strategic Capabilities at Firm Level in China: A Dynamic Resource-Based-View Case Study". *Industry and Innovation*, 16(4-5), 411–434.

Lyons G., Hammond P., Mackay K. (2019). "The importance of user perspective in the evolution of MaaS". In: Hensher D.A., Mulley C., eds. *Transportation Research Part A: Policy and Practice*. 22–36. Special Issue on Developments in Mobility as a Service (MaaS) and Intelligent Mobility; vol. 121

Lovins, A.B., Lovins, L.H., Hawken, P. (1999). A road map for natural capitalism. *Harvard Business Review*, 77(3), 145–161.

MaaS Alliance (2017). "Guidelines and Recommendations to Create the Foundations for Thriving MaaS Ecosystem". White Papers.

MaaS Alliance, (2022). What Is MaaS? <https://MaaS-Alliance.Eu/homepage/what-is-MaaS>

Mahadevan, B. (2000). Business models for Internet-based e-commerce: An anatomy. *California Management Review*, 42(4), 55–69.

Mangematin, V., Lemarie, S., Boissin, J.P., Catherine, D., Corolleur, F., Coronini, R., et al. (2003). Development of SMEs and heterogeneity of trajectories: The case of biotechnology in France. *Research Policy*, 32(4), 621–638.

Mansoori, Y., Karlsson, T., Lundqvist, M. (2019). The influence of the lean startup methodology on entrepreneur-coach relationships in the context of a startup accelerator. *Technovation*. Vol. 84-85, pp. 37-47

Marcon, A., Ribeiro, J. L. D. (2021). “How do startups manage external resources in innovation ecosystems? A resource perspective of startups’ lifecycle”. *Technological Forecasting and Social Change*, 171, 120965.

Martins, L. L., Rindova, V. P., Greenbaum, B. E. (2015). “Unlocking the hidden value of concepts: a cognitive approach to business model innovation”. *Strategic Entrepreneurship Journal*, 9(1), 99-117.

Massa, L., Tucci, C. L. and Afuah, A. (2017). ‘A critical assessment of business model research’. *Academy of Management Annals*, 11, 73–104.

McGrath, R. G. (2010). ‘Business models: A discovery driven approach’. *Long Range Planning*, 43, 247–61.

McMullen, J. S., Dimov, D. (2013). Time and the Entrepreneurial Journey: The Problems and Promise of Studying Entrepreneurship as a Process. *Journal of Management Studies*, 50(8), 1481-1512.

Meurs H., Sharmeena F., Marchaua V., van der Heijdena R. (2020). “Organizing integrated services in mobility-as-a-service systems: Principles of alliance formation applied to a MaaS-pilot in the Netherlands”. *Transportation Research Part A*, 131, 178-195.

Morgan T., Anokhin S., Ofstein L., Friske W. (2020). “SME response to major exogenous shocks: The bright and dark sides of business model pivoting”. *International Small Business Journal*, Volume 38 (5).

Morris, M., Schindehutte, M., Allen, J. (2005). The entrepreneur's business model: Toward a unified perspective. *Journal of Business Research*, 58(6), 726–735.

Mulley C. (2017). "Mobility as a Service (MaaS) - does it have critical mass?". *Transp. Rev.*;37(3):247–251.

Osterwalder, A., Pigneur, Y., Tucci, C.L., (2005). "Clarifying Business Models: Origins, Present, and Future of the Concept". *Communications of the Association for Information Systems* 16, 1e25.

Osterwalder, A. and Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Hoboken, NJ: Wiley.

Paschen, J., (2017). "Choose wisely: crowdfunding through the stages of the startup life cycle". *Bus. Horiz.* 60, 179–188.

Penrose E. T. (1959). "The Theory of the Growth of the Firm", John Wiley, New York.

Peralta, C.B., da, L., Echeveste, M.E., Lermen, F.H., Marcon, A., Tortorella, G., (2020). "A framework proposition to identify customer value through lean practices". *J. Manuf. Technol. Manage.* 31, 725–747.

Perren L., Ram M. (2004). "Case-Study Method in Small Businesszhan and Entrepreneurial Research: Mapping Boundaries and Perspectives". *International Small Business Journal*. Volume 22(1).

Peteraf, M. A. (1993) "The cornerstones of competitive advantage: a resource-based view", *Strategic Management Journal*, 14, pp. 179–191.

Picken, J.C., (2017). "From startup to scalable enterprise: laying the foundation". *Bus. Horiz.* 60, 587–595.

Polydoropoulou A., Pagoni I., Tsirimpa A., Roumboutsos A., Kamargianni M., Tsouros I. (2020). "Prototype business models for Mobility-as-a-Service". *Transp. Research Part A*, vol. 131, issue C, 149-162

Prescient and Strategic Intelligence (P&S Intelligence). (2022). "Global Mobility as a Service (MaaS) Market". Report from psmarketresearch.com

Priem, R.L., Butler, J.E., Li, S., (2013). "Toward reimagining strategy research: retrospection and on the on the 2011 AMR Decade Award Article". *Acad. Manage. Rev.* 38, 471–489.

Raff D.M.G. (2000). Superstores and the evolution of firm capabilities in American bookselling, *Strategic Management Journal* 21(10/11), 1043e1059

Reymen, I., Andries, P., Berends, H., Mauer, R., and Stephan, U. (2015), "Understanding dynamics of strategic decision-making in venture creation: A process study of effectuation and causation" in *Strategic Entrepreneurship Journal*, vol. 9, pp. 351–379.

Ries E. (2011). *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses.* Crown Books.

Rothaermel, F.T., Deeds, D.L., 2004. Exploration and exploitation alliances in biotechnology: a system of new product development. *Strateg. Manag. J.* 25, 201–221.

Sarasini, S., Sochor, J., Arby, J. (2017). "What characterises a sustainable MaaS business model?" 1st International Conference on Mobility as a Service, 28–29. Tampere, Finland.

Sirmon, D.G., Hitt, M.A., Ireland, R.D., (2007). "Managing firm resources in dynamic environments to create value: looking inside the black box". *Acad. Manag. Rev.* 32, 273–292.

Sirmon, D.G., Hitt, M.A., Ireland, R.D., Gilbert, B.A., (2011). "Resource orchestration to create competitive advantage: breadth, depth, and life cycle effects". *J. Manage.* 37, 1390–1412.

Sochor J., Arby H., Karlsson I.C.M., Sarasini S. (2018). "A topological approach to mobility as a service: a proposed tool for understanding requirements and effects, and for aiding the integration of societal goals". *Res. Transp. Bus. Manag.*;27:3–14.

Sok, P., O'Cass, A., (2011). Achieving superior innovation-based performance outcomes in SMEs through innovation resource-capability complementarity. *Ind. Mark. Manage.* 40, 1285–1293.

Sosna, M., Trevinyo-Rodriguez, R. and Velamuri, S.R. (2010), "Business model innovation through trial and-error learning", in *Long Range Planning*, vol. 43 Nos 2-3, pp. 383-407.

Strauss, A., Corbin, J. M. (1990). "Basics of qualitative research: Grounded theory procedures and techniques". Sage Publications, Inc.

Teece, D.J., (2010). "Business models, business strategy and innovation". *Long Range Planning* 43 (2–3), 172–194.

Teece, D.J. (2016). "Dynamic capabilities and entrepreneurial management in large organizations: Toward a theory of the (entrepreneurial) firm". *European Economic Review*, 86, pp. 202–216.

Teece, D.J. (2017). "Towards a capability theory of (innovating) firms: Implications for management and policy". *Cambridge Journal of Economics*, 41(3), pp. 693–720, bew063

Teece, D.J. (2018). "Business models and dynamic capabilities". *Long Range Planning*, Volume 51, Issue 1, pp. 40-49.

Tracey, P., Jarvis, O. (2007). Toward a theory of social venture franchising. *Entrepreneurship Theory and Practice*, 31(5), 667–685.

Voelpel, S.C., Leibold, M., Tekie, E.B., (2004). "The wheel of business model reinvention: how to reshape your business model to leapfrog competitors". *Journal of Change Management* 4 (3), 259e276.

Vogel, P. (2017). "From venture idea to venture opportunity". *Entrepreneurship theory and practice*, 41(6), 943-971.

Von Briel, F., Davidsson, P., and Recker, J. (2018). "Digital Technologies as External Enablers of New Venture Creation in the IT Hardware Sector". *Entrepreneurship theory and practice*, 42, 47-69.

Warner K.S.R., Wager M. (2019). "Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal". *Long Range Planning* Volume 52, Issue 3, Pages 326-349.

Willemstein, L., van der Valk, T., Meeus, M.T.H. (2007). Dynamics in business models: An empirical analysis of medical biotechnology firms in the Netherlands. *Technovation*, 27, 221–232.

Yin R.K. (1994). "Case Study Research: Design and Methods". SAGE Publications

Zott C, Amit R. (2007). Business model design and the performance of entrepreneurial firms. *Organization Science* 18: 181–199.

Zott C., Amit R. (2010). "Business Model Design: An Activity System Perspective". *Long Range Planning*, Volume 43, Issues 2–3, pp. 216-226

Zott C., Amit R., Massa L. (2011). "The business model: Recent developments and future research". *Journal of Management*, 37, 1019–42.

3.8. APPENDIX A – INTEVIEW QUESTIONS

1) Can you tell us the story of your company's formation and what were the key resources and capabilities you brought in at start?

2) How did your start-up progress in your journey up until now? Could you highlight the key milestones of this journey and how your start-up adapted its resources and capabilities at different stages of development?

3) We're also curious about the evolution of your start-up's business model over time. What were the main turning points and the driving factors behind these changes?

4) What are the main challenges or opportunities you faced and how did you overcome/seize them?

4. From Configurations to Outcomes: Benchmarking Success in MaaS Systems

While the first three empirical chapters unpack MaaS transformation on the supply side—showing how MaaS triggers strategic and organizational change among incumbents, how start-ups evolve role-specific business models, and how these adaptation pathways co-produce alternative ways of operating and implementing MaaS—they also converge on a central implication: MaaS does not converge into a single dominant design. Rather, MaaS materialises through multiple ecosystem configurations that are path-dependent and context-sensitive, shaped by local institutional conditions, the set of actors involved, and, crucially, the type of system initiator that takes the lead in developing, orchestrating, and commercialising the MaaS offering.

These configurations, however, are not abstract system typologies detached from firm behaviour; they emerge from the cumulative alignment (or misalignment) of business model archetypes, incumbent reconfiguration strategies, and start-up role trajectories identified in the previous chapters. This plurality creates a remaining analytical challenge that directly concerns the thesis' overarching question: once MaaS is understood as producing qualitatively different ecosystem configurations, how should “successful goal achievement” be defined and assessed in a way that enables meaningful comparison across heterogeneous implementations?

Accordingly, this chapter addresses RQ4: “How do different MaaS ecosystem configurations translate into distinct profiles of multidimensional goal achievement, and what explains variation in performance across implementations?” by presenting the paper “Towards Excellence: Developing a Multidimensional Benchmarking Framework for Assessing Success in Mobility as a Service (MaaS)

Systems.” The paper develops a comprehensive benchmarking framework that operationalises MaaS success as inherently multidimensional and enables systematic, cross-case evaluation of MaaS initiatives within the current mobility landscape.

Specifically, the study synthesises six core dimensions along which MaaS success can be defined – Technical, Organizational, Economic and Financial, User, Societal, and Contextual –, derived through a structured review of influential MaaS research and refined through expert input. Building on this conceptual foundation, the paper translates the framework into an evaluative design based on Multi-Criteria Decision Analysis (MCDA): it employs AHP to elicit expert-based weights for dimensions and descriptors, and TOPSIS to benchmark initiatives against an “ideal MaaS solution” defined by optimal indicator performance. The framework is then populated with data from MaaS systems and projects worldwide, enabling consistent cross-case comparison across ten prominent MaaS initiatives.

Towards Excellence: Developing a Multidimensional Benchmarking Framework for Assessing Success in Mobility as a Service (MaaS) Systems

4.1. Abstract and Keywords

Abstract – *In the rapidly evolving landscape of urban mobility, Mobility as a Service (MaaS) heralds a transformative shift, aiming at providing transport users towards an integrated and seamless travel experience meeting their different and specific needs. As cities face challenges like congestion and pollution,*

MaaS offers an option for a smarter, cleaner, and more efficient urban transportation future. However, assessing the success of MaaS initiatives remains a complex challenge due to the absence of a standardized framework. Currently, evaluations rely on disparate metrics or perspectives. Without a systematic approach to evaluating success, comparing MaaS systems becomes challenging, hindering the ability to identify best practices, drive improvements, and scale successful initiatives. To bridge the gap, our research aims at developing a comprehensive benchmarking framework for evaluating MaaS systems and identifying those that excels within the current mobility landscape. By applying Multi-Criteria Decision Analysis (MCDA) techniques and leveraging on experts' insights, in this paper we identify six critical dimensions— namely Technical, Organizational, Economic and Financial, User, Community, and Contextual—that collectively define MaaS success, and identify the ideal MaaS solution used as a benchmark. By providing stakeholders with a standardized approach to evaluating MaaS success, our research aims to inform decision-making, drive performance improvements, and promote sustainable urban mobility solutions.

Keywords— Mobility as a Service; MaaS; Success; MCDA; Benchmarking

4.2. Introduction

As urbanization accelerates and cities expand, there is a growing imperative to design mobility systems capable of tackling pressing challenges such as traffic congestion, air pollution, and inefficiencies of existing transportation systems (Jones, 2014; ITF, 2021). The rapid digitalization of mobility and advancements in transportation technology are opening new paradigms to address these issues. Mobility as a Service (MaaS) is widely recognized by researchers and policymakers worldwide as one of the most promising. Over the past decade, MaaS has emerged as a transformative paradigm that leverages digital innovation to integrate multiple transportation modes/alternatives into a seam-

less, user-centric platform (Hietanen, 2014). By enabling travellers to plan, book, and pay for multimodal trips through a single interface, MaaS enhances accessibility to a diverse range of mobility services, reduces reliance on private car use, and contributes to the development of more sustainable and interconnected solutions (Kamargianni and Matyas, 2017; Sochor et al., 2018). The concept holds substantial potential to revolutionize mobility, yet this potential has never been fully realized or empirically validated at scale (Krauss et al., 2022).

Indeed, the real-world deployment of MaaS has been fragmented and, in most cases, inconclusive (Smith and Hensher, 2020). A multitude of MaaS trials and initiatives have been launched globally, often backed by public funding (Hensher et al., 2020). In particular, the European Union has actively supported research and innovation in this field, financing numerous projects – such as CIVITAS, MaaSIFIE, and IP4MaaS – aimed at fostering MaaS development, testing its feasibility, and refining its implementation strategies. At the national level, several governments have also undertaken efforts to establish MaaS ecosystems, as seen in the MAAS4ITALY initiative, a government-backed program in Italy designed to promote nationwide MaaS adoption by encouraging collaboration among mobility providers, digital platforms, and regulatory bodies. Despite this continuous influx of projects and investments, MaaS remains in a state of slow and uncertain evolution, with no clear roadmap for scaling successful implementations (Hensher et al., 2023).

While explanations for this stagnation often emphasize organizational complexity, regulatory barriers, or business-model uncertainties (Krauss et al., 2022; Butler et al., 2021; Kandanaarachchi et al., 2024), we argue that a fundamental yet overlooked obstacle lies in the absence of a shared understanding and a standardized methodology for evaluating MaaS initiatives across diverse contexts (Belossarov et al., 2023). Some trials have reported success in specific aspects, demonstrating that certain barriers and complexities can be effectively

addressed (Karlsson et al., 2016). However, the lack of consistency in evaluation methodologies means that success is measured differently across countries and projects, making cross-comparisons challenging and limiting the ability to extract best practices at a global level (Chiba and Abe, 2024). Previous research has attempted to develop evaluation frameworks or define success metrics for MaaS, but these efforts have often remained fragmented or limited in scope, failing to capture the full complexity of MaaS. Some studies focus on specific technical features (Belossarov et al., 2023) or evaluate individual service attributes (Nikolaidou et al., 2023), while others emphasize sustainability outcomes (Muller et al., 2024). Many existing frameworks adopt a single-stakeholder perspective, either from the viewpoint of users, mobility providers, or government agencies, without capturing the interdependencies among them (Dadashzadeh et al., 2022; Muller et al., 2024; Orozco-Fontalvo et al., 2024). Additionally, much of the existing literature has focused on ex-ante adoption factors and contextual analyses (e.g., Aba and Esztergár-Kiss, 2024; Roumboutsos et al., 2021; Kamargianni and Goulding, 2018), assessing the conditions under which MaaS could be successfully implemented rather than evaluating its actual performance once deployed. While these contributions are valuable for identifying the potential enablers and barriers to MaaS adoption, they often fail to provide ex-post or in medias evaluations that would allow ongoing projects to be assessed, refined, and benchmarked against one another.

In this study, we introduce a novel evaluation framework for MaaS success that accounts for its complexity and multidimensional nature, providing a structured method for assessing and benchmarking implementations. The framework was developed using a Multi-Criteria Decision Analysis (MCDA) approach to ensure a comprehensive and systematic evaluation. The proposed methodology follows a mixed and multi-phased design. First, we conducted a comprehensive review of the MaaS literature, focusing on influential and highly cited works. Using Scopus as the primary database, we identified and analysed

67 seminal papers to explore prevailing theories and conceptualizations of MaaS, revealing the key dimensions that underpin its success. This review confirmed that MaaS cannot be effectively assessed using simplistic or unidimensional metrics but instead requires a structured evaluation framework that captures its diverse and interrelated components. Building on this analysis, we synthesized a theoretical framework that defines MaaS success across six critical dimensions: Technical, Organizational, Economic and Financial, User, Societal, and Contextual. Second, we quantified the relative importance of the six dimensions in determining MaaS success by applying the Analytic Hierarchy Process (AHP) (Saaty, 1980; Ishizaka and Labib, 2011). Third, we defined key descriptors for each dimension and identified their corresponding indicators to ensure a structured and measurable evaluation. Descriptors represent the core components of each dimension, while indicators are specific, quantifiable metrics used to assess them. For example, within the Technical dimension, descriptors include Data Management, Platform Design, and Software Update and Maintenance. Corresponding indicators for Data Management, for example, include the presence of data analytics capabilities, standardized data formats, and API compatibility, and so on. To refine this process and validate the selection of descriptors and indicators, we conducted a survey among experts in urban mobility, transportation planning, and MaaS implementation. Finally, the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Hwang and Yoon, 1981; Shih et al., 2007) was employed to develop the benchmarking framework. In particular, we defined an "ideal MaaS solution" based on the optimal performance of each indicator across the six dimensions. This ideal solution serves as a benchmark against which actual MaaS systems can be evaluated. By collecting extensive data from MaaS systems and projects globally, we populated the benchmarking framework and calculated the proximity of each system to the ideal solution.

We believe that our research makes a significant contribution by advancing a practical, robust, and standardized framework for evaluating MaaS success, one that is grounded in both theory and practice. Unlike previous evaluation approaches, which have been fragmented and inconsistent, our framework captures the inherently multidimensional nature of MaaS success, offering a comprehensive and systematic method to assess its implementation. Beyond its theoretical contribution, the framework provides a valuable tool for Public Transport Authorities (PTAs), MaaS providers, and other stakeholders involved in MaaS deployment. By enabling a structured assessment of trials and facilitating comparisons across different initiatives, it allows stakeholders to identify best practices, diagnose performance gaps, and refine implementation strategies. Additionally, its ability to support both inter- and intra-dimensional evaluations ensures that decision-makers can target specific areas for improvement or optimize overall system performance. Moreover, the framework offers practical recommendations for policymakers, helping them move beyond fragmented pilot programs toward more scalable and sustainable MaaS solutions. By providing a structured evaluation methodology, policymakers can use the framework to inform regulatory decisions, guide funding allocations, and establish performance benchmarks that support MaaS growth.

This paper is structured as follows: Section 4.3 presents the theoretical background on MaaS, offering a comprehensive review of existing literature. Section 4.4 details the methodology adopted. Section 4.5 introduces and demonstrates the application of the benchmarking framework, showcasing the main results derived from the evaluation of global MaaS initiatives. Finally, Section 4.6 concludes the paper by discussing the key implications for both theory and practice, while identifying potential avenues for future research.

4.3. Theoretical Background

4.3.1. Disentangling the MaaS concept

MaaS represents both a vision for the future of transportation— a novel way of conceptualizing how mobility services are organized, delivered, and consumed in response to evolving users and city lifestyles – and a tangible set of digital mobility solutions currently under experimentation in diverse geographic, institutional, and policy contexts worldwide (Jittrapirom et al., 2017; Hensher et al., 2020). At its core, MaaS involves integrating multiple transport services, including public transit, ride-hailing, car-sharing, and micro-mobility options such as bike- and scooter-sharing, into a unified digital platform. Through this platform – often a smartphone application – users can seamlessly plan, book, and pay for their (tailored) multimodal journeys, enjoying greater convenience and flexibility compared to traditional transport offerings (Kamargianni and Matyas, 2017).

Since its inception, scholars have viewed MaaS as a potentially transformative innovation capable of radically reshaping the existing transport landscape (Sochor et al., 2018). However, despite nearly a decade of extensive research and practical experimentation, there remains no universally accepted definition or conceptual consensus on what exactly constitutes MaaS (Arias-Molinares and Garcia-Palomares, 2020). Early conceptualizations often envisioned MaaS as a “one-size-fits-all” solution – a kind of Netflix for mobility – where users could access all available transport modes through a single digital interface, typically via subscription-based packages (Hietanen, 2014; Heikkilä, 2013). However, more recent definitions reflect a clear shift toward greater contextual adaptability and modular integration. For instance, Hensher et al. (2021) emphasize that a service does not need to integrate all possible transport modes to qualify as MaaS. Rather, it should offer a tailored “portfolio of multimodal mobility services” deliberately structured to respond to distinct

user needs within a specific context. Consequently, MaaS implementations can vary significantly in scope – not only in the number and type of services integrated, but also in their geographical scale and target user groups. Nevertheless, the lack of clear conceptual boundaries continues to make it difficult to define which components are essential, which are optional, and what value is actually being delivered to users (Hensher et al., 2020).

Broadly speaking, MaaS can be theoretically framed as a third level – or result-oriented – Product-Service System (PSS) (Cook et al., 2006), whereas users do not pay for access to a specific vehicle or individual transport service, but rather for the fulfilment of a function, namely the ability to reliably move from one location (point A) to another (point B) (Enoch and Potter, 2023). This outcome is achieved not by relying on a single mode or provider, but through the intelligent and dynamic orchestration of multiple complementary transport services, precisely configured according to users' preferences and real-time requirements. As a digital aggregator and orchestrator, MaaS thus facilitates enhanced customization, responsiveness, and seamless multimodality or intermodality, aligning the supply of mobility services much more closely with actual demand (Enoch and Potter, 2023; Hensher et al., 2023). This vision is powerful, as it not only redefines how users experience and consume mobility, but also transforms the broader transportation ecosystem by fostering a system-level approach grounded in integration, interoperability, and collaboration among all involved actors (Kamargianni and Matyas, 2017). Hence, MaaS is far more complex than a digital application (Hensher et al., 2020). Its realization requires a careful balance between user-centered service design – adapted to contextual specificities –, sophisticated technological infrastructure, and effective governance structures that can support collaboration across the ecosystem, while also ensuring the service's long-term economic viability (Krauss et al., 2022; Hensher et al., 2021; Kandanaarachchi et al., 2024). Unpacking these interdependencies reveals the inherently multidimensional nature of MaaS and underscores the

significant challenges associated with implementing and scaling such systems. To fully capture the complexity of MaaS – and to move beyond superficial or fragmented analyses – it becomes essential to systematically examine the distinct yet interrelated dimensions that collectively define its functioning. Indeed, no single component can adequately explain the functioning or the success of MaaS in isolation. Rather, it is only through the combined assessment of these critical dimensions that one can genuinely understand the mechanisms underlying MaaS, and subsequently develop rigorous tools for describing, classifying, and consistently evaluating diverse MaaS initiatives.

4.3.2. Research Gap

Several scholars have proposed conceptual and operational frameworks to classify and evaluate MaaS systems, yet existing approaches remain fragmented, each emphasizing distinct dimensions of MaaS without capturing its inherent multidimensionality in a comprehensive manner. One of the earliest and most influential contributions is by Jittrapirom et al. (2017), who identified nine foundational characteristics of MaaS – such as integration of transport modes, tariff options, one platform, multiple actors, use of technology, demand orientation, registration requirement, personalization, customization – based on an extensive review of early definitions and initiatives. Subsequent research has expanded the scope of MaaS evaluation, though often focusing on singular or narrowly defined perspectives. Several studies have concentrated specifically on the technical and functional aspects of MaaS platforms. For example, Sochor et al., (2018) proposed a four-level integration framework to categorize MaaS schemes based on the degree of integration achieved – namely information, booking, ticketing, and payment, bundling of services, societal goals inclusion – highlighting the progressive steps required to move from basic information provision to fully integrated mobility services. However, this framework primarily

focuses on the value proposition of MaaS, classifying services according to the level of integration offered to end users. In a similar way, Lyons et al. (2019) introduced the Levels of MaaS Integration (LMI) taxonomy, a six-level framework ranging from no integration (Level 0) to full integration under all conditions (Level 5), which evaluates MaaS initiatives based on their degree of informational, operational, and transactional integration, as well as the cognitive effort required from users. Belossarov et al. (2023) propose a typology of MaaS systems based on operational features such as routing availability, booking and payment features, ticketing, and availability of supplementary services. Complementing this, Orozco-Fontalvo et al. (2024) propose the IMPReSS framework, a method that can be used to classify and compare MaaS systems based on six essential features: Information access, Multimodality, Payment, Reservation, Subscription, and Societal goals. The method is complemented by a “completeness score” that facilitates ranking MaaS systems based on their integration level and alignment with societal goals. Other scholars have emphasized broader impacts, particularly around inclusivity and sustainability. For instance, Dadashzadeh et al. (2022) introduced the MaaS Inclusion Index (MaaSINI), a framework designed to assess platforms in terms of accessibility and inclusivity towards vulnerable social groups. Their index specifically evaluates the digital accessibility, availability of suitable transport options, and inclusive data-sharing practices. Similarly, Muller et al. (2024) have adopted a holistic sustainability perspective, applying a STEEP (Social, Technical, Economic, Environmental, and Political) framework to assess the broader sustainability impacts of MaaS through simulation-based methodologies.

A considerable portion of existing literature has adopted ex-ante perspectives, primarily examining factors influencing MaaS readiness and adoption, rather than ongoing operational evaluation. Goulding and Kamargianni (2018) introduced the MaaS Maturity Index, a composite indicator assessing city-level readiness through dimensions such as data openness, citizen familiarity, policy

and regulation frameworks, transport infrastructure, and ICT availability. Aba and Esztergár-Kiss (2024) present the MaaS Readiness Index (MRI), which integrates technical readiness, policy support, and coopetition, and is operationalized through a carefully weighted set of indicators derived via a combination of Analytical Hierarchy Process (AHP) and Interpretive Structural Modeling (ISM) method. Finally, Núñez and Antoniou (2025) developed the MaaS Potential Index (MaaSPI), a scalable, data-driven evaluation framework examining dimensions such as governance, mobility supply, socio-demographic profiles, infrastructure access, and innovation, particularly emphasizing the Global South context.

Although these contributions significantly enrich our understanding of various enabling factors, barriers, and potential implementation scenarios, they often remain limited to ex-ante evaluations. Most existing frameworks provide minimal guidance on how to assess MaaS performance once operational, and they rarely facilitate ongoing monitoring, comparison, or benchmarking of diverse MaaS initiatives across contexts. Moreover, existing approaches typically privilege a single-stakeholder perspective – whether users, operators, or public institutions – rather than capturing the essential interdependencies among these actors. To overcome these limitations, we propose a multidimensional evaluation framework designed to reflect the complex interactions shaping the success and sustainability of MaaS initiatives.

4.3.3. A multidimensional framework for evaluating MaaS initiatives

We argue that a comprehensive evaluation of MaaS requires recognizing and integrating six interdependent dimensions, each of which plays a distinct yet interconnected role in shaping the design, implementation, and long-term viability of MaaS systems: technical, organizational, economic and financial, user, societal, and contextual (see Fig. 4.1 for reference). These dimensions serve

not only as analytical lenses but also as building blocks through which MaaS value is delivered, co-created, and captured (Teece, 2010).

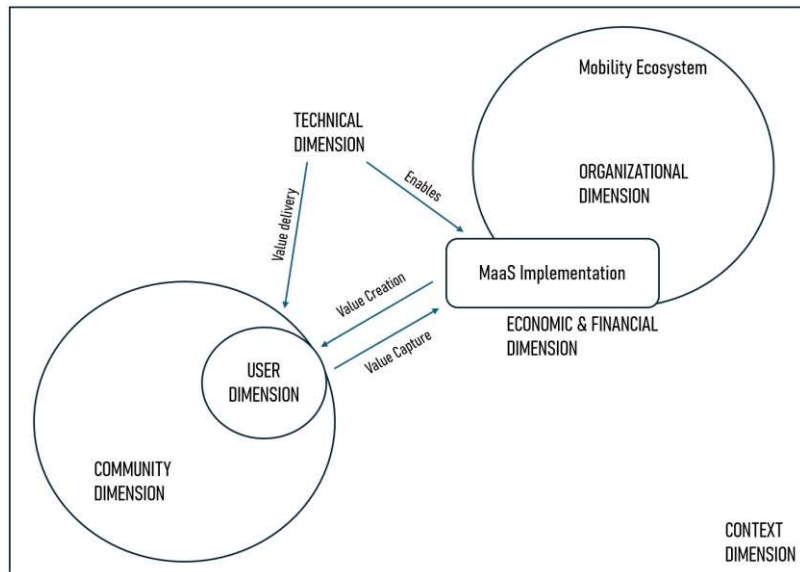


Figure 4.1 - Multidimensional nature of MaaS

The technical dimension refers to the technological infrastructure and capabilities essential for enabling MaaS systems (Jittrapirom et al., 2017; Harrison et al., 2020; Estzegar-Kiss et al., 2020). This includes digital platforms and back-end architectures supporting core functionalities such as journey planning, real-time information provision, booking, ticketing, and integrated payment systems. These functionalities rely on advanced algorithms capable of dynamically orchestrating multimodal transport options by matching users' preferences, contextual constraints (e.g., time, cost, accessibility), and real-time operational conditions (e.g., traffic, vehicle availability) (Jittrapirom et al., 2017; Sochor et al., 2018). Routing and recommendation engines continuously process large volumes of mobility data to propose optimized travel solutions, while pricing and bundling algorithms tailor fare options and mobility packages to individual user profiles and preferences (Maas, 2022). Moreover, these digital infrastruc-

tures typically depend on interoperable Application Programming Interfaces (APIs) and established data-sharing protocols to ensure seamless integration among diverse transport service providers (Kamargianni and Matyas, 2017). Although early MaaS implementations such as WienMobil demonstrated that MaaS could be introduced without extensive technological backbones, robust technology remains a fundamental enabler for achieving scalability, integration, and personalized user experiences (Mulley, 2017; Hensher et al., 2020; Utrianen and Pollanen, 2018).

Closely connected is the organizational dimension, which encompasses the governance structures, stakeholder roles, and coordination mechanisms essential for implementing MaaS initiatives (Kamargianni and Matyas, 2017; Wong et al., 2019; Zhang and Zhang, 2021). Given the inherent complexity of MaaS ecosystems—often involving public authorities, private mobility providers, technology firms, and regulatory entities—this dimension specifically addresses how different actors negotiate responsibilities, share resources, and jointly manage MaaS services (Kandanaarachchi et al., 2024). Important issues include the nature and effectiveness of partnerships, contractual arrangements, data-sharing agreements, and ownership configurations (e.g., public-led, private-led, or hybrid) (Smith et al., 2018; Wong et al., 2019; Meng et al., 2020).

The economic and financial dimension explores the business and funding models underpinning MaaS schemes, addressing both the value created for users and the value captured by service providers (Krauss et al., 2022; Reck et al., 2020; Carbonara et al., 2024). This involves evaluating the attractiveness and affordability of MaaS offerings from a user standpoint, alongside the sustainability of revenue streams, pricing structures (such as pay-as-you-go vs. subscription-based bundles), cost efficiencies, and strategies for revenue sharing among stakeholders (Polydoropoulou et al., 2020). A critical challenge here lies in identifying economic models that are viable in the long term and compelling for

both users and partners, ensuring equitable and sustainable value distribution across the entire MaaS ecosystem (Aapaoja et al., 2017; König et al., 2016). Ultimately, the scalability and enduring success of MaaS depend on effectively solving this multifaceted value equation (Krauss et al., 2022).

Integral to these dimensions is the user dimension, which emphasizes the importance of understanding individual users' needs, preferences, behaviours, and overall experiences with MaaS (Lyons et al., 2019; Fioreze et al., 2019; Ho et al., 2018). MaaS schemes that fail to resonate meaningfully with their users – or lack sufficient levels of personalization, convenience, and reliability – will face adoption challenges regardless of their technical sophistication or governance structures (Lyons et al., 2019). Hence, this dimension assesses how MaaS interacts with its users, influences their travel behaviour, and delivers tangible value, notably in terms of ease-of-use, flexibility, trustworthiness, satisfaction, willingness-to-pay, and potential shifts toward more sustainable mobility patterns (Ho et al., 2018; Reck et al., 2020).

Moving beyond individual-level impacts, the societal (or community) dimension considers broader consequences of MaaS for communities and society at large (Eckhardt et al., 2020; Dadashzadeh et al., 2022; Whitmore et al., 2022). It evaluates whether MaaS initiatives positively contribute to societal objectives such as reducing congestion, lowering emissions, increasing accessibility and inclusivity, and improving public health and well-being (Sochor et al., 2018; Orozco-Fontalvo et al., 2024). In essence, a MaaS system that optimizes individual user experience yet fails to deliver socially equitable or environmentally sustainable outcomes would be insufficient from a systemic perspective (Hensher et al., 2020).

Finally, the contextual dimension acknowledges that MaaS implementations are deeply embedded in specific local and regional contexts, shaped by policy frameworks, legal conditions, existing transport infrastructures, cultural

norms, and societal attitudes (Karlsson et al., 2019; Pangbourne et al., 2020; Goulding and Kamargianni, 2018; Butler et al., 2021). This dimension captures the contextual enablers and barriers that condition MaaS feasibility and effectiveness.

Together, these dimensions constitute a comprehensive analytical framework through which MaaS schemes can be systematically analysed, benchmarked, and evaluated. In the following sections, we detail the operationalization of this framework and demonstrate its application to the benchmarking of current MaaS initiatives.

4.4. *Methods*

Given the multidimensional nature of MaaS systems, a traditional single-criterion analysis and evaluation approach would be insufficient to capture their inherent complexity. We therefore adopt a Multiple Criteria Decision Analysis (MCDA) methodology, which explicitly considers multiple and potentially conflicting evaluation criteria simultaneously, enabling a structured and transparent assessment of alternatives (Greco et al., 2016). MCDA techniques have been extensively applied in the transportation field, as this domain frequently involves complex, multi-stakeholder objectives and requires balancing trade-offs among technical, social, environmental, and economic factors (Yannis et al., 2020). Compared to conventional approaches like cost-benefit or cost-effectiveness analyses, MCDA is more flexible and inclusive, especially in situations involving data constraints, non-monetizable outcomes, or divergent stakeholder interests (Karleuša et al., 2013; Pérez et al., 2015). These features make MCDA particularly suitable for assessing complex and innovative mobility solutions such as MaaS (Basbas and Makridakis, 2007; Stewart, 1992).

In this study, we operationalize the MCDA approach by combining two well-established techniques: the Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). AHP is a structured technique for organizing and analysing complex decisions through a hierarchical decomposition of a problem (Saaty, 1980). It relies on pairwise comparisons to derive priority scales, enabling the quantification of subjective preferences across multiple criteria. Decision-makers are asked to assess the relative importance of elements with respect to higher-level objectives, using a consistent verbal-to-numerical scale that captures subjective judgments. These comparisons are then synthesized into a set of priority weights, typically computed through the principal eigenvalue method (Ishizaka and Labib, 2011). In this study, AHP is primarily used to determine the weights of the evaluation dimensions within the proposed framework. Specifically, we apply a two-level AHP structure (Ortega et al., 2023), where experts assess the relative importance of six key dimensions – Technical, Organizational, Economic and Financial, User, Societal, and Contextual – in shaping the success of MaaS implementations, as well as the relative importance of the descriptors within each dimension. This weighting process ensures that the evaluation model reflects the value judgments and priorities of key stakeholders, thus grounding the framework in both practical relevance and theoretical rigor (Greco et al., 2025). Building on this weighting structure, we apply TOPSIS to benchmark real-world MaaS initiatives. TOPSIS is based on the principle that the most desirable alternative is the one closest to an ideal solution – defined here as a hypothetical configuration representing optimal performance across all criteria (Hwang and Yoon, 1981). By computing the geometric distance of each initiative from this ideal reference, we obtain a closeness score reflecting their relative performance and facilitating structured comparative assessments. This method is particularly suited to our framework because it accommodates both quantitative and qualitative indicators and provides an intuitive and scalable assessment of

performance (Greco et al., 2025). Importantly, it relies on a compensatory logic, whereby weaknesses in one dimension may be offset by strengths in others, which is especially useful for comparing diverse MaaS initiatives and facilitates a more nuanced discussion of trade-offs and improvement priorities in the results. The combined AHP–TOPSIS approach is well-established in transportation literature, often applied to leverage the strengths of both methods – AHP for deriving weights and TOPSIS for ranking alternatives (e.g., Shelton and Medina, 2010; Benallou et al., 2023). Consistent with methodological best practices, we carefully align the AHP-derived weights with the aggregation requirements of TOPSIS. The following sections provide a detailed description of the methodology adopted in this study.

4.4.1. Framework development

The development of the evaluation framework was structured through a three-phase process, combining systematic academic research, insights from grey literature, and expert judgments to ensure both theoretical rigor and practical relevance (see Figure 4.2). These phases were not entirely sequential but rather iterative, allowing for continuous refinement of the framework as new insights emerged (Arksey and O’Mulley, 2005). In Phase 1, we conducted a scoping review to gain a fundamental understanding of the MaaS concept and its inherent complexity. We used Scopus as the primary database and employed the following search string: "Mobility as a Service (MaaS)" OR "mobility-as-a-service (MaaS)", which yielded over 800 documents. From these, we selected and reviewed in-depth the 40 most cited papers to ensure coverage of the most influential scholarly contributions. To further enrich the analysis, we examined the bibliographies of these papers, identifying an additional 27 relevant documents. This process ultimately resulted in a corpus of 67 scientific papers and one academic book, of which 56 were peer-reviewed journal articles

and 11 were conference proceedings. Through this review, we synthesized an initial conceptual framework composed of six key dimensions deemed critical for assessing MaaS success: Technical, Organizational, Economic and Financial, User, Societal, and Contextual.

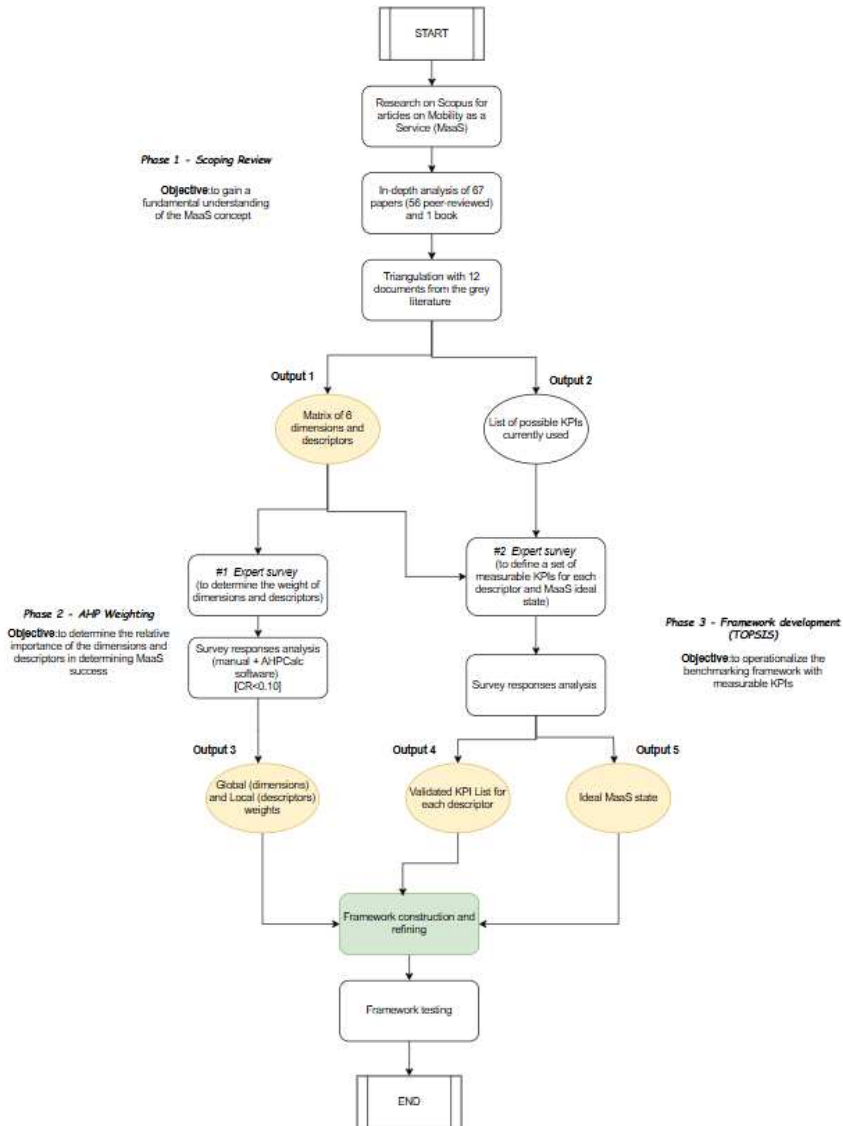


Figure 4.2 - Graphic representation of the framework development process

In Phase 2, we sought to deepen the characterization of each dimension by systematically extracting and mapping the specific aspects or themes that consistently emerged in the literature as critical. These aspects, referred to as descriptors, serve to operationalize the dimensions into observable and evaluable categories. To broaden the perspective and address potential gaps in the academic literature, we triangulated our findings with insights from white papers, technical reports, and grey literature produced by recognized mobility organizations and industry actors. In total, 12 additional documents were incorporated, resulting in 79 documents analysed overall. This triangulated approach strengthened the robustness of the framework by integrating both scholarly and practitioner viewpoints. Table 4.1 presents the six dimensions alongside the corresponding descriptors identified through this phase. Building on this foundation, we applied the AHP technique, supported by a survey administered to a panel of experts, to determine the relative weight of each dimension and descriptor in influencing MaaS success. The detailed procedure of the AHP application is explained in the following subsection.

Finally, in Phase 3, we defined a set of specific indicators (KPIs) for each descriptor to enable the empirical measurement and benchmarking of MaaS initiatives. Indicators are quantifiable or clearly observable variables that translate abstract descriptors into concrete metrics, allowing for consistent and systematic assessments across different cases (Kaplan and Norton, 1996; Harrington, 1991). Their identification is essential to operationalize the framework and ensure its practical usability. We adopted a two-step approach: first, we developed a preliminary list of indicators based on their theoretical relevance in the academic and grey literature; second, we validated and refined this list through a second survey administered to a panel of experts in urban mobility, transportation planning, and MaaS development. This iterative validation ensured that the selected indicators were both theoretically sound and practically meaningful for decision-makers. In total, two expert surveys were conducted at different

stages: the first to support the weighting of dimensions and descriptors using AHP, and the second to validate and refine the set of operational indicators, ensuring that the framework is both conceptually robust and practically applicable.

4.4.1. Weighting of Dimensions using AHP

We employed the Analytic Hierarchy Process (AHP) to determine the relative importance of the dimensions and descriptors within our framework. AHP is particularly well-suited to this purpose, as it systematically translates expert judgments into quantitative weights, enabling rigorous prioritization of dimensions that are often qualitative or abstract in nature. Its pairwise comparison approach is especially valuable in the MaaS context, where evaluation criteria are diverse and stakeholder perspectives may diverge. This method helps structure complex assessments, promotes consistency, and enhances the transparency and replicability of the weighting process (Saaty, 1980; Ishizaka and Labib, 2011). Specifically, we applied a two-level AHP approach (Ortega et al., 2023), first weighting the six overarching dimensions – Technical, Organizational, Economic and Financial, User, Societal, and Contextual – and then their underlying descriptors. The primary goal of this application was to quantify the relative influence of each dimension and descriptor on MaaS success, ensuring that the framework reflects the nuanced judgments of domain experts. To this end, we designed and administered a structured survey targeting a broad panel of 171 experts, including scholars, practitioners, and entrepreneurs in the MaaS and mobility sectors. We received 22 completed responses, yielding a response rate of approximately 13%, in line with the 10–15% threshold often considered highly satisfactory in expert surveys (Baruch and Holtom, 2008).

Table 4.1 – Framework definition

Dimension	Definition	Descriptors		Main References
Technical Dimension	Covers the technological backbone of MaaS, including data management, platform architecture, system interoperability, and the operational performance of integrated transport services. This dimension assesses the ability of MaaS platforms to deliver seamless, reliable, and scalable multimodal solutions.	(a) Data Management	Refers to the processes and systems for collecting, integrating, storing, securing, and utilizing mobility-related data to enable seamless operations, user services, and analytics within MaaS platforms.	Jittrapirom et al., 2017; Esztergar-Kiss et al., 2020; Maas, 2022; Harrison et al., 2020; Giesecke et al., 2016
		(b) Platform Design	Encompasses the architecture, functionalities, user interface, and technical interoperability of the MaaS platform, ensuring smooth integration of multiple services and ease of use for end-users.	
		(c) Software and Update Maintenance	Addresses the ongoing management, updating, and technical support of the MaaS software infrastructure to ensure reliability, security, and continuous improvement over time.	
Organizational Dimension	Examines the governance structures, stakeholder roles, and coordination mechanisms that underpin MaaS initiatives. It focuses on how actors—public authorities, private providers, and intermediaries—collaborate, share responsibilities, and adapt organizationally to support	(d) Governance Structure	Relates to the organizational model and decision-making framework governing the MaaS ecosystem, including leadership roles, accountability mechanisms, and coordination between actors.	Kamargianni and Matyas, 2017; Wong et al., 2018; Hensher, 2017; Karlsson et al., 2020; Wong et al., 2019; Meurs et al., 2020
		(e) Partnerships and Collaborations	Captures the extent, diversity, and quality of strategic alliances among stakeholders, such as public authorities, private operators, and technology providers, necessary to deliver integrated mobility services.	
		(f) Innovation	Refers to the MaaS initiative's capacity to adopt new technologies, business models,	

Reshaping Mobility through MaaS: Business Model Archetypes, Actor Dynamics, and System Success

	effective implementation and system evolution.	and Adaptability	and service features in response to evolving market demands, policy shifts, and user needs.	
Economic and Financial Dimension	Assesses the economic sustainability and financial logic of MaaS systems, including value propositions, revenue streams, pricing strategies, and investment models. This dimension aims to identify whether MaaS initiatives can achieve long-term viability and deliver value to both users and service providers.	(g) Value Proposition	Defines the unique bundle of benefits, convenience, and functionalities offered by the MaaS system to its users, aiming to address their mobility needs better than traditional or fragmented solutions.	Sochor et al., 2018; Reck et al., 2020; Utrianen and Pollanen, 2018; Ambrosino et al., 2016; Krauss et al., 2022; Polydoropoulou et al., 2020; König et al., 2016; Caiati et al., 2020
		(h) Revenue Streams	Identifies the mechanisms and sources through which the MaaS operator or ecosystem generates income, such as subscription fees, commissions, data monetization, or pay-per-use models.	
		(i) Pricing Strategy	Describes the approach adopted to set and structure user fees, fares, or packages within the MaaS system, balancing affordability, competitiveness, and economic viability.	
		(j) Economic Sustainability	Refers to the system's ability to maintain financial viability over time, covering operational costs, investments, and growth without relying on unsustainable subsidies or unprofitable models.	
		(k) Investments	Captures the scale, sources, and allocation of financial resources invested in the development, scaling, or improvement of the MaaS initiative.	
User Dimension	Focuses on the needs, preferences, behaviors, and experiences of MaaS users. It investigates whether MaaS	(l) User Segments	Relates to the identification and targeting of different user groups within the MaaS market, considering factors such as demographics, mobility needs, digital literacy, and preferences.	Lyons et al., 2019; Guidon et al., 2020; Ho et al., 2018;
		(m) User	Measures the degree to which MaaS users perceive the service as meeting or	

	platforms meet user expectations, improve convenience, and influence travel choices and mode shifts, ultimately shaping user satisfaction, retention, and behavioral change.	Satisfaction	exceeding their expectations regarding quality, convenience, reliability, and value.	Jittrapirom et al., 2020; Storme et al., 2020
		(n) User Retention	Refers to the system's capacity to maintain active users over time, minimizing churn and building loyalty through continuous engagement and service improvement.	
		(o) User Habits	Explores the behavioral patterns of MaaS users, including their modal choices, trip purposes, frequency of use, and openness to multimodal travel facilitated by MaaS.	
Societal Dimension	Analyzes the broader societal and environmental effects of MaaS, such as its contributions to sustainability, social inclusion, equity, accessibility, and urban livability. This dimension highlights the extent to which MaaS initiatives align with public policy goals and generate positive externalities.	(p) Environmental Impact	Assesses the MaaS initiative's contribution to reducing emissions, energy consumption, and other negative environmental externalities associated with urban mobility.	Becker et al., 2020; Whitmore et al., 2022; Merkert and Wong, 2020
		(q) Social Impact	Refers to the broader societal effects of MaaS, including implications for accessibility, equity, inclusiveness, and social cohesion in urban and peri-urban contexts.	
Contextual Dimension	Accounts for the local and regional conditions that shape MaaS implementation, including regulatory frameworks, transport and digital infrastructure, cultural factors, urban form, and	(r) Transportation Infrastructure	Captures the physical mobility assets (e.g., roads, public transit networks, stations) available in the deployment area that enable the functioning and integration of MaaS services.	Butler et al., 2021; Pangbourne et al., 2020; Goulding and Kamargianni, 2018; Smith et
		(s) Technological Infrastructure	Relates to the underlying digital and communication technologies (e.g., mobile networks, payment systems, IoT) that support MaaS operations, data exchanges, and user interfaces.	

Reshaping Mobility through MaaS: Business Model Archetypes, Actor Dynamics, and System Success

	demographic dynamics. This dimension ensures that the framework remains sensitive to the variability and specificity of different implementation contexts.	(t) Social and Cultural Environment	Describes the prevailing social norms, cultural attitudes toward shared mobility, and public acceptance of digital platforms, which can influence MaaS adoption and use.	al., 2019; Mukhtar-Landgren et al., 2016
		(u) Legal Environment	Encompasses the regulatory and policy frameworks that govern MaaS implementation, including licensing, data protection, competition law, and mobility service regulations.	
		(v) Urbanization / Population	Captures the characteristics of the urban and demographic context where MaaS is implemented, including population density, urban form, and spatial patterns influencing mobility demand.	

The survey was organized into three main sections. The first section presented an overview of the study's objectives and explained the purpose of the framework, followed by clear and accessible descriptions of each of the six dimensions to ensure a shared understanding among participants. In the second section, participants completed the first set of pairwise comparisons, evaluating the relative importance of the six dimensions (requiring 15 comparisons, based on the formula $n(n-1)/2$). In the third and final section, participants performed pairwise comparisons of the descriptors within each dimension. We employed the classic Saaty verbal scale (Saaty, 1980), which allows participants to express preferences on a 1–9 scale: 1 for equal importance, 3 for moderate importance, 5 for strong importance, 7 for very strong importance, and 9 for extreme importance, with even numbers serving as intermediate values. These qualitative judgments were then converted into numerical values for constructing the pairwise comparison matrices. For analysis, we followed the standard two-level AHP procedure. At the first level, we aggregated expert judgments into a group matrix, computed the principal eigenvector, and assessed the consistency ratio (CR) to ensure coherent judgments concerning the weights of the 6 identified dimensions (Saaty, 1980; Ishizaka and Labib, 2011). At the second level, we calculated the local weights of the descriptors within each dimension and then multiplied these by the corresponding dimension weights to obtain their global priorities. To ensure data quality, we retained only responses with a CR below 0.10, as recommended in AHP applications. The CR is calculated by comparing the consistency index ($CI = [\lambda_{\max} - n]/[n - 1]$) against a random index (RI) representing the expected CI of a random matrix. Ultimately, 13 responses were included in the final analysis (7.6% of total). The relatively high exclusion rate can likely be attributed to the novelty and evolving nature of the MaaS field, where expert consensus is still developing and judgments across complex, interdependent criteria remain challenging. Finally, we cross-checked our manual calculations using AHPcalc software (Goepel, 2013), which validated the consistency.

cy ratios and derived priorities, strengthening the methodological robustness of the analysis.

4.4.2. Benchmarking and ranking using TOPSIS

To effectively benchmark MaaS initiatives, we integrated the AHP-derived weights into the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Hwang and Yoon, 1981). While AHP produces relative weights based on expert judgments, TOPSIS requires these weights as explicit importance coefficients applied to empirical performance data. To ensure methodological coherence, we normalized the global weights obtained from AHP to sum to unity. This normalization maintained consistency between the two methods, aligning with established practices in the MCDA literature (Yannis et al., 2020; Shelton and Medina, 2010). To identify suitable performance indicators for each descriptor within our evaluation framework, we administered a second survey to the same pool of 171 experts involved previously. The primary objective of this survey was to select the most relevant Key Performance Indicators (KPIs) to empirically assess each descriptor. The questionnaire was divided into six sections, each corresponding to a dimension, and respondents indicated which KPIs were crucial for capturing the descriptor's performance. A preliminary set of potential KPIs derived from our extensive review of academic and grey literature was provided, supplemented by open-ended fields to allow experts to propose additional metrics. In total, we received 33 responses to the survey (19%). Interestingly, very few respondents proposed new indicators, suggesting either that the predefined list was sufficiently comprehensive or that respondents preferred to work within the provided structure. The resulting KPIs spanned qualitative, quantitative, and binary (yes/no) variables. Additionally, experts specified their perceived ideal target value for each KPI in open-ended responses, which was critical for constructing the ideal reference points in TOP-

SIS (Hwang and Yeon, 1981). In analysing responses, we adopted a selection threshold to focus on the most broadly supported indicators. Specifically, we retained only those KPIs that were selected by at least 40% of respondents. This cutoff allowed us to prioritize indicators that achieved a reasonable degree of expert consensus, balancing comprehensiveness with parsimony. Including only the most frequently endorsed KPIs ensured the model's interpretability and minimized noise from marginal or overly specialized metrics. To define the ideal solution required by TOPSIS, we synthesized the directional insights offered by experts. For numerical KPIs, precise optimal values were established where feasible. However, many indicators were qualitative or ordinal, described with terms like "highest possible," "lowest possible," or "depends on context". For these, we defined directional anchors aligned with expert consensus: indicators with a positive direction (e.g., "number of services integrated") had ideals set at the highest level, whereas negative indicators (e.g., "average booking time") had ideals at the lowest possible level.

Once the KPIs and ideal solutions were established, we proceeded with the TOPSIS normalization and scoring process. Initially, KPI values were normalized to ensure comparability across different scales:

- Ordinal variables (e.g., High, Medium, Low) were normalized to numerical scores:

$$x_i^{norm} = \begin{cases} 1 & \text{if High (optimal direction)} \\ 0.5 & \text{if Medium} \\ 0 & \text{if Low (least optimal direction)} \end{cases}$$

- Quantitative (numeric) variables were normalized using min-max normalization:

$$x_{ij}^{norm} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}$$

where x_{ij} is the observed KPI value for alternative i , and $\min(x_j)$, $\max(x_j)$ are the minimum and maximum possible values, respectively, for KPI j .

- Binary variables were normalized straightforwardly as:

$$x_{ij}^{norm} = \begin{cases} 1 & \text{if Yes} \\ 0 & \text{if No} \end{cases}$$

The ideal value for each normalized KPI was consequently set to 1, indicating maximum desired performance or full compliance with the descriptor's optimal condition. For descriptors described by multiple KPIs (each capturing distinct facets), we calculated an average normalized descriptor score:

$$\overline{x_{id}} = \frac{1}{m_d} \sum_{j=1}^{m_d} x_{idj}^{norm}$$

where $\overline{x_{id}}$ is the average normalized score for descriptor d of alternative i , and m_d is the number of KPIs under descriptor d . Including multiple KPIs for each descriptor enhances the robustness of the evaluation by mitigating potential biases associated with any single indicator, improving the reliability of the measurement, and better capturing the multidimensional complexity of each evaluation domain (OECD, 2008). Furthermore, the linear aggregation employed is consistent with established best practices in the construction of composite indicators (OECD, 2008; Greco et al., 2019) and serves two main methodological purposes. On the one hand, it helps smoothing out random variability that may arise from individual indicators; on the other, it promotes a balanced representation of the multidimensional aspects captured by the set of indicators (Greco et al., 2019). These averaged descriptor scores were then weighted by their relative importance obtained from AHP:

$$S_{id} = w_d \times \overline{x_{id}}$$

where S_{id} is the weighted score of descriptor d for alternative i , and w_d is the global AHP-derived weight for descriptor d .

The final weighted score for each dimension was computed as the sum of its weighted descriptors:

$$S_{ik} = \sum_{d \in k} S_{id}$$

where S_{ik} represents the score of alternative i on dimension k .

In the ideal solution scenario, each descriptor reaches its maximum (normalized value equals 1). Thus, the ideal dimensional score S_k^* corresponds exactly to the AHP-derived weight of the dimension itself, as descriptor weights collectively sum to their dimension's global weight. Finally, the benchmarking process required calculating the Euclidean distance of each real-world alternative from this ideal configuration. For each alternative i , the Euclidean distance to the ideal solution (D_i^*) was calculated as:

$$D_i^* = \sqrt{\sum_{k=1}^n (S_{ik} - S_k^*)^2}$$

Where n is the total number of dimensions, S_{ik} the observed score of alternative i on dimension k , and S_k^* the ideal score of dimension k . We adopted the Euclidean distance (L2 norm) to calculate the distance of each alternative from the ideal solution, in line with the original formulation of TOPSIS proposed by Hwang and Yoon (1981). While alternative distance metrics such as the Manhattan (L1 norm) or Chebyshev (L^∞ norm) distances could be employed (Greco et al., 2025), the Euclidean distance was selected for its widespread use in MCDA applications, its straightforward geometric interpretation, and its compatibility with the compensatory logic underpinning TOPSIS.

Finally, to normalize these distances into a comprehensible benchmarking score, we computed a closeness coefficient (C_i) for each alternative:

$$C_i = 1 - \frac{D_i^*}{D_{max}}$$

where D_{max} is the maximum observed distance among all alternatives. This yields a standardized ranking metric ranging from 0 to 1, where a higher closeness coefficient indicates superior performance and closer proximity to the ideal MaaS configuration.

4.4.3. Data Collection

To apply and test the proposed evaluation framework, we collected empirical data on ten MaaS implementations worldwide. These cases were purposefully selected to represent a diverse mix of public-sector projects, private-sector initiatives, and hybrid deployments by MaaS companies. Our selection criteria prioritized (1) the availability of robust secondary data (e.g., project documentation, company reports, public evaluations), (2) the prominence or recognition of the MaaS initiative within the field (ensuring relevance and visibility), and (3) geographical diversity, so as to capture a broad range of contextual conditions and market environments.

The data collection process primarily relied on secondary sources. Specifically, we gathered information from official project documentation, company reports, evaluation studies, white papers, press releases, and other publicly available materials. We systematically gathered and compiled the relevant information for each case, focusing on the indicators specified in our framework. All collected data were organized in a dedicated Excel database, which allowed us to efficiently process, normalize, and compare the cases using the AHP-TOPSIS procedure described in the preceding sections. This structured approach

ensured that data processing and benchmarking could be performed in a streamlined and replicable manner. Table 4.2 summarizes the ten MaaS cases included in the study, reporting key descriptive information for each initiative, including the name of the MaaS initiative, the country or region of deployment, the leading actor(s) involved, and the current deployment stage.

4.1. Results

4.1.1. Weighting results

The weighting results presented in this subsection were derived from the expert survey conducted using the AHP, as described in Section 3.2. The resulting weights (see Figure 4.3) reflect collective expert perceptions regarding which factors are most critical to determining the overall success of MaaS implementations. We argue that these priorities closely mirror the prevailing discussions and insights emerging from both academic research and practical experiences in the MaaS domain.

The results indicate that experts attribute the greatest importance to the Contextual Dimension (21.14%), highlighting the critical role of local and regional conditions – such as transportation infrastructure, technological maturity, regulatory frameworks, and socio-cultural environments – in shaping MaaS implementations. The high relevance attributed to this dimension aligns with established knowledge in MaaS research, which emphasizes that the feasibility, scalability, and adoption of MaaS solutions are highly contingent on contextual enablers and constraints (Hensher et al., 2021; Smith and Hensher, 2020; Hensher et al., 2020).

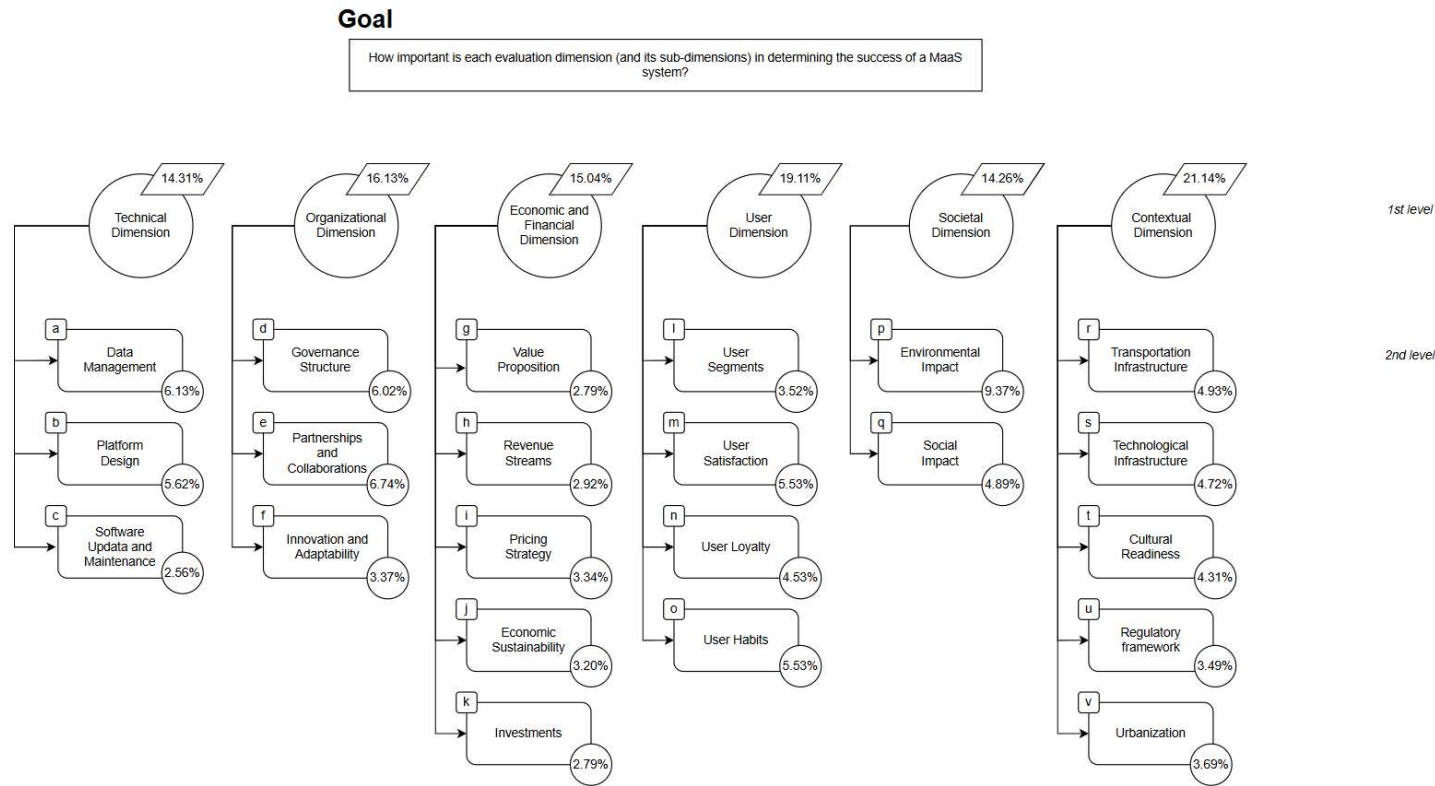
Table 4.2 - Real-world MaaS implementations analysed

#	Name of company / MaaS initiative	Country	Leading actor(s)	Status	Launch year
1	Whim	Finland (EU)	Private (MaaS Global)	Terminated	2016
2	Uber	Denver (USA)	Private	Operating	2019
3	Citymapper	London (UK)	Private	Terminated	2014 (as app) → 2019 (pass)
4	Jelbi	Berlin (EU)	Public-Private	Operating	2019
5	Ubigo	Stockholm (EU)	Public-Private	Operating	2013 (pilot) → 2019 relaunch
6	Glimble	Netherlands (EU)	Private	Operating	2021
7	iMove	Sydney (Australia)	Public-Private	Terminated	2019
8	Zipster	Singapore	Private	Terminated	2019
9	TOMove (MaaS4Italy)	Turin (EU)	Public-Private	Operating	2022
10	EMT Madrid	Madrid (EU)	Public	Operating	2018

The User Dimension, with the second-highest weight (19.11%), confirms the centrality of user acceptance, satisfaction, and behavioural adaptation in determining the success and long-term sustainability of MaaS services. This finding is consistent with prior literature underscoring that MaaS solutions must be designed around user needs, preferences, and travel habits to foster adoption and sustained use (Utriainen and Pöllänen, 2018). Notably, the prioritization of the Contextual and User dimensions together reflects that MaaS success fundamentally depends on both the uptake by users and the system's capacity to influence travel behaviour – factors that are inherently shaped by the broader cultural, institutional, and infrastructural context in which MaaS operates (Sochor et al., 2018; Lyons et al., 2019).

In particular, cultural attitudes toward shared mobility, trust in digital platforms, and openness to data sharing vary across regions and directly affect user willingness to adopt MaaS offerings (Mulley, 2017; Lyons et al., 2019). The Organizational dimension emerged as the most important factor (16.13%) after the Contextual and User dimensions, reflecting experts' recognition of its pivotal role in MaaS development. Indeed, the formation and consolidation of MaaS systems inherently depend on building effective partnerships and establishing collaborative governance structures among multiple stakeholders (Kamargianni and Matyas, 2017; Kandanaarachchi et al., 2024). However, achieving such collaboration is far from straightforward: MaaS ecosystems typically bring together diverse actors, each with distinct, and sometimes conflicting, goals, priorities, and competitive interests (Hensher et al., 2020). Aligning these actors around shared objectives requires overcoming institutional silos, negotiating power asymmetries, and building mutual trust – challenges that are well-documented in the MaaS governance literature (Pangbourne et al., 2020; MaaS Alliance, 2017). Similarly, the Economic and Financial dimension underscores the necessity for MaaS providers to achieve economic sustainability while delivering value to users.

Figure 4.3 – AHP Results



Experts' weighting of this dimension (at the fourth place, with 15.04%) signals awareness that MaaS models must balance affordability, revenue generation, and long-term financial viability – a challenge that remains at the forefront of MaaS research and practice. The pivotal role of business models in shaping MaaS sustainability and growth is widely recognized in both academic literature (Krauss et al., 2022; Polydoropoulou et al., 2020) and industry insights, highlighting the ongoing need for MaaS operators to define viable value propositions, pricing strategies, and revenue mechanisms. The Technical Dimension, although foundational for MaaS operations, ranked lower (14.31%), likely reflecting an assumption among experts that technological aspects, while necessary, are increasingly standardized and less differentiating across various MaaS initiatives (Maas, 2022; Harrison et al., 2020). Lastly, the relatively lower weighting assigned to the Societal Dimension (14.26%) suggests that, while the broader social and environmental impacts of MaaS – such as promoting sustainability, equity, and inclusivity – are recognized as important long-term objectives, they are perceived by experts as indirect outcomes rather than immediate operational priorities. This interpretation aligns with the idea that achieving societal benefits is contingent on first establishing a well-functioning and adopted MaaS system (Sochor et al., 2018; Merkert and Wong, 2020; Ambrosino et al., 2016).

As for descriptors in the Technical dimension, experts placed the greatest emphasis on Data Management (6.13%), recognizing the central role of robust data handling, integration, and security in enabling effective MaaS operations. This finding resonates with prior research underscoring data as the 'backbone' of MaaS platforms (Jittrapirom et al., 2017). Platform Design followed closely (5.62%), suggesting that user interface quality and system usability are also viewed as essential for driving adoption. In contrast, Software and Update Maintenance received lower weight (2.56%), likely reflecting its characterization as an operational rather than a strategic concern in the experts' judgment.

Within the Organizational Dimension, the highest weight was allocated to Partnerships and Collaborations (6.74%) and Governance Structure, confirming the widely acknowledged challenge of orchestrating multi-actor ecosystems in MaaS development (Kamargianni and Matyas, 2017). Instead, Innovation and Adaptability received comparatively less emphasis (3.37%). As for the Economic and Financial Dimension, the distribution of weights was relatively balanced across descriptors, with Pricing Strategy (3.34%) and Economic Sustainability (3.20%) receiving marginally higher importance. In the User Dimension, experts clearly prioritized factors related to user experience, with User Satisfaction and User Habits each receiving 5.53%. User Retention (4.53%) also received notable attention, while User Segments (3.52%) was relatively less emphasized. The Societal Dimension showed a clear preference for Environmental Impact (9.37%) over Social Impact (4.89%), reflecting current policy discourses and public expectations that MaaS should contribute meaningfully to environmental sustainability goals. Finally, the Contextual Dimension exhibited a relatively even distribution across its descriptors. Transportation Infrastructure (4.93%) and Technological Infrastructure (4.72%) were slightly prioritized, highlighting the foundational role of infrastructural readiness in enabling MaaS deployments. Meanwhile, Social and Cultural Environment (4.31%), Urbanization and Population Density (3.69%), and Legal Environment (3.49%) were also recognized as important contextual factors, albeit to a lesser extent. This pattern suggests that experts view MaaS success as deeply intertwined with a constellation of enabling conditions, reinforcing the idea that no single contextual factor acts in isolation but rather interacts with others to shape implementation feasibility (Butler et al., 2021).

4.1.2. *KPI results and Ideal MaaS*

To operationalize our evaluation framework and enable the empirical assessment of MaaS implementations, we conducted a dedicated survey to identify the most relevant Key Performance Indicators (KPIs) for each descriptor. The results of this process are summarized in Table 4.3, which presents the finalized set of KPIs for each descriptor, along with their ideal target values for benchmarking purposes.

4.1.2.1. *Technical Dimension*

From a technical perspective, an ideal MaaS is characterized by a robust, standardized, and interoperable data infrastructure. It ensures the presence of standardized data formats, facilitating seamless integration across transport operators, and guarantees API compatibility to support real-time data exchange with external systems. Moreover, it embraces open data availability, aligning with prevailing principles of transparency and interoperability advocated in the mobility ecosystem literature. The ideal platform also maximizes user convenience and accessibility by supporting all major payment methods – credit and debit cards, e-wallets, and SMS payments – ensuring that users encounter no barriers in completing transactions. Additionally, it provides real-time information updates and achieves an average booking time of less than one minute. This threshold aligns with insights from digital usability research, which indicates that booking times exceeding one minute are likely to increase user frustration and abandonment rates (Wickens et al., 2021). In terms of system performance, the ideal MaaS maintains a system uptime approximately of 99.9%, reflecting high service reliability consistent with industry benchmarks. Finally, it sustains a balance between continuous improvement and operational stability by offering regular, yet manageable, software updates – targeting approximately one to two updates per month – to promote system evolution without disrupting platform operations.

Table 4.3 - Definition of KPIs and their thresholds

Dimension	Descriptors	KPIs	Threshold	Ideal
Technical	a) Data Management	Presence of data analytics capabilities	Yes/No	Yes
		Presence of standardized data formats	Yes/No	Yes
		API compatibility	Yes/No	Yes
		Available open data	Yes/No	Yes
	b) Platform Design	Number of payment methods	All (3), Some (2), One (1) with All = credit/debit + e-wallets + SMS	All
		Real Time information provision	Yes/No	Yes
		Average time take to complete a booking	Low <1min, Medium 1-2min, High >2min	Low
	c) Software updates / Maintenance	Number of updates per month	Very frequent >2, Average 1–2, Low <1	Average
		System uptime percentage	High >99.9%, Medium 99–99.9%, Low <99%	High
Organizational	d) Governance structure	Diversity of stakeholders included	High (public + private + NGOs/users), Medium (2 types), Low (1 type)	High
		Stakeholder role clarity	High (formalized), Medium (partially formal), Low (unclear)	High
	e) Partnerships and	Total number of partnerships	High >10, Medium 5–10, Low <5	High

	collaboration	Number of joint projects with partners	High >4/year, Medium 2–4/year, Low <2/year	High
	f) Innovation / Adaptability	Percentage increase in the range of services or geographical coverage	High >20%/year, Medium 10–20%/year, Low <10%/year	High
Economic and Financial	g) Value proposition	Service Integration	Levels 1–4	4
		Number of services integrated	High >5, Medium 3–5, Low 1–2	High
		Presence of incentives for users	Yes/No	Yes
		Personalization / Customization	Yes/No	Yes
		Number of cities / region covered by platform	High (national/international), Medium (regional), Low (single city)	High
	h) Revenue streams	Diversity of revenue streams	High ≥ 4 , Medium 2–3, Low 1	High
	i) Pricing strategy	Presence of dynamic pricing	Yes/No	Yes
		Presence of personalized pricing	Yes/No	Yes
	j) Economic sustainability	ROI/ROA, ROE	High >15%, Medium 5–15%, Low <5%	High
		EBIT	Positive / Negative	Positive
		Average cost per user	Low <€10/month, Medium €10–30, High >€30	Low
	k) Investments	Total investments in service development on	High >15%, Medium 5–15%, Low <5%	High

Reshaping Mobility through MaaS: Business Model Archetypes, Actor Dynamics, and System Success

		turnover		
User	l) User segments	Market is segmented	Yes/No	Yes
	m) User Satisfaction	Average rating of the app	High 4.5–5, Medium 3.5–4.4, Low <3.5	High
	n) User Loyalty / Retention	Percentage of new users who join based on referral	High >30%, Medium 10–30%, Low <10%	High
		Percentage of users who continue to use the service after the first month	High >50%, Medium 30–50%, Low <30%	High
	o) User Habits	Percentage of active users	High >60%, Medium 30–60%, Low <30%	High
		Number of new users registration per month	High >1,000, Medium 100–1,000, Low <100	High
		Incentives to change habits	Yes/No	Yes
Societal	p) Environmental Impact	Decrease in carbon emissions	Yes/No	Yes
		Decrease in number of trips by single-occupancy vehicles	Yes/No	Yes
		Decrease in congestion	Yes/No	Yes
	q) Social Impact	Improvements in safety	Yes/No	Yes
		Impact on rural or disadvantaged users	Yes/No	Yes

Contextual	r) Transportation Infrastructure	Transport Readiness	Yes/No	Yes
	s) Technological Infrastructure	Technological Readiness	Yes/No	Yes
	t) Social and Cultural Environment	Cultural Readiness	Yes/No	Yes
	u) Legal Environment	Regulatory framework	Yes/No	Yes
	v) Urbanization / Population	Percentage of target population that has adopted MaaS	High >50%, Medium 20–50%, Low <20%	High

All KPIs in this dimension are directly measurable through observable system characteristics or publicly available service specifications, allowing for objective evaluation of a platform's technical readiness.

4.1.2.2. Organizational Dimension

For the Organizational Dimension, the ideal MaaS is characterized by strong stakeholder engagement and an organizational structure designed to foster collaboration, coordination, and adaptability. The original conceptualization of MaaS has consistently emphasized the necessity of building a diverse, multi-actor coalition to make the system operable and deliver an integrated, high-value service offering (Kamargianni and Matyas, 2017; Jittrapirom et al., 2017). The KPIs identified within this dimension operationalize this foundational principle by translating the abstract notion of 'collaboration' into measurable organizational attributes. Specifically, indicators such as 'Diversity of stakeholders included' and 'Stakeholder role clarity' capture not only the breadth of actor involvement but also the extent to which governance roles and responsibilities are formalized. Likewise, the 'Total number of partnerships' and 'Number of joint projects per year' provide tangible measures of partnership density and collaborative activity, offering insight into how cooperation is structured and enacted in practice. These KPIs are observable and measurable with data retrievable from official project reports, public documentation, policy briefs, or company websites, thereby ensuring feasibility for secondary data analysis. In particular, stakeholder role clarity can be proxied through the existence of formal governance documents – such as contracts, Memorandums of Understanding (MoUs), consortium agreements, or organizational charts – that explicitly delineate the roles, responsibilities, and decision-making structures of participating actors within the MaaS ecosystem.

4.1.2.3. *Economic and Financial Dimension*

For the Economic and Financial Dimension, the ideal MaaS is characterized by a financially sustainable, scalable, and customer-oriented business model that balances affordability for users with economic viability for providers. At its core, in line with early theorizations, an ideal MaaS delivers a high-value proposition by offering seamless, multimodal integration at the highest level of service bundling – specifically, Level 4 integration as intended in Sochor et al. (2018). This level of integration is complemented by a broad coverage, ideally spanning national or international regions, and by embedding user incentives and customization options to foster adoption and loyalty. In terms of revenue generation, the ideal MaaS supports a diverse portfolio of revenue streams, exceeding four distinct sources, to mitigate financial risks and enhance resilience against market fluctuations (Krauss et al., 2022). Pricing strategies further contribute to this financial sustainability, with dynamic and personalized pricing mechanisms enabling adaptive responses to demand patterns while improving user satisfaction (Polydoropoulou et al., 2020). Economic sustainability is operationalized through financial indicators such as ROI/ROA/ROE, where the ideal threshold was identified as approximately 15% - this value reflects a commonly accepted benchmark for financial health and investor attractiveness in technology and mobility sectors. Similarly, achieving a positive EBIT is critical as it reflects operational profitability. Instead, the target of maintaining an average cost per user below €10/month draws from pricing strategies in subscription-based mobility services such as public transport season tickets or bike-sharing schemes. Furthermore, the ideal MaaS system invests at least 15% of its turnover in service development and innovation. This threshold is aligned with practices in the tech-enabled mobility sector, where ongoing platform enhancements, integration of new mobility modes, and technological upgrades are essential for maintaining competitiveness in dynamic markets (McKinsey, 2023). Most KPIs under this dimension are objectively measurable through publicly

available company reports, investor presentations, policy documents, or media coverage. However, financial performance indicators may not always be transparently disclosed for all MaaS initiatives, especially early-stage ventures. In such cases, these figures may need to be estimated based on reported revenues, service scale, or comparable industry benchmarks, acknowledging a degree of approximation in secondary data analysis.

4.1.2.4. User Dimension

For the User Dimension, the ideal MaaS system is defined by its ability to attract, satisfy, and retain a broad and active user base while fostering behavioural shifts toward multimodal, shared, and sustainable transport options. An ideal MaaS provider segments the market to tailor offerings for different demographics, needs, or travel patterns (Polydoropoulou et al., 2020). A proxy for user satisfaction is the average rating of the app in digital marketplaces. In an ideal MaaS system, this rating would be 4.5 or higher (on a 5-point scale), aligning with widely accepted benchmarks for 'excellent' app performance in app stores such as Google Play and the Apple App Store. User loyalty and retention are equally critical proxies for ongoing engagement and sustained use. The ideal MaaS system would achieve more than 30% of new users joining through referral mechanisms and maintain more than 50% of users continuing to use the service beyond the first month. These thresholds align with patterns observed in platform-based business models and benchmarks reported in industry events and practitioner discussions (Harrison et al., 2020). With respect to user activity, an ideal MaaS platform maintains an active user base comprising more than 60% of registered users, ensuring that sign-ups convert into regular service use. Similarly, sustaining at least 1,000 new user registrations per month reflects a desirable growth trajectory observed in successful MaaS or app-based mobility platforms (Harrison et al., 2020). These KPIs are relatively easy to measure or approximate: app store ratings, referral data, retention and activation metrics,

and active user statistics are often published in reports, shared in media releases, or available through app analytics dashboards. In cases where direct data is unavailable, proxies such as periodic user reports or inferred metrics from app performance can be used.

4.1.2.5. Societal Dimension

For the Societal Dimension, the ideal MaaS system achieves positive externalities at both environmental and social levels. Indicators such as decrease in carbon emissions, reduction in single-occupancy vehicle trips, and decline in congestion reflect its contribution to sustainable mobility goals. While these impacts are harder to observe directly from a service operator's data, they can be estimated through secondary sources such as project evaluation reports, government sustainability assessments, or urban mobility observatories. Social impact indicators, like improvements in safety and service accessibility for disadvantaged or rural users, can similarly be assessed through public evaluation reports, social inclusion audits, or third-party impact studies.

4.1.2.6. Contextual Dimension

Finally, for the Contextual Dimension, an ideal MaaS operates in contexts characterized by transport readiness, technological infrastructure, cultural readiness, a supportive regulatory framework, and a high degree of urbanization or MaaS penetration. As these are environmental enablers rather than operator-controlled outcomes, information is generally retrievable from secondary public sources rather than MaaS provider data.

4.1.3. MaaS systems' evaluation results and rankings

This section presents the empirical results of the evaluation framework applied to ten selected MaaS initiatives. The analysis follows the AHP-TOPSIS

methodology described in the previous sections, integrating expert-derived weights and performance indicators across six key dimensions: Technical, Organizational, Economic and Financial, User, Societal, and Contextual. Each initiative's performance was assessed against an “ideal MaaS configuration” and benchmarked through the computation of a closeness coefficient (C_i), which reflects the relative proximity of each system to the optimal reference. Table 4.4 reports the scores achieved by each initiative across the six dimensions, along with the overall performance index (D_i^*) and the corresponding closeness coefficient (C_i).

As expected, no real-world implementation fully matches the ideal configuration, and substantial variability in performance emerged both across initiatives and dimensions. The results suggest the existence of three distinct performance clusters rather than a smooth continuum, with marked differentiation in their internal logics (see Figure 4.4). At the top of the ranking (see Table 4.5), Citymapper (UK) achieved the lowest D_i^* (7.87) and highest C_i (0.495), closely followed by Uber ($C_i = 0.436$) and iMOVE ($C_i = 0.400$). These initiatives performed strongly not only because of high absolute scores, but because they excelled in the most influential dimensions within the AHP-TOPSIS framework—specifically the Contextual and User dimensions, which together account for over 40% of the total weight. All three operate in dense urban environments with advanced transport infrastructure and supportive regulatory ecosystems, reflected in strong Contextual scores (Citymapper and iMOVE reach 19.29; Uber scores 15.80). At the same time, they demonstrate outstanding performance in the User dimension – 16.71 for Citymapper, 15.68 for iMOVE, and 15.47 for Uber – thanks to intuitive interfaces, seamless payment systems, and high levels of user satisfaction. Importantly, they also maintain consistently good results across the remaining dimensions, avoiding critical weaknesses in areas such as economic viability or governance. While their technical scores are solid rather than exceptional, this reinforces the idea that once a basic threshold of plat-

form robustness is reached, success hinges more on user alignment and contextual fit. The mid-ranking group, consisting of Jelbi ($C_i = 0.389$), Whim ($C_i = 0.362$), UbiGo ($C_i = 0.331$), and Glimble ($C_i = 0.312$), reflects a different dynamic. These initiatives display respectable yet uneven performances, with strong technical and user credentials but financial fragility and scale limitations. All four platforms tick nearly every technical box and achieve solid user engagement, with app ratings between 3.8/5 and 4.5/5 and high post-month retention for three of the four cases. Organizational basics are likewise in place, yet their economic indicators are uniformly weak and revenue diversification remains only medium to high. Jelbi, for instance, excels in technical and organizational scores yet suffers from narrow geographic reach, modest service integration (level 2) and the lowest user rating (3.8/5). Whim mirrors this pattern, adding weaker societal performance into the mix, while UbiGo and Glimble both face challenges linked to revenue generation and partnership density. Taken together, these cases underline that without a viable, diversified business model and wider market scale—even the best technical platforms with satisfied users plateau in mid-table performance. Following this line, the bottom-tier initiatives – Zipster, EMT Madrid, and TOMove – shows that solid technical basics are not enough when scale and monetisation remain weak. These systems exhibit uniformly weak performances across dimensions, yet the Economic and Financial dimension stands out as the most critical bottleneck, with none surpassing 8.6 points (EMT Madrid's score is as low as 5.43 and TOMove reaches just 7.03). Combined with mediocre technical achievements and moderate contextual readiness, these weaknesses in business-model viability produce D_i^* values markedly higher (worse) than the median. Practically, limited market reach, un-diversified revenues and shallow user engagement undermine otherwise adequate technical and organizational foundations, leaving these initiatives at the bottom of the benchmark.

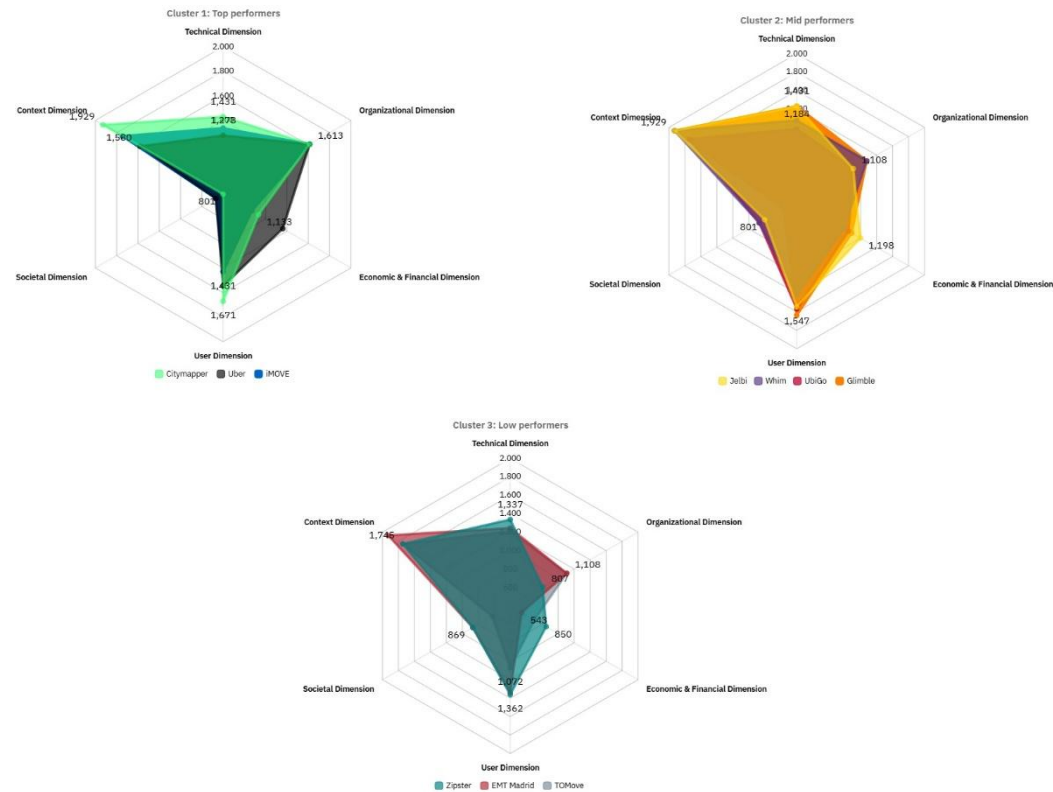
Table 4.4 – Real-world implementations score

Dimension	Ideal	Whim	Uber	Citymapper	Jelbi	UbiGo	Glimble	TOMove	Zipster	EMT Madrid	iMOVE
Technical	14,31	12,78	12,78	14,31	14,31	11,84	14,31	12,10	13,37	12,44	13,37
Organizational	16,13	12,76	16,13	16,13	11,08	11,08	12,76	11,08	8,07	11,08	16,13
Economic & Financial	15,04	9,91	13,60	11,33	11,98	10,49	10,89	7,03	8,50	5,43	10,70
User	19,11	14,17	15,47	16,71	15,47	15,68	16,37	10,72	13,62	13,41	14,31
Societal	14,26	8,69	8,69	8,01	8,01	8,69	5,57	6,25	8,69	8,69	8,69
Contextual	21,14	19,29	15,80	19,29	19,29	17,45	19,29	17,45	17,45	19,29	17,45
	D_i*	9,942	8,787	7,874	9,523	10,433	10,731	15,587	13,550	13,724	9,349
	C_i	0,3622	0,4363	0,4948	0,3890	0,3307	0,3116	0	0,1307	0,1195	0,4002

Table 4.5 - Final Rankings

#	MaaS Implementation	D _i *	C _i
1	Citymapper (UK)	7,874	0,4948
2	Uber (USA)	8,787	0,4363
3	iMOVE (Australia)	9,349	0,4002
4	Jelbi (Berlin)	9,523	0,3890
5	Whim	9,942	0,3622
6	UbiGo (Stockholm)	10,433	0,3307
7	Glimble (Netherlands)	10,731	0,3116
8	Zipster (Singapore)	13,550	0,1307
9	EMT Madrid (Spain)	13,724	0,1195
10	TOMove (Italy)	15,587	0

Figure 4.4 - Performance of the 3 identified clusters



Cross-case examination of the dimensions reveals that the Economic and Financial dimension is systematically lower than all others, with only Uber surpassing 13 points, indicating it acts as the most significant constraint across initiatives. Conversely, while the Societal dimension also registers relatively low scores, its lower weighting in the AHP structure lessens its overall impact. Furthermore, Across the ten cases the technical baseline is remarkably uniform: every platform exposes open APIs, 0.99 system uptime, real-time information and at least some form of data analytics. Yet the benchmarking results show that technical soundness is only the entry ticket. Performance improves only when technical capabilities are complemented by a compelling value proposition and a context-sensitive, engaging user experience. Technical excellence must translate into perceived convenience – through features like broad payment options, fast booking, and adaptive pricing – and be supported by a governance model capable of scaling the service within its urban and regulatory environment. Where these demand-side elements are lacking, the AHP-TOPSIS results show that further technical enhancements offer little compensatory value.

4.1.4. Sensitivity Analysis

To assess the robustness of the evaluation framework, we conducted a sensitivity analysis targeting the ordinal variables, which represent the most subjective component of the assessment process (OECD, 2008). In the original model, ordinal indicators classified as High, Medium, or Low were normalized linearly as 1, 0.5, and 0, respectively. While intuitive, this approach treats the difference between categories as equidistant, which may not accurately reflect expert interpretations or stakeholder preferences. To test the influence of this assumption, we recalibrated the normalization scale using the following transformation: High = 1, Medium = 0.7, and Low = 0.2, thus granting greater credit

to medium-level performance. All dimension-level scores, aggregate D_i^* values, and closeness coefficients (C_i) were then recalculated using this new scheme. The results of this sensitivity analysis reveal stability in the ranking outcomes (see Table 4.6).

Table 4.6 – Sensitivity Analysis results

#	MaaS Implementation	D_i^{*New}	ΔD_i^*	C_i^{New}	ΔC_i
1	Citymapper (UK)	7,1709	0,7033	0,4688	0,0260
2	Uber (USA)	7,9422	0,8447	0,4117	0,0246
3	Whim	8,1011	1,8405	0,3999	-0,0377
4	iMOVE (Australia)	8,2262	1,1233	0,3907	0,0095
5	UbiGo (Stockholm)	8,8367	1,5963	0,3454	-0,0148
6	Glimble (Netherlands)	9,7530	0,9777	0,2776	0,0340
7	Jelbi (Berlin)	10,1313	-0,6080	0,2495	0,1395
8	Zipster (Singapore)	10,3785	3,1718	0,2312	-0,1006
9	EMT Madrid (Spain)	11,6659	2,0582	0,1359	-0,0163
10	TOMove (Italy)	13,5001	2,0870	0	0

The top-ranked initiatives – Citymapper, Uber, and iMOVE – maintain their leading positions, and the lowest-ranked initiatives – Zipster (Singapore), EMT Madrid (Spain), and TOMove (Italy) – remain at the bottom, suggesting that the highest- and lowest-performing clusters are robust to this methodological adjustment, with ΔC_i values consistently in the 10^{-2} range. These findings suggest that the evaluation framework is not overly sensitive to changes in the subjective treatment of qualitative inputs, at least not in ways that affect the

overall ranking structure. Mid-ranking initiatives experienced only modest reshuffling. Whim slightly overtook iMOVE to reach third place, while Jelbi dropped below Glimble due to its relatively higher share of “Low” and “Medium” ordinal scores. However, these changes were minor in magnitude – Jelbi’s C_i changed by just 0.14 – and did not affect the clustering structure identified in the baseline analysis. The three performance bands observed in the original results were preserved, thus confirming the internal validity and robustness of the framework. Hence, while alternative codings of ordinal indicators naturally produce some shifts in absolute values, they do not compromise the framework’s ability to differentiate between high, medium, and low-performing MaaS initiatives. This confirms its reliability as a comparative benchmarking tool.

4.2. Discussion and Conclusion

The aim of this work is to develop a multidimensional evaluation framework capable of capturing the inherent complexity of MaaS initiatives, and to systematically benchmark performance of heterogeneous implementations to an “ideal” reference model. Drawing on extensive literature analysis, expert consultation, and MDCA methodologies, we propose a comprehensive framework consisting of six critical dimensions – Technical, Organizational, Economic and Financial, User, Societal, and Contextual – weighted through an AHP and operationalized via the TOPSIS method. The application of this framework to ten prominent global MaaS initiatives provided empirical validation and allowed for a nuanced comparative analysis.

The quantitative analysis presented here largely confirms – in a structured and mathematical manner – insights previously discussed in MaaS literature and observed in practice. The results unequivocally demonstrate that none of the real-world MaaS initiatives analysed here come even close to bridging the gap with the ideal MaaS state as theoretically and empirically defined in this

study, highlighting not only persistent shortcomings, but also the considerable distance that still separates current practice from the aspirational benchmark. While several initiatives show significant strengths, each has evident deficiencies, underscoring that achieving the ideal MaaS model remains profoundly challenging. Furthermore, the analysis reveals that the top-performing initiatives – Citymapper, Uber, and iMOVE – are all privately operated or embedded in hybrid governance structures with strong private-sector leadership. These configurations consistently outperformed others in the most influential dimensions of the AHP-TOPSIS framework, including Contextual, User, Organizational, and Economic and Financial aspects. Their success appears tied to greater agility in platform development, more dynamic user engagement strategies, and a stronger capacity to attract and allocate investment effectively. In contrast, public-sector-led or heavily subsidized initiatives such as EMT Madrid and TOMove systematically underperform across these same dimensions, constrained by limited revenue diversification, rigid pricing models, and less efficient cost structures. These findings contribute to the ongoing debate surrounding the optimal governance model for MaaS systems, suggesting that hybrid or private-sector-driven configurations may be better suited to achieving high-performing outcomes, particularly in competitive or mature urban mobility environments (e.g., Aapaoja et al., 2017; Smith et al., 2018; Pangbourne et al., 2020; Wong et al., 2019).

The dominance of the Contextual and User dimensions emerges as a third critical insight. Together, these two dimensions carry the highest combined weight in the AHP-derived structure (40%) and serve as clear differentiators between leading and lagging implementations. This supports prior literature emphasizing that MaaS success is not solely determined by technological integration or service bundling (Sochor et al., 2018; Hensher et al., 2020), but rather by contextual readiness and user-centered value delivery (Hensher et al., 2021; Lyons et al., 2019). Strong contextual conditions facilitate deployment,

while user-centric design fosters sustained adoption and engagement. The performance of Citymapper and iMOVE in particular confirms that effective MaaS systems are deeply embedded in their urban environments and finely attuned to end-user expectations.

This leads to a fourth and closely related insight: technical robustness, while necessary, is not sufficient (Kamargianni and Matyas, 2017; Maas, 2022). Most initiatives scored relatively well in the Technical dimension, reflecting adequate system uptime, API compatibility, and standardized data management. However, as the results demonstrate, these technical features do not inherently translate into high overall performance unless they are complemented by user-centric design elements and enabling institutional frameworks. Moreover, without an enabling governance structure that facilitates service scaling and cross-sector collaboration, even technically robust platforms struggle to deliver consistent value. As the AHP-TOPSIS results show, in the absence of these complements, further technical refinement offers little compensatory value.

A fifth, and perhaps most consequential, insight concerns the Economic and Financial dimension, which consistently emerges as the system's most severe bottleneck. Even among the top-ranked initiatives, none achieve outstanding financial scores. For mid- and lower-tier initiatives, the picture is even more critical, with economic fragility visibly constraining scalability and long-term viability. This result is far from surprising. The difficulty of capturing value in MaaS ecosystems has been widely acknowledged in both theoretical literature and practice (Krauss et al., 2022). However, the contribution of this study lies in offering a quantitative confirmation of this bottleneck and mapping its systemic implications across a diverse set of initiatives.

Finally, societal outcomes remain largely underdeveloped—though it is important to recognize that such impacts tend to materialise over longer time horizons. Effects related to behavioral change, modal shift, and emissions re-

duction are inherently cumulative, and many current MaaS deployments are either recent or limited in geographic and demographic scope. Nevertheless, the available data reveals only modest evidence of progress. Most platforms still lack robust longitudinal adoption metrics, offer insufficient coverage in transport-disadvantaged areas, and show limited success in reducing private car dependency or delivering measurable environmental benefits. While certain features—such as green routing, digital incentives, or safety enhancements—are present in isolated cases, they do not yet constitute systemic approaches to sustainability or inclusion. This gap between ambition and implementation reinforces a concern raised by critical MaaS scholarship: that the narrative of MaaS as a transformative, sustainable mobility paradigm may currently outpace its demonstrable public value (Pangbourne et al., 2020; Hensher et al., 2020).

4.2.1. Implications

The evaluation framework developed in this study provides not only a diagnostic tool to assess the performance of MaaS initiatives, but also a strategic instrument to guide investment, governance, and policy formulation. Its multidimensional design enables a holistic understanding of what drives MaaS success, and where barriers persist. Indeed, at the broadest level, the framework establishes a standardized approach to benchmark initiatives that supports both inter- and intra-dimensional performance analysis. This allows stakeholders – whether transport ministries, city authorities, or mobility providers – to identify relative strengths and weaknesses in a structured way. One key application is horizontal benchmarking: public agencies can compile scores across cities to create comparative dashboards, helping identify peers with similar contexts but stronger performance. This facilitates lateral learning and the transfer of effective practices. For example, a city with low user engagement might study higher-scoring peers for inspiration on dynamic pricing or interface

design. The framework also enables longitudinal monitoring. Repeating the assessment every 12 to 18 months allows stakeholders to track the effects of specific interventions over time. This is especially valuable in dynamic systems like MaaS, where interdependencies and feedback loops shape outcomes. In addition, the framework supports adaptive prioritization. Since AHP weights reflect expert judgment, they can be adjusted as policy goals evolve. A city prioritizing social equity, for example, might temporarily increase the weight of the Societal dimension to reflect new political mandates. This flexibility enhances the framework's use as a policy tool.

Furthermore, the ability to benchmark performance against an empirically derived, theoretically grounded ideal also supports more strategic resource allocation. Rather than treating all underperformance as equal, stakeholders can use the framework's scoring matrix to target specific weaknesses that constrain system evolution. For instance, if an initiative performs well in the Technical and Contextual dimensions but lags in Economic and Financial metrics, investment might be steered toward improving revenue architecture, experimenting with alternative pricing strategies, or partnering with private sector actors to improve cost recovery.

Leaving this important premise aside, the findings of this study have clear implications for mobility providers, city authorities, and policymakers. As for mobility providers and MaaS operators, one of the most evident insights from this analysis is that technical robustness alone is no longer a distinguishing factor. While features such as API compatibility, system uptime, and standardized data formats remain essential, they are now considered baseline capabilities. What sets top-performing initiatives apart is their ability to transform technical robustness into visible, user-friendly experiences. In mature MaaS ecosystems, it is perceived convenience – not backend sophistication – that drives adoption. Providers must therefore focus on front-end design, personalization, and clear communication of value to ensure users recognize and benefit

from this convenience. Equally pressing is the issue of economic sustainability. The results reinforce the fact that MaaS ventures cannot depend indefinitely on public subsidies or singular revenue sources. To build viable financial models, providers must experiment with diversified monetization strategies from the outset. This may include tiered subscription packages, corporate mobility offerings, partnerships for ancillary services such as parking or insurance, advertising-based revenue, or commission structures integrated into the platform. Such diversification not only improves financial resilience but also reduces exposure to fluctuations in public funding or user volume. Finally, the analysis also highlights the strategic value of contextual alignment. Leading platforms do not apply uniform solutions across geographies; rather, they adapt to the specific regulatory, infrastructural, and cultural characteristics of the cities in which they operate. Citymapper, for example, has succeeded in part by leveraging London's dense, multimodal transport infrastructure and its supportive open-data policies. Moreover, the Contextual dimension of the framework should be treated not only as an evaluation criterion but as a tool for strategic market selection. By targeting cities with favorable institutional conditions and high multimodal readiness, and then tailoring services to local usage patterns, providers can significantly enhance the chances of effective adoption and sustained performance.

For city authorities and regional transport agencies tasked with overseeing MaaS operations, the framework offers a valuable instrument for both planning and governance. Indeed, it can serve as a practical design checklist when structuring tenders or upgrading existing deployments. Authorities can assess current weaknesses – such as limited mode integration, inadequate payment systems, or weak user engagement – and embed corrective measures as contractual requirements.

Finally, for policymakers at the national or regional level, the findings of this study underscore the critical role of context-shaping interventions in enabling successful MaaS implementations. Key measures include mandating open data standards, enforcing integrated ticketing across modes and operators, and establishing regulatory sandboxes that allow for agile experimentation with dynamic pricing and bundled services. Importantly, public support should shift from subsidizing pilots to incentivizing business model innovation. Grant programs should prioritize initiatives with credible monetization strategies – such as tiered subscriptions, corporate mobility partnerships, or cross-sector collaborations – and require applicants to demonstrate break-even projections beyond the pilot phase, so that financial resilience can be treated as a prerequisite, not a consequence. Moreover, the superior performance of privately-led or hybrid governance models calls for a recalibration of policy instruments. If these models are to become the mainstream, policymakers must design outcome-based contracts that embed measurable societal goals – such as modal shift, emissions reduction, and inclusive access – into the core objectives of MaaS providers.

4.2.2. Limitations

The evaluation framework developed in this study represents a structured, transparent and replicable method to assess heterogeneous MaaS initiatives. However, the framework is not without limitations, and several methodological and empirical constraints affect the generalizability of the findings and the strength of the policy prescriptions derived from them.

First, the quality and symmetry of the underlying data constitute a fundamental constraint. Most indicators were drawn from secondary sources such as public reports, policy briefs, and operator websites. While some metrics (e.g., user ratings or number of services integrated) were readily available, others—particularly financial and behavioral indicators—required proxy-based estima-

tion due to limited disclosure. For example, EBIT, ROI, and referral rates had to be inferred in many cases, especially for private platforms that withhold sensitive data. Public schemes, conversely, often disclose costs but lack granular uptake figures. This asymmetry introduces uncertainty and potentially smooths real differences across initiatives, particularly in the economic dimension, where no project approached the ideal benchmark.

Second, the construction of weights and ordinal scales rests on a necessarily limited pool of expert judgement. Although the AHP process followed best practices, the final sample of thirteen consistent expert responses, while sufficient for illustrative purposes, is too small and heterogeneous to infer universally valid weights. Furthermore, the linear ordinal coding scheme (High = 1, Medium = 0.5, Low = 0) is not theory-driven and may oversimplify nuanced performance differences. A targeted sensitivity analysis (recalibrating Medium = 0.7, Low = 0.2) confirmed the overall robustness of top and bottom performers but revealed sensitivity in middle-tier rankings, suggesting that small scale shifts can produce non-negligible reordering. Future applications should consider triangulating expert judgements with empirical outcome distributions (e.g., NPS, adoption rates) to refine ordinal mappings and increase construct validity.

Third, conceptually, the framework treats all six dimensions as static and additive, whereas MaaS systems are inherently dynamic and complex, shaped by recursive interdependencies among dimensions. For example, technical platform maturity directly affects the quality of the user experience—faster booking times, seamless payments, real-time updates—which in turn enhances adoption rates and retention. Increased user engagement then improves the platform's economic performance through higher revenues or increased leverage with partners, which can be reinvested to further enhance technical capabilities, closing a positive feedback loop. Similarly, broader contextual readiness (e.g. open data policies, multimodal infrastructure) facilitates service integra-

tion, which improves functional coverage and user satisfaction, thereby strengthening the political and financial support needed to maintain regulatory enablers—another loop reinforcing system maturity. These reciprocal effects mean that the success or failure of MaaS is not merely the sum of its parts, but the result of how those parts interact over time. While the current model offers a high-resolution comparative snapshot, it lacks temporal sensitivity. Future research could incorporate longitudinal data or systems-dynamics approaches to better capture the evolutionary trajectories of MaaS deployments and the cumulative effects of reinforcement or breakdown across dimensions.

Finally, the external validity of the findings is constrained by the sample composition. The ten initiatives evaluated operate primarily in digitally advanced, metropolitan areas of Western Europe, North America, and Australia. The framework has yet to be applied to rural contexts, low-income urban settings, or regions where informal transport plays a dominant role. This bias is particularly relevant for the Contextual dimension, which carries significant weight and may privilege infrastructural and regulatory conditions typical of Global North cities. Without recalibrating the model for other geographies and governance environments, the framework risks mischaracterizing structural barriers as performance failures.

Despite its limitations, this study shows that structured, multidimensional evaluation can meaningfully support the development of MaaS. With continued refinement and application, such frameworks can help bring the vision of integrated, inclusive, and sustainable mobility closer to reality.

4.3. References

Aapaoja A., Eckhardt J., Nykanen L. (2017). Business Models for MaaS. 1st International Conference on Mobility as a Service (ICOMaaS).

Aba, A., Esztergár-Kiss, D. (2024). Creation of the MaaS readiness index with a modified AHP-ISM method. *Communications in Transportation Research*, 4, 100122.

Ambrosino, G., Nelson, J. D., Boero, M., and Pettinelli, I. (2016). Enabling intermodal urban transport through complementary services: From flexible mobility services to the shared use mobility agency. Workshop 4. Developing inter-modal transport systems. *Research in Transportation Economics*, 59, 179–184.

Arksey, H., and O'Malley, L. (2005). Scoping Studies: Towards a Methodological Framework. *International Journal of Social Research Methodology: Theory and Practice*, 8(1), 19–32.

Baruch, Y., and Holtom, B. C. (2008). Survey response rate levels and trends in organizational research. *Human Relations*, 61(8), 1139–1160

Basbas, S., and Makridakis, C. M. (2007). A review of the contribution of multi-criteria analysis to the evaluation process of transportation projects. *International Journal of Sustainable Development and Planning*, 2(4), 387–407.

Belossarov, A., Aba, A., Esztergár-Kiss, D. (2023). Using the Analytical Hierarchy Process Method to Evaluate Mobility as a Service (MaaS) Applications. *Journal of Urban Technology*, 30(4), 83–112.

Benallou I., Azmani A., Azmani M. (2023). A combined AHP-TOPSIS model for the evaluation and selection of truck drivers. *Journal of Theoretical and Applied Information Technology*, Vol.101. No 7

Butler, L., Yigitcanlar, T., Paz, A., 2021. Barriers and risks of Mobility-as-a-Service (MaaS) adoption in cities: a systematic review of the literature. *Cities* 109, 103036.

Carbonara N., Messeni Petruzzelli A., Panniello U., De Vita D. (2024). Embracing new disruptions: Business model innovation in the transition to Mobility as a Service (MaaS). *Journal of Cleaner Production*, 464, 142744

Chiba, T., Abe, R. (2024). Factors affecting continuation of Mobility as a Service projects in regional and rural areas: An analysis of 50 projects in Japan. *Research in Transportation Business and Management*, 57, 101226.

Dadashzadeh, N., Woods, L., Ouelhadj, D., Kamargianni, M., Antoniou, C. (2022). Mobility as a Service Inclusion Index (MaaSINI): Evaluation of inclusivity in MaaS systems and policy recommendations. *Transport Policy*, 127, 191–202.

Enoch M., Potter S., (2023). MaaS (Mobility as a Service) market futures explored. *Transport Policy*, 134, 31-40

Estzegar-Kiss D., Kerényi T., Mátrai T., Aba A. (2020). Exploring the MaaS market with systematic analysis. *European Transport Research Review*, 12, 67

Fioreze T., de Gruijter M., Geurs K. (2019). On the likelihood of using mobility-as-a-service: a case study on innovative mobility services among residents in Netherlands. *Case Study on Transport Policy*, 7(4), p.790-801

Goepel K. (2013). Implementing the Analytic Hierarchy Process as a Standard Method for Multi-Criteria Decision Making in Corporate Enterprises – a New AHP Excel Template with Multiple Inputs. *International symposium on the analytic hierarchy process*, Kuala Lumpur, Malaysia.

Goulding R., Kamargianni M. (2018). The Mobility as a Service Maturity Index: Preparing the Cities for the Mobility as a Service Era. *MaaS Lab Publications*

Greco, S., Ehrgott, M., and Figueira, J. R. (2016). *Multiple Criteria Decision Analysis: State of the Art Surveys*. Springer.

Greco S., Ishizaka A., Tasiou M., Torrisi G. (2019). On the Methodological Framework of Composite Indices: A Review of the Issues of Weighting, Aggregation, and Robustness. *Soc Indic Res* (2019) 141:61–94

Greco S., Słowiński R., Wallenius J. (2025). Fifty years of multiple criteria decision analysis: From classical methods to robust ordinal regression. *European Journal of Operational Research*, Volume 323 (2), Pages 351-377

Harrington, J. H. (1991). *Business Process Improvement – The Breakthrough Strategy for Total Quality, Productivity, and Competitiveness*. McGraw-Hill

Harrison G., Gühnemann A., Shepherd S. (2020). The business case for a journey planning and ticketing app—Comparison between a simulation analysis and real-world data. *Sustainability*, 12(10):4005

Heikkilä S. (2013). *Mobility as a Service—A Proposal for Action for the Public Administration, Case Helsinki*. Master's thesis. Aalto University

Hensher, D.A., Ho, C.Q., Mulley, C., Nelson, J.D., Smith, G., Wong, Y.Z., (2020). *Understanding Mobility as a Service (MaaS): Past, Present and Future*. Elsevier.

Hensher D.A., Ho C.Q., Reck D.J., Smith G. (2021). *The Sydney Mobility as a Service (MaaS) Trial: Design, Implementation, Lessons and the Future*. iMove Australia.

Hensher, D.A., Mulley, C., Nelson, J.D. (2023). What is an ideal (Utopian) mobility as a service (MaaS) framework? A communication note. *Transportation Research Part A: Policy and Practice*. Volume 172, 103675

Hietanen, S., 2014. "Mobility as a Service" – the new transport model? *Eurotransport* 12 (2), 2–4.

Ho C.Q., Hensher D.A., Mulley C., Wong Y.Z. (2018). Potential uptake and willingness-to-pay for Mobility as a Service (MaaS): A stated choice study. *Transportation Research Part A*, 117, 302-318

Hwang, C. L., and Yoon, K. (1981). *Multiple Attribute Decision Making: Methods and Applications*. Springer-Verlag.

Ishizaka, A., and Labib, A. (2011). Review of the main developments in the analytic hierarchy process. *Expert Systems with Applications*, 38(11), 14336-14345.

ITF, 2021. *The innovative mobility landscape: the case of mobility as a service*. International Transport Forum Policy Papers, No. 92. OECD Publishing, Paris.

Jittrapirom P., Caiati V., Feneri A.-M., Ebrahimi S., González M.J.A., Narayan J. (2017). Mobility as a Service: A critical review of definitions, assessments of schemes, and key challenges. *Urban Planning*, 2(2), 13-25

Jones, P., 2014. The evolution of urban mobility: the interplay of academic and policy perspectives. *IATSS Res.* 38 (1), 7–13.

Kamargianni, M., Matyas, M., 2017. The business ecosystem of mobility-as-a-service. In: Paper Presented at the 96th Transportation Research Board (TRB) Annual Meeting. Washington, DC.

Kamargianni, M., Goulding, R. (2018). The Mobility as a Service Maturity Index: Preparing the Cities for the Mobility as a Service Era. Proceedings of 7th Transport Research Arena TRA 2018, Vienna, Austria

Kandanaarachchi T.B., Nelson J.D., Ho C.Q. (2024). Conceptualising trust and collaboration among stakeholders in MaaS ecosystems. *Transport Policy*, Volume 157, Pages 98-110

Kaplan, R.S., Norton, D.P.: *The Balanced Scorecard*. Harvard Business School Press (1996)

Karleuša, B., Deluka-Tibljaš, A., and Dragčević, V. (2013). Review of multicriteria-analysis methods application in decision making about transport infrastructure. *Građevinar*, 65(7), 619–631.

Karlsson, I.C.M., Sochor, J., Strömberg, H., 2016. Developing the 'Service' in Mobility as a Service: experiences from a field trial of an innovative travel brokerage. *Transport. Res. Procedia* 14 (2016), 3265–3273.

Karlsson I.C.M., Mukhtar-Landgren D., Smith G., Koglin T., Kronsell A., Lund E., Sarasini S., Sochor J. (2020). Development and implementation of Mobility-as-a-Service – A qualitative study of barriers and enabling factors. *Transportation Research Part A*, 131, 283-295

König D., Eckhardt J., Aapaoja A., Sochor J., Karlsson M. (2016). Business and operator models for MaaS. *MaaSIFIE Project*

Krauss, K., Moll, C., Kohler, J., Axhausen, K.W., 2022. Designing mobility-as-a-service business models using morphological analysis. *Transportation Business and Management* 45 (Part C), 100857.

Lyons G., Hammond P., Mackay K. (2019). The importance of user perspective in the evolution of MaaS. *Transportation Research Part A*."

Maas B. (2022). Literature Review of Mobility as a Service. *Sustainability*, 14(14), 8962

MaaS Alliance (2017). Guidelines and recommendations to create the foundations for a thriving MaaS Ecosystem. White Papers.

McKinsey (2023). The future of mobility. *McKinsey Quarterly*.

Meng L., Somenahalli S., Berry S. (2020). Policy implementation of multi-modal (shared) mobility: Review of a supply-demand value proposition canvas. *Transport Reviews*, 40 (5), pp. 670-684

Merkert R., Wong Y.Z. (2020). Workshop 3: Emerging business models and implications for the transport ecosystem. *Research in Transportation Economics*

Muller, M., Correia, G. H. D. A., Park, S., Fusco, B., Lee, R. (2024). Enhancement of the impacts 2050 model to enable a whole system sustainability assessment of rideshare. *Multimodal Transportation*, 3(4), 100171.

Mulley C. (2017). Mobility as a Service (MaaS) – Does it have critical mass? *Transportation Reviews*, 37(3), 247-251

Nikolaidou, A., Papadopoulos, E., Politis, I., Basbas, S. (2023). An Indicator-Based Methodological Framework for Assessing an eMaaS Scheme. *World Electric Vehicle Journal*, 14(7), 186.

Núñez C., Antoniou C. (2025). The Mobility as a Service Potential Index (MaaSPI): Assessing the conditions for MaaS across countries based on public sources. *Research in Transportation Business and Management*, Volume 60, 101360

OECD (2008). *Handbook on Constructing Composite Indicators, Methodology and user guide*.

Orozco-Fontalvo, M., Soares Lopes, A., Vale, D., Moura, F. (2024). IMPRESS: A comprehensive method to classify MaaS systems. *Transport Policy*, 155, 234–241.

Ortega J., Moslem S., Tòth J., Ortega M. (2023). A two-phase decision making based on the grey analytic hierarchy process for evaluating the issue of park-and-ride facility location. *Journal of Urban Mobility*, Volume 3, 100050

Roumboutsos, A., Pagoni, I., Tsimipa, A., Polydoropoulou, A. (2021). An ecosystem innovation framework: Assessing mobility as a service in Budapest. *Sustainability*, 13(7), 3753.

Pangbourne K., Mladenović M.N., Stead D., Milakis D. (2020). Questioning mobility as a service: Unanticipated implications for society and governance. *Transportation Research Part A: Policy and Practice*, 131, Pages 35-49

Pérez, J. C., Carrillo, M. H., and Montoya-Torres, J. R. (2015). Multicriteria approaches for urban passenger transport systems: A literature review. *Annals of Operations Research*, 226(1), 69–87.

Polydoropoulou A., Pagoni I., Tsimpa A., Roumboutsos A., Kamargianni M., Tsouros I. (2020). Prototype business models for Mobility-as-a-Service. *Transportation Research Part A*, 131, pp. 149-162

Reck D.J., Hensher D.A., Ho C.Q. (2020). MaaS bundle design. *Transportation Research Part A*, 141, Pages 485-501

Saaty, T. L. (1980). *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*. McGraw-Hill.

Shih, H. S., Shyr, H. J., and Lee, E. S. (2007). An extension of TOPSIS for group decision making. *Mathematical and Computer Modelling*, 45(7-8), 801-813.

Smith G., Sochor J., Karlsson I.C.M. (2018). Mobility as a Service: Development scenarios and implications for public transport. *Research in Transportation Economics*, 69, 592-599

Smith, G., and Hensher, D. A. (2020). Towards a framework for mobility-as-a-service policies. *Transport Policy*, 89, 54-65

Shelton J., Medina M. (2010). Integrated Multiple-Criteria Decision-Making Method to Prioritize Transportation Projects. *Transportation Research Record: Journal of the Transportation Research Board*, No. 2174, pp. 51–57.

Sochor, J., Arby, H., Karlsson, I.C.M., Sarasini, S., 2018. A topological approach to mobility as a service: a proposed tool for understanding requirements and effects, and for aiding the integration of societal goals. *Res. Transp. Bus. Manag.* 27, 3–14.

Stewart, T. J. (1992). A critical survey on the status of multiple criteria decision making theory and practice. *Omega*, 20(5–6), 569–586.

Teece D.J. (2010). Business models, business strategy and innovation. *Long Range Planning*, 43 (2-3), Pages 172-194

Utriainen R., Pöllänen M. (2018). Review on mobility as a service in scientific publications. *Research in Transportation Business and Management*, 27, Pages 15-23

Wickens C.D., Helton W.S., Hollands J.G., Banbury S. (2021). *Engineering Psychology and Human Performance*. Routledge.

Wong Y.Z., Hensher D.A., Mulley C. (2018). Stated preference design for mobility as a service (MaaS) broker/aggregator contracts. ATRF 2018 - Australasian Transport Research Forum 2018, Proceedings.

Wong Y.Z., Hensher D.A., Mulley C. (2019). Mobility as a Service (MaaS): Charting a future context. *Transportation Research Part A*, 131, Pages 5-19

Yannis G., Kopsacheili A., Dragomanovits A., Petraki V. (2020). State-of-the-art review on multi-criteria decision-making in the transport sector. *Journal of Traffic and Transportation Engineering (English Edition)*. Volume 7 (4), Pages 413-431

Zhang Z., Zhang N. (2021). Novel development scheme of mobility as a service: Can it provide a sustainable environment for China? *Sustainability (Switzerland)*, 13(8), 4233

CONCLUSIONS

This thesis set out to explain MaaS as an ecosystem-level transformation that unfolds through firm-level strategic adaptation and results in heterogeneous operational configurations with uneven performance outcomes (i.e., multidimensional goal achievement). The overarching research question guiding the thesis is: *How is MaaS reshaping the mobility ecosystem, and which business model and ecosystem configurations are associated with successful goal achievement?*

Rather than treating MaaS as a single organizational design choice, the thesis approaches MaaS as a transformation process in which actors progressively reconfigure business models, capabilities, partnerships, and integration strategies to manage new interdependencies across mobility services, digital interfaces, data, payments, and governance. Synthesising the four empirical studies, this perspective explains why MaaS does not converge on a single dominant design. On the supply side, MaaS is enacted through recurring actor-level patterns (business model archetypes and ecosystem roles) that shape how systems are assembled and governed in practice. Each actor contributes as a building block of the overall MaaS configuration. Which configurations prove feasible, and how they perform, are strongly conditioned by local contextual factors and, critically, by the type of actor that initiates and orchestrates the system, considering differences in legacy assets, institutional positioning, technological readiness, and strategic objectives. Accordingly, these system-level outcomes can only be assessed through a multidimensional lens.

Building on this premise, the integrated findings of the thesis are synthesised into four contributions, each corresponding to one research sub-question (RQ). RQ1 asked: “How does MaaS materialise into heterogeneous

business model configurations among MaaS providers, and what recurring patterns structure the current MaaS design space?”

The first empirical study shows that MaaS can be observed empirically as a plurality of operational configurations rather than as a single, unified model of service provision. The global mapping of MaaS providers reveals five recurring business model archetypes – Mobility Platforms, Highly-diversified Providers, Lowly-diversified Providers, Enablers, and Mobility-embedded Providers – which capture distinct ways in which firms operationalise MaaS in practice. This typology shows that the “MaaS provider” role is not uniform, but can be enacted through distinct logics that differ in how integration is achieved, governed, and monetised. Furthermore, the differences between providers reflect trade-offs across a set of strategic and operational dimensions (such as market orientation, integration depth, asset ownership, geographical scope, revenue architecture, scalability and go-to-market logics, core strategic orientation, and key viability triggers) that are in turn influenced by the implementation context and, critically, by the type of actor initiating and orchestrating the MaaS system.

Second, MaaS reshapes the mobility ecosystem by triggering systematic ecosystem-based business model transformations among established organisations, thereby answering RQ2, which asked: *“How does the introduction of MaaS trigger business model reconfiguration among incumbent actors, and which strategies do they adopt to reposition themselves within the mobility ecosystem?”*. The evidence indicates that incumbents adapt not simply by adding digital features to existing offerings, but also by repositioning their business models within a changing ecosystem architecture, where value creation depends on orchestrating and accessing complements (public transport, micromobility, ride-hailing, parking, payment, ticketing, data) and where competitive advantage increasingly lies in controlling or influencing key

“control points” such as the customer interface, data access, and clearing and settlement. In this lens, MaaS pushes service providers to move from standalone offerings toward bundle- and complementarity-based value propositions, built through partnerships, acquisitions, and intensified use of data analytics, while reinforcing safety, reliability, and sustainability as differentiation levers. In parallel, MaaS expands value capture mechanisms through experimentation with subscriptions, loyalty programmes, dynamic and personalised pricing, and partnership-based revenue sharing and co-promotion. On the delivery side, the transition is marked by deeper inter-organizational connectivity, enabled by APIs, data sharing practices, cloud infrastructures, and continuous platform updates. Technology providers were found to move beyond supplying standalone components and to reposition as strategic MaaS enablers offering broader mobility-management portfolios. Compared to the pre-MaaS focus on discrete products complemented by customization and support, MaaS pushed them to develop integrated, “platformised” solutions (such as white-label MaaS modules, ticketing and payment infrastructures, data platforms, and mobility management tools) that enable interoperability and real-time coordination across actors. This shift was enabled by ecosystem expansion strategies, especially partnerships, acquisitions, and joint ventures used to access complementary capabilities. MaaS also reshaped monetisation and delivery: alongside traditional sales and implementation fees, providers increasingly relied on SaaS and licensing logics (and related platform-style revenue mechanisms), while strengthening cloud-based operations, continuous updates, and implementation capabilities (e.g., project management, training, knowledge transfer) to deliver complex ecosystem integrations at scale. Across both categories, MaaS-induced transformation is driven by a small set of recurring adaptation mechanisms that operate across actor types. Partnership and network strategies are used not only to expand and enrich offerings, but also to enter new markets, secure key resources, and develop capabilities;

digitalisation and technology investment (e.g., data infrastructures, analytics, platform upgrades, emerging technologies) becomes central to both innovation and integration; finally, customer-centric development shapes how offerings are packaged and delivered.

Third, the thesis shows that MaaS ecosystem formation is further shaped by entrepreneurial entrants and their role-based evolution over the new venture creation process, thereby answering RQ3, which asked: *“How do MaaS start-ups contribute to MaaS ecosystem formation through role-based business model evolution?”*. The third empirical study demonstrates that, rather than following a single scaling blueprint, start-ups iteratively revise their business models and proactively acquire resources and competences to sustain (or change) their positioning within the ecosystem. By distinguishing orchestrators, enablers, and components, the third study shows that entrepreneurial pathways diverge depending on role: different business model trajectories are associated with different capability-building priorities, investment patterns, and partnership needs across the three NVC phases. In the inception phase, all three start-up roles emphasise novelty and concentrate on product design, entrepreneurial problem-solving, early technology development, and the formation of initial partnerships and social resources as a basis for market entry – while already displaying distinctive emphases (e.g., orchestrators toward network-building, enablers toward innovation resources, components toward physical/hardware-dependent resources). In the development phase, business models diverge more sharply: orchestrators increasingly prioritise ecosystem building and product development to sustain integrated offerings, especially through subscription design, data analytics, personalisation, and customer care; enablers pivot toward modularised, interoperability-oriented solutions by investing in APIs/SDKs and pairing them with project-delivery and network-development competences; components concentrate on efficiency, strengthening supply-chain and operational

capabilities that preserve service reliability and availability while controlling costs. In the scaling phase, all roles face the organizational challenge of replication across cities, requiring financial and organizational resources, more formal structures, and competences in recruiting and commercial development; yet they continue to consolidate distinct role logics (e.g., orchestrators refine lock-in/efficiency through tailored bundles and expanded partnerships; enablers extend complementarities through collaboration with other tech actors and continued product development; components scale via disciplined market selection and logistics/operations excellence).

Fourth, the thesis addresses the remaining evaluative question at the core of MaaS transformation, the RQ4, which asked: *“How do different MaaS ecosystem configurations translate into distinct profiles of multidimensional goal achievement, and what explains variation in performance across implementations?”*. It shows that MaaS materialises into different ecosystem-level configurations as the mobility ecosystem is progressively reshaped through a transformation process in which diverse actors (incumbents, technology providers, and start-ups) adapt their business models, capabilities, partnerships, and integration strategies, thereby acting as building blocks of the emerging system. Which configuration ultimately takes form is strongly conditioned by the application context and, critically, by the type of actor that initiates and orchestrates the system, since the initiator’s legacy assets, institutional position, and strategic objectives influence the ecosystem’s governance arrangements, coordination mechanisms, and allocation of decision rights. Because these configurations combine heterogeneous elements – technical architectures, organizational and contractual arrangements, economic logics, user value propositions, societal ambitions, and contextual enablers or constraints – assessing goal achievement (“success”) requires a multidimensional approach rather than a narrow focus on technical integration or pilot-level indicators. The final empirical study therefore addresses this

evaluative challenge by developing a multidimensional benchmarking framework that operationalises MaaS goal achievement across six complementary dimensions (Technical, Organizational, Economic and Financial, User, Societal, and Contextual). Rather than treating these dimensions as independent checklists, the framework captures how performance emerges from their interaction: strong technical capabilities matter only insofar as they enable a reliable service experience; organizational effectiveness reflects the ability to stabilise partnerships, governance, and coordination; economic viability concerns whether value can be captured and the system sustained over time; user outcomes reflect adoption, satisfaction, and retention; societal outcomes reflect the extent to which MaaS contributes to sustainability and inclusion; and contextual conditions capture the infrastructural, regulatory, and socio-cultural environment within which the system is embedded. Empirically, benchmarking ten global initiatives confirms that no case approaches an “ideal MaaS”, and that outcomes cluster into distinct performance tiers: leading systems perform strongly in the most influential dimensions and avoid critical weaknesses elsewhere, whereas mid-tier initiatives often pair solid technical and user foundations with persistent financial fragility and scale constraints. Across the sample, the analysis underscores three implications: (i) technical robustness is an “entry ticket” rather than a differentiator, as many platforms meet similar baseline requirements; (ii) the Economic and Financial dimension emerges as the most consistent bottleneck for implementations; and (iii) societal outcomes remain comparatively underdeveloped, partly because they materialise over longer time horizons and are difficult to demonstrate without sustained adoption and longitudinal evidence. Finally, the comparative results contribute to the governance debate by suggesting that private-sector-led or hybrid configurations tend to outperform purely public-led initiatives in the most decisive dimensions of goal achievement.

This thesis holds a set of interrelated theoretical and practical implications. Theoretically, the thesis reframes MaaS scholarship from a predominantly “barriers and enablers” perspective (Mukhtar-Landgren et al., 2016; Butler et al., 2020; Karlsson et al., 2020; Pangbourne et al., 2020) toward a transformation-and-configuration lens (Cozzolino and Geiger, 2024). Rather than treating limited diffusion as the direct consequence of static frictions (e.g., regulation, coordination complexity, data access), it conceptualises MaaS as a dynamic ecosystem-formation process in which outcomes depend on how actors respond to those frictions through concrete adaptation mechanisms. In this view, MaaS ecosystems do not (fail to) stabilise simply because “barriers exist”, but because incumbents and entrants must reconfigure their value creation, delivery, and capture logics (Teece, 2010), develop new capabilities and relational arrangements (Jacobides et al., 2018; Teece, 2018), and renegotiate interdependencies across mobility services, digital interfaces, data, payments, and institutional rules (Adner, 2017). Persistent pilots and uneven scaling therefore appear less as a generic lack of enabling conditions and more as the outcome of incomplete, misaligned, or inconsistently coordinated transformation pathways across participating actors (Jacobides et al., 2024). Crucially, the thesis makes this process empirically observable by tracing its microfoundations through the business model lens: ecosystem reconfiguration is enacted through distributed business model innovation, as actors recombine complements into multimodal bundles (value creation), redesign interoperability architectures via APIs, data-sharing routines and platform modularisation (value delivery), and experiment with monetisation mechanisms such as subscriptions, licensing, revenue sharing, and dynamic pricing (value capture) (Amit and Zott, 2001; Demil and Lecocq, 2010; Teece, 2018).

A second theoretical implication refers to the fact that the thesis significantly advances the industry-side understanding of MaaS by strengthening and extending the literature on MaaS business models.

Specifically, it provides an empirically grounded vocabulary to describe and compare the building blocks through which MaaS ecosystems are assembled. By identifying five recurring business model archetypes among MaaS providers and coupling them with a role-based categorisation of entrepreneurial entrants (orchestrator, enabler, component), while also clarifying how incumbents adapt their business models, the thesis reduces the conceptual ambiguity that has characterised prior research and offers a shared language to describe what actors are, what they do, and how their models differ in practice (König et al., 2016; Aapaoja et al., 2017a; Polydoropoulou et al., 2020; Krauss et al., 2022). Importantly, this contribution goes beyond taxonomic clarity: it creates a common basis for systematic confrontation across heterogeneous cases (cities, governance settings, market maturities), thus enabling cumulative theory-building on the industry dynamics of MaaS (e.g., comparative work on archetype viability conditions, role complementarity and rivalry, and how different actor portfolios cohere into distinct system-level configurations over time).

A third theoretical implication is that MaaS evolution is best understood as equifinal and context dependent, rather than as a field moving toward a single dominant design (Hensher et al., 2020). Across the thesis, the emergence of heterogeneous MaaS realities is treated as an inherent property of the phenomenon: MaaS solutions crystallise through different combinations of actor types and roles, legacy asset bases, institutional positions, and strategic objectives, all operating within contextual conditions that enable some pathways while constraining others. In this sense, configurations that are viable and scalable in one setting may be fragile in another because they rely on different contextual supports (e.g., institutional rules, ticketing regimes, data access, multimodal infrastructure, cultural readiness) and because they reflect different initiator positions and coordination capacities. This reinforces a configurational logic in which system outcomes depend on fit and alignment

among building blocks (Hensher et al., 2021; Adner, 2017) and it encourages MaaS scholarship to shift from blueprint-seeking to theorising trade-offs, boundary conditions, and alternative pathways to goal achievement (Meyer et al., 1993; Gresov and Drazin, 1997).

Finally, the thesis reconnects MaaS formation to MaaS performance by theorising “success” as a multidimensional goal-achievement profile rather than as a single outcome variable. This matters because MaaS is simultaneously a market offering (that must be viable, scalable, and deliver a compelling user experience) and a policy instrument (that is expected to contribute to societal goals such as modal shift, equity, and emissions reduction) (Geels, 2005; Pangbourne et al., 2020). By formalising these dimensions within a single evaluative architecture, the thesis provides a coherent basis to compare heterogeneous MaaS realities without collapsing them into reductive indicators (e.g., integration level or adoption rates) that obscure underlying trade-offs (Belossarov et al., 2023; Orozco-Fontalvo et al., 2024). In doing so, it advances a configurational understanding of MaaS performance: similar technical capabilities may coexist across initiatives, yet outcomes diverge depending on whether governance arrangements effectively coordinate interdependent actors, whether value capture mechanisms support financial sustainability beyond subsidies or thin margins, whether the user proposition generates sustained engagement, and whether the institutional and infrastructural context supports scaling and operational stability (Sochor et al., 2018; Lyons et al., 2019; Dadashzadeh et al., 2022). Conceptually, the thesis thus reframes performance not as the direct consequence of “more integration”, but as the result of cross-dimensional alignment, making visible the structural tensions and complementarities that explain why MaaS initiatives often remain stuck at pilot level despite meeting baseline technical requirements (Krauss et al., 2022).

From a practical perspective, the findings of this thesis generate useful insights for a broad set of stakeholders involved in MaaS ecosystems.

Specifically, they speak to (i) MaaS providers, particularly orchestrators responsible for designing, operating, and scaling integrated mobility services; (ii) businesses participating in MaaS ecosystems, including both established incumbents and entrepreneurial start-ups; and (iii) cities, public transport authorities (PTAs), and policymakers tasked with governing MaaS as part of broader urban mobility and sustainability strategies.

For MaaS providers, the thesis highlights the importance of configuration clarity. The business model archetypes identified in the thesis function as practical design templates that allow providers to understand what kind of MaaS they are actually building and which trade-offs this entails. Rather than pursuing generic “integration” goals, providers should make explicit choices regarding integration depth versus coordination complexity, subscription-based versus commission-based revenue architectures, B2C reach versus B2B stability, and scalability versus control over service quality. A key implication is the need to avoid “muddled hybrids” that combine incompatible economic and operational logics without resolving their underlying viability conditions.

For incumbent service providers and technology firms, the thesis underscores that MaaS requires genuine business model innovation rather than the addition of a new digital channel or the deployment of a standalone platform. Participating in MaaS entails developing and sustaining a set of ecosystem-facing capabilities that go well beyond software provision, including partner coordination, data and interface management, contractual governance, and service-level orchestration. Firms must therefore make deliberate positioning choices about where they want to play in the ecosystem (whether as orchestrators, enablers, or specialised complementors) and which control points they seek to influence, such as the customer interface, data access, ticketing and payment infrastructure, or operational assets. These choices

directly shape required capabilities, partnership strategies, and investment priorities. Similarly, for start-ups and investors, the role-based lens developed in the thesis highlights that MaaS ventures are organisations whose scalability and survival depend on building distinct bundles of resources and capabilities aligned with their ecosystem role. Orchestrators require strong relational, organizational, and institutional capabilities (e.g., partner onboarding, contracting, governance design, legitimacy building) in addition to user-facing product excellence; enablers depend on modular design of their offering, interoperability standards, and scalable B2B delivery capabilities; and components hinge on operational efficiency, hardware reliability, and the replication of tightly specified routines. Crucially, the thesis shows that pivoting across roles is possible but not costless: it requires deliberate investment in new resources and competences, rather than incremental adjustments to the existing platform or offering. Making these capability gaps explicit reduces the risk of “blind pivots” and supports more disciplined entrepreneurial strategies and investment decisions grounded in a realistic assessment of what each role actually demands.

For cities, PTAs, and policymakers, the thesis implies that MaaS should be treated first and foremost as an ecosystem governance and configuration challenge, rather than as the procurement of an app or a sequence of loosely connected pilots. The main public lever is the institutional and contractual architecture that makes multi-actor integration workable in practice: access rules for ticketing and payments (including clearing and settlement), interoperability requirements (APIs, data standards, identity/account-based ticketing), data governance and accountability, cross-operator service-level governance, and a clear allocation of roles and decision rights. In procurement and programme design, the thesis therefore recommends using empirically observed archetypes and ecosystem roles as design templates, so that key structural choices (e.g., integration depth, monetisation logic, etc.) are made

explicit and translated into concrete tender requirements and enforceable contractual provisions. In parallel, policy support should evolve from subsidising “pilots” as an end in itself toward enabling business-model innovation and collaboration, prioritising initiatives that credibly demonstrate (i) post-pilot financial sustainability pathways, (ii) implementable integration and data-sharing arrangements, and (iii) orchestration and execution capabilities that can sustain delivery at scale. Finally, the thesis argues for multidimensional performance governance: because MaaS configurations combine technical, organizational, economic, user, societal, and contextual elements, steering and learning require benchmarking that goes beyond integration levels or adoption counts. A repeatable, comparable assessment enables diagnostic governance (pinpointing binding constraints such as economic fragility or governance misalignment), supports horizontal learning across peer cities, and allows longitudinal monitoring of interventions, turning pilot narratives into evidence-based configuration improvement.

Notwithstanding these contributions, the thesis is subject to a number of limitations that delimit the scope of its claims and point to a clear agenda for further research. Empirically, much of the evidence base is skewed toward Europe and other digitally mature Global North contexts, where early policy support, open-data regimes, and dense multimodal infrastructures have facilitated MaaS experimentation. As a result, the analysis underrepresents dynamics in North America, Asia–Pacific, and especially the Global South, where informal transport systems, cash-based transactions, weaker data mandates, and different institutional logics may give rise to substantially different MaaS pathways and system “building blocks.” Future research should therefore broaden the geographical and institutional coverage of MaaS cases, explicitly examining how these factors shape integration feasibility, actor incentives, and business model design.

A second limitation concerns case selection. Some parts of the empirical design deliberately privileged more established initiatives (such as providers with multi-year implementations and a minimum degree of integration) in order to analyse models that have been operationally tested rather than purely aspirational. While this choice enhances reliability, it may overlook frontier innovation and early-stage experimentation, including pilots, that could signal emerging archetypes, novel governance arrangements, or alternative viability mechanisms. Subsequent studies could adopt a broader definitional scope that explicitly incorporates pilots and early-stage initiatives, enabling researchers to capture experimentation dynamics and anticipate future industry trajectories.

Methodologically, the archetypes and role-based building blocks identified in the thesis are derived primarily through qualitative coding and cross-case comparison. Although this approach offers interpretive depth and theoretical insight, it remains exploratory. Future research could complement this work with quantitative and configurational validation on larger samples, using techniques such as cluster analysis, latent class analysis, or qualitative comparative analysis (QCA). Mixed-method designs would be particularly valuable in testing robustness, identifying boundary conditions, and capturing hybrid configurations that qualitative categorisation may partially flatten.

The benchmarking component of the thesis also faces inherent data limitations. Performance assessment relies heavily on secondary sources, which are often asymmetric and incomplete – especially with respect to financial and behavioural indicators that private actors are reluctant to disclose. In addition, expert-judgement weighting and ordinal scoring, while transparent and replicable, remain sensitive to sampling and measurement assumptions. The evaluation agenda could be strengthened by expanding primary data collection, integrating longitudinal designs with repeated measurements (e.g., every 12–18 months), and triangulating expert assessments with disclosed KPIs where available.

Beyond these methodological extensions, the thesis also opens two particularly consequential avenues for advancing industry-side MaaS research. The first concerns the governance of MaaS ecosystems. Future studies should systematically investigate the main governance forms through which MaaS configurations are stabilised in practice. Developing a governance-focused vocabulary would complement the business model building blocks identified in this thesis and offer sharper insight into power asymmetries, control points, and coordination mechanisms within MaaS ecosystems.

The second avenue concerns an explicitly configurational explanation of investment and co-specialisation. While the thesis shows that MaaS outcomes depend on alignment among heterogeneous actors, further research is needed to explain when and why actors are willing to commit resources and co-specialise around MaaS. This includes studying which combinations of factors – such as contextual readiness (e.g., account-based ticketing and open-data mandates), credible revenue architectures beyond subsidies or thin commissions, orchestrator legitimacy and capability, risk-sharing and contractual design, and complementor strategic fit – trigger sustained investment and deepen interdependencies. Addressing this question would help explain how MaaS ecosystems move from loose aggregation toward genuinely integrated and value-enhancing configurations, thereby strengthening both theoretical understanding and practical relevance.

ACKNOWLEDGEMENTS

This dissertation would not have been possible without the support of many people and institutions who accompanied me throughout my doctoral journey.

First and foremost, I would like to express my sincere gratitude to my supervisors. I am deeply thankful for their constant availability, guidance, and trust throughout the development of this research. Each of them has been an equally important point of reference, contributing in a complementary way to my academic growth. Their intellectual rigor, openness to discussion, and continuous encouragement have been fundamental in shaping both the direction and the quality of this work. I am particularly grateful for the freedom I was given to develop my research interests, combined with thoughtful feedback and constructive critique at every stage of the PhD.

I would also like to acknowledge the institutional support provided by the National Centre for Sustainable Mobility (MOST). The research activities carried out within the MOST project constitute a central foundation of this thesis. The project offered a stimulating interdisciplinary environment, access to valuable resources, and opportunities for collaboration and dissemination that significantly enriched the empirical and conceptual development of the work presented here.

On a more personal note, I wish to thank my family for their unconditional support throughout this long and demanding journey. Their constant presence, patience, and trust in my choices have provided a stable foundation on which I could rely at every stage of the doctoral process. Their encourage-

ment, understanding, and quiet confidence in my work have been a continuous source of strength, especially during moments of uncertainty and fatigue.

Finally, my deepest and most heartfelt thanks go to my partner. Her presence has been constant and essential throughout this journey. With love, patience, and understanding, she has supported me through both the challenges and the achievements that marked this path. She has been my guiding star—the steady reference point that has oriented my choices and given meaning to my efforts. Her ability to remind me of what truly matters has made this journey not only possible, but profoundly meaningful.

LIST OF FIGURES

Figure 1.1 – Geographic distribution of MaaS sample 27

Figure 1.2 - Governance types of MaaS sample 27

Figure 1.3 – Country-level distribution of MaaS sample 28

Figure 1.4 - Business Model Canvas for Mobility Platforms 32

Figure 1.5 - Business Model Canvas for Highly-Diversified Providers 35

Figure 1.6 - Business Model Canvas for Lowly-Diversified Providers 37

Figure 1.7 - Business Model Canvas for Enablers 39

Figure 1.8 - Business Model Canvas for Mobility Embedded Providers 41

Figure 1.9 - Positioning of MaaS business model archetypes by degree of service integration and asset ownership 46

Figure 1.10 - Positioning of MaaS business model archetypes by degree of service integration and geographical scope 47

Figure 2.1 - A simplified representation of the MaaS Business Ecosystem according to Kamargianni and Matyas (2017) and Garcia et al. (2019) 78

Figure 2.2 - Key Initiatives towards MaaS by Uber, Lime, BVG, Mercedes-Benz, Masabi, Siemens Mobility 86

Figure 3.1 - Theoretical Framework for Business Model Evolution in MaaS Start-Ups 156

Figure 4.1 - Multidimensional nature of MaaS 185

Figure 4.2 - Graphic representation of the framework development process 191

Figure 4.3 – AHP Results 207

Figure 4.4 - Performance of the 3 identified clusters 222

LIST OF TABLES

Table 1.1 - Refined sample of MaaS providers and basic descriptors	24
Table 1.2 - Comparative framework across MaaS business-model archetypes	48
Table 1.3 - Advantages and Disadvantages of each archetype	50
Table 2.1 - Aspects influencing MaaS adoption	73
Table 2.2 - Overview of the six selected cases	82
Table 2.3 – Survey structure	85
Table 2.4 - Value creation, capture, and delivery framework applied to Service Providers	87
Table 2.5 - Value creation, capture, and delivery framework applied to Technology Providers	97
Table 3.1 – Case Studies Overview	142
Table 3.2 – List of Interviewees	143
Table 3.3 - Overview of resources, competences, and business model evolution for MaaS Global, SkedGo, and RideMovi	145
Table 4.1 – Framework definition	194
Table 4.2 - Real-world MaaS implementations analysed	205
Table 4.3 - Definition of KPIs and their thresholds	211
Table 4.4 – Real-world implementations score	221
Table 4.5 - Final Rankings	221
Table 4.6 – Sensitivity Analysis results	224

BIBLIOGRAPHY

Aapaoja, A., Eckhardt, J., Nykanen, L., (2017a). "Business Models for MaaS". 1st International Conference on Mobility as a Service (ICOMaaS). Tampere, Finland.

Aapaoja A., Eckhardt J., Sochor J. (2017b). "MaaS service combinations for different geographical areas". 24th World Congress on Intelligent Transportation Systems, Montreal.

Aba, A., Esztergár-Kiss, D. (2024). "Creation of the MaaS readiness index with a modified AHP-ISM method". *Communications in Transportation Research*, 4, 100122.

Abell, D.F. (1980). "Defining the business: The starting point of strategic planning". Englewood Cliffs, NJ:Prentice-Hall.

Acciarini, C., Cappa, F., Boccardelli, P., Oriani, R. (2023). "How Can Organizations Leverage Big Data to Innovate Their Business Models? A Systematic Literature Review". *Technovation*, 123, 102713.

Adner, R. (2017). "Ecosystem as structure: An actionable construct for strategy". *Journal of Management*, 43(1), 39–58.

Adner, R., Kapoor, R., (2010). "Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations". *Strateg. Manag. J.* 31, 306–333.

Afuah, A., (2004). "Business Models: A Strategic Management Approach". McGraw-Hill/Irwin, New York.

Aithal A., Aithal P.S. (2020). "Development and Validation of Survey Questionnaire & Experimental Data – A Systematical Review-based Statistical

Approach". *International Journal of Management, Technology, and Social Sciences (IJMTS)*, 5(2), 233-251. ISSN: 2581-6012.

Albino, V., Berardi, U., & Dangelico, R. M. (2015). "Smart Cities: Definitions, Dimensions, Performance, and Initiatives". *Journal of Urban Technology*, 22(1), 3–21.

Alyavina E., Nikitas, A., Njoya Tchouamou, E. (2024). "Mobility-as-a-Service and unsustainable travel behaviour: Exploring the car ownership and public transport trip replacement side-effects of the MaaS paradigm". *Transport Policy*, Volume 150, Pages 53-70.

Ambrosino, G., Nelson, J. D., Boero, M., & Pettinelli, I. (2016). "Enabling intermodal urban transport through complementary services: From flexible mobility services to the shared use mobility agency. Workshop 4. Developing inter-modal transport systems". *Research in Transportation Economics*, 59, 179–184.

Amit, R. and Zott, C. (2001). "Value creation in e-business". *Strategic Management Journal*, 22(6–7), 493–520.

Amit R., Zott C. (2012). "Creating Value through Business Model Innovation". *MIT Sloan Management Review*.

Amit R., Zott C. (2015). "Crafting Business Architecture: The Antecedents of Business Model Design". *Strat. Entrepreneurship J.*, 9: 331–350.

Amit R., Zott C. (2020). "Business Model Innovation Strategy: Transformational Concepts and Tools for Entrepreneurial Leaders". John Wiley & Sons.

Arias-Molinares, D., Garcia-Palomares, J.C., (2020). "The Ws of MaaS: understanding mobility as a service from a literature review". *IATSS Res.* 44 (3), 253–263.

Arksey, H., & O'Malley, L. (2005). "Scoping Studies: Towards a Methodological Framework". *International Journal of Social Research Methodology: Theory & Practice*, 8(1), 19–32.

Aspelund, A., Berg-Utby, T., & Skjevdal, R. (2005). "Initial resources' influence on new venture survival: a longitudinal study of new technology-based firms". *Technovation*, 25(11), 1337-1347.

Audouin M., Finger M. (2018). "The development of Mobility-as-a-Service in the Helsinki metropolitan area: A multilevel governance analysis". *Research in Transportation Business & Management*, Volume 27, Pages 24-35.

Autio, E. (2022). "Orchestrating ecosystems: A multi-layered framework". *Innovation: Organization & Management*, 24(1), 96–109.

Baden-Fuller, C. and Mangematin, V. (2013). "Business models: A challenging agenda". *Strategic Organization*, 11, 418–27.

Bakker, R. M., & Shepherd, D. A. (2017). "Pull the Plug or Take the Plunge: Multiple Opportunities and the Speed of Venturing Decisions in the Australian Mining Industry". *Academy of management journal*, 60(1), 130-155.

Baldwin, C.Y. (2024). "Focusing the ecosystem lens on innovation studies". *Research Policy*. Volume 53, Issue 3, 104949.

Banister, D. (2008). "The sustainable mobility paradigm". *Transport Policy*, 15(2), 73–80.

Barney, J. B. (1991). "Firm resources and sustained competitive advantage", *Journal of Management*, 17(1), pp. 99–120.

Barney, J. B. (1995). "Looking inside for competitive advantage". *The Academy of Management Executive*, 9, pp. 49–61.

Baruch, Y., & Holtom, B. C. (2008). "Survey response rate levels and trends in organizational research". *Human Relations*, 61(8), 1139–1160.

Basbas, S., & Makridakis, C. M. (2007). "A review of the contribution of multi-criteria analysis to the evaluation process of transportation projects". *International Journal of Sustainable Development and Planning*, 2(4), 387–407.

Belk, R. (2014). "You are what you can access: Sharing and collaborative consumption online". *Journal of Business Research*, 67(8), 1595–1600.

Belossarov, A., Aba, A., Esztergár-Kiss, D. (2023). "Using the Analytical Hierarchy Process Method to Evaluate Mobility as a Service (MaaS) Applications". *Journal of Urban Technology*, 30(4), 83–112.

Benallou I., Azmani A., Azmani M. (2023). "A combined AHP-TOPSIS model for the evaluation and selection of truck drivers". *Journal of Theoretical and Applied Information Technology*, Vol.101. No 7.

van den Berg, V. A. C., Verhoef, E. T., & Rietveld, P. (2022). "Business models for Mobility as a Service (MaaS)". *Transportation Research Part B*, 157, 203–229.

Bird, B. (1988). "Implementing Entrepreneurial Ideas: The Case for Intention". *The Academy of Management Review*, 13(3), 442-453.

Birkinshaw, J., Ansari, S., (2015). "Understanding management models: going beyond "what" and "why" to "how" work gets done in organizations". In: Foss, N.J., Saebi, T. (Eds.), *Business Model Innovation: the Organizational Dimension*. Oxford University Press, Oxford, pp. 85e103.

Bocken N.M.P., Rana P., Short S.W. (2015). "Value mapping for sustainable business thinking", *Journal of Industrial and Production Engineering*, 32:1, 67-81.

Bojovic N., Genet C., Sabatier V. (2017). "Learning, signaling, and convincing: The role of experimentation in the business modeling process". *Long Range Planning*, pp. 1-17.

Boston Consulting Group (BCG) (2024). "Moving Millions: A Recipe to Make Urban Mobility Work". Boston Consulting Group. Available at: <https://www.bcg.com/publications/2024/transforming-urban-mobility>

Braun, V., & Clarke, V. (2006). "Using thematic analysis in psychology". *Qualitative Research in Psychology*, 3(2), 77–101.

Braun V., Clarke V., Boulton E., Davey L., McEvoy C. (2021). "The online survey as a qualitative research tool". *International Journal of Social Research Methodology*, 24:6, 641-654.

Brush, C. G., Patricia, G. G., Myra, M. H., & Harold, S. H. (2001). "From Initial Idea to Unique Advantage: The Entrepreneurial Challenge of Constructing a Resource Base [and Executive Commentary]". *The Academy of Management Executive* (1993-2005), 15(1), 64-80.

Bujang M.A., Yoon H., Lee K., Yee K. (2022). "A Step-by-step Guide to Questionnaire Validation Research". Institute for Clinical Research, NIH MYISBN.

Butler, L., Yigitcanlar, T., Paz, A., (2021). "Barriers and risks of Mobility-as-a-Service (MaaS) adoption in cities: a systematic review of the literature". *Cities* 109, 103036.

Carbonara N., Messeni Petruzzelli A., Panniello U., De Vita D., (2024). "Embracing new disruptions: Business model innovation in the transition to Mobility as a Service (MaaS)". *Journal of Cleaner Production*, 464 (142744).

Casadesus-Masanell, R., Ricart J.E. (2010). "From strategy to business models and onto tactics". *Long Range Planning*, 43 (2–3), pp. 195-215.

Cavalcante, S., Kesting, P., Ulhøi, J., (2011). "Business Model Dynamics and Innovation: (Re)establishing the Missing Linkages". *Management Decision* 49 (8), 1327e1342.

Cenamora, J. and Frishammar, J. (2021). "Openness in platform ecosystems: Innovation strategies for complementary products". *Research Policy*, 50, 104148.

Chen, A. (2021). "The Cold Start Problem: How to Start and Scale Network Effects". HarperCollins.

Chesbrough, H. (2010). "Business model innovation: Opportunities and barriers". *Long Range Planning*, 43(2–3), 354–363.

Chiba, T., Abe, R. (2024). "Factors affecting continuation of Mobility as a Service projects in regional and rural areas: An analysis of 50 projects in Japan". *Research in Transportation Business and Management*, 57, 101226.

Choi, Y. R., Lévesque, M., & Shepherd, D. (2008). "When Should Entrepreneurs Expedite or Delay Opportunity Exploitation?". *Journal of business venturing*, 23, 333-355.

Climent R.C., Haftor D.M. (2021). "Value creation through the evolution of business model themes". *Journal of Business Research*. Volume 122, Pages 353-361.

Cohen B., Kietzmann J. (2014). "Ride On! Mobility Business Models for the Sharing Economy". *Organization & Environment*, 27(3), 279–296.

Cohen, S. L., Bingham, C. B., & Hallen, B. L. (2019). "The role of accelerator designs in mitigating bounded rationality in new ventures". *Administrative Science Quarterly*, 64(4), 810-854.

Cook, M. B., Bhamra, T., & Lemon, M. (2006). "The transfer and application of product service systems: From academia to UK manufacturing firms". *Journal of Cleaner Production*, 14(17), 1455–1465.

Cozzolino, A. and Geiger, S. (2024). "Ecosystem disruption and regulatory positioning: Entry strategies of digital health startup orchestrators and complementors". *Research Policy*, 53(2), 104913.

Creswell, J. W., & Plano Clark, V. L. (2017). "Designing and Conducting Mixed Methods Research" (3rd ed.). SAGE.

Cruz, C.O., Sarmiento, J.M., (2020). "Mobility as a Service" platforms: a critical path towards increasing the sustainability of transportation systems". *Sustainability* 12 (16), 6368.

Dadashzadeh, N., Woods, L., Ouelhadj, D., Kamargianni, M., Antoniou, C. (2022). "Mobility as a Service Inclusion Index (MaaSINI): Evaluation of inclusivity in MaaS systems and policy recommendations". *Transport Policy*, 127, 191–202.

DaSilva C.M., Trkman P. (2014). "Business Model: What It Is and What It Is Not". *Long Range Planning*, 47: 379-389.

Davidsson, P., Gruenhagen, J. H. (2021). "Fulfilling the process promise: A review and agenda for new venture creation process research". *Entrepreneurship theory and practice*, 45(5), 1083-1118.

Davis, Jason P., Eisenhardt, Kathleen M., Bingham, Christopher B., (2007). "Developing theory through simulation methods". *Acad. Manag. Rev.* 32 (2), 480–499.

Demil, B., Lecocq, X. (2010). "Business model evolution: In search of dynamic consistency". *Long Range Planning*, 43: 227-246

Dyer J.H., Singh H., Hesterly W.S. (2018). "The relational view revisited: A dynamic perspective on value creation and value capture". *Strategic Management Journal*. Volume39, Issue12, Pages 3140-3162.

Ebrahimigharehbaghi S., Sharmeen F., Meurs H. (2017). "Innovative Business Architectures (BAs) for Mobility as a Service (MaaS) – exploration, assessment, and categorization using operational MaaS cases". Conference paper.

Eckhardt, J., Aapaoja, A., Nykänen, L., Sochor, J., (2017). "Mobility as a Service business and operator models". In: 12th ITS European Congress. Strasbourg, France.

Eckhardt, J., Nykänen, L., Aapaoja, A., & Niemi, P. (2018). "MaaS in rural areas – case Finland". *Research in Transportation Business & Management*, 27, 75–83.

Eckhardt J., Lauhkonen A., Aapaoja A. (2020). "Impact assessment of rural PPP MaaS pilots". *European Transport Research Review*, 12(1), 49.

Eisenhardt K.M. (1989). "Building Theories from Case Study Research". *The Academy of Management Review*, Vol. 14, No. 4, pp. 532-550.

Eisenhardt, K.M., Graebner, M.E., (2007). "Theory building from cases: diverse opportunities and challenges". *Acad. Manag. J.* 50, 25–32.

Eisenmann, T. R. (2021). "Why startups fail". Random House Audio.

El-Sherif, A. (2021). "Urban mobility systems components". In Vacca, J.R. (ed.), *Solving Urban Infrastructure Problems Using Smart City Technologies*. Elsevier, 89–106.

Enoch M., Potter S. (2023). "MaaS (Mobility as a Service) market futures explored". *Transport Policy* 134 31–40.

Estzegar-Kiss D., Kerényi T., Mátrai T., Aba A. (2020). "Exploring the MaaS market with systematic analysis". *European Transport Research Review*, 12, 67.

Fioreze T., de Gruijter M., Geurs K. (2019). "On the likelihood of using mobility-as-a-service: a case study on innovative mobility services among resi-

dents in Netherlands". Case Study on Transport policy, Volume 7, Issue 4, Pages 790-801.

Foss, N.J., Saebi, T., (2017). "Fifteen years of research on business model innovation: how far have we come, and where should we go?". *J. Manag.* 43 (1), 200–227.

Fukugawa, N., (2018). "Is the impact of incubator's ability on incubation performance contingent on technologies and life cycle stages of startups?: evidence from Japan". *Int. Entrep. Manag. J.* 14, 457–478.

Furr, N., & Ahlstrom, P. (2011). "Nail it then scale it: the entrepreneur's guide to creating and managing breakthrough innovation". NISI Institute.

García R.J.R., Lenz G., Haveman S.P., Bonnema G.M. (2020). "State of the Art of Mobility as a Service (MaaS) Ecosystems and Architectures—An Overview of, and a Definition, Ecosystem and System Architecture for Electric Mobility as a Service (eMaaS)". *World Electric Vehicle Journal* 11, no. 1: 7.

Garnsey, E., Lorenzoni, G., Ferriani, S. (2008). "Speciation through entrepreneurial spin-off: The AcornARM story". *Research Policy*, 37(2), 210–224.

Gawer, A. (2021). "Digital platforms and ecosystems: Remarks on the dominant organizational forms of the digital age". *Long Range Planning*. Volume 54, Issue 5, 102045.

Geels, F.W. (2005). "Technological transitions and system innovations: A co-evolutionary and socio-technical analysis". *IMP Innovation, Strategy and Sustainability*. Edward Elgar Ed., ISBN: 1845420098/9781845420093.

George, G., Bock, A.J., (2011). "The business model in practice and its implications for entrepreneurship research". *Entrepreneurship Theory and Practice* 35 (1), 83–111.

Geissinger, A., Laurell, C., Sandström, C., (2020). "Digital disruption beyond uber and airbnb—tracking the long tail of the sharing economy". *Technol. Forecast. Soc. Change* 155, 119323.

Giesecke, R., Surakka, T., Hakonen, M., (2016). "Conceptualising mobility as a service". In: *Proceedings of the Eleventh International Conference on Ecological Vehicles and Renewable Energies (EVER)*, Monte Carlo, Monaco, pp. 1–11.

Girotra K., Netessine S. (2014). "Four Paths to Business Model Innovation". *Harvard Business Review*.

Glaser, B.G., Strauss, A.L., (1967). "The Discovery of Grounded Theory: Strategies for Qualitative Research". Aldine Transaction.

Goepel K. (2013). "Implementing the Analytic Hierarchy Process as a Standard Method for Multi-Criteria Decision Making in Corporate Enterprises – a New AHP Excel Template with Multiple Inputs". *International symposium on the analytic hierarchy process*, Kuala Lumpur, Malaysia.

Goulding R., Kamargianni M. (2018). "The Mobility as a Service Maturity Index: Preparing the Cities for the Mobility as a Service Era". *MaaS Lab Publications*.

Greco, S., Ehrgott, M., & Figueira, J. R. (2016). "Multiple Criteria Decision Analysis: State of the Art Surveys". Springer.

Greco S., Ishizaka A., Tasiou M., Torrisi G. (2019). "On the Methodological Framework of Composite Indices: A Review of the Issues of Weighting, Aggregation, and Robustness". *Soc Indic Res* (2019) 141:61–94.

Greco S., Słowiński R., Wallenius J. (2025). "Fifty years of multiple criteria decision analysis: From classical methods to robust ordinal regression". *European Journal of Operational Research*, Volume 323 (2), Pages 351-377.

Gresov, C. and Drazin, R. (1997). "Equifinality: Functional equivalence in organization design". *Academy of Management Review*, 22(2), 403–428.

Guidon S., Wicki M., Bernauer T., Axhausen K. (2019). "Transportation service bundling – for whose benefit? Consumer valuation of pure bundling in the passenger transportation market", *Transportation Research Part A: Policy and Practice*, 131, 91-106.

HaCon Company. (2022). "MaaS Business Models – Lessons Learned". Available at: https://www.youtube.com/watch?v=gvaX6hODxVs&ab_channel=HaconCompany

Hamari, J., Sjöklint, M. and Ukkonen, A. (2016). "The sharing economy: Why people participate in collaborative consumption". *Journal of the Association for Information Science and Technology*, 67(9).

Hamel, G. (1999). "Bringing Silicon Valley inside". *Harvard Business Review*, 77(5), 70–84.

Harrington, J. H. (1991). "Business Process Improvement – The Breakthrough Strategy for Total Quality, Productivity, and Competitiveness". McGraw-Hill.

Harrison C., Eckman B., Hamilton R., Hartswick P., Kalagnanam J., Paraszczak J., Williams P. (2010). "Foundations for Smarter Cities". *IBM Journal of Research and Development* 54: 4, pp.1–16.

Harrison G., Gühnemann A., Shepherd S. (2020). "The business case for a journey planning and ticketing app-Comparison between a simulation analysis and real-world data". *Sustainability (Switzerland)*.

Heikkilä, S., (2014). "Mobility as a service—a proposal for action for the public administration, case helsinki". Master of Science in Technology. Aalto University, Helsinki.

Hensher D.A. (2017). "Future bus transport contracts under a mobility as a service (MaaS) regime in the digital age: are they likely to change?". *Transp. Res. A Policy Prac.*;98:86-96.

Hensher D.A., Ho C.Q., Mulley C., Nelson J.D., Smith G., Wong Y.Z. (2020). "Understanding Mobility as a Service (MaaS): Past, Present and Future". Book, Elsevier Ed.

Hensher D.A., Mulley C. (2021). "Mobility bundling and cultural tribalism - Might passenger mobility plans through MaaS remain niche or are they truly scalable?". *Transport Policy*, Volume 100, Pages 172-175.

Hensher D.A., Ho C.Q., Reck D.J., Smith G. (2021). "The Sydney Mobility as a Service (MaaS) Trial Design, Implementation, Lessons and the Future". iMove project final report.

Hensher D.A., Xi H. (2022) "Mobility as a service (MaaS): are effort and seamlessness the keys to MaaS uptake?", *Transport Reviews*, 42:3, 269-272.

Hensher, D.A., Mulley, C., Nelson, J.D. (2023). "What is an ideal (Utopian) mobility as a service (MaaS) framework? A communication note". *Transportation Research Part A: Policy and Practice*. Volume 172, 103675.

van den Heuvel, C., Kao, P.-J., Matyas, M., (2020). "Factors driving and hindering business model innovations for mobility sector start-ups". *Research in Transportation Business & Management* 37, 100568.

Hietanen, S. (2014) "'Mobility as a Service' – the new transport model?". *Eurotransport*, 12(2).

Ho C.Q., Hensher D.A., Mulley C., Wong Y.Z. (2018). "Potential uptake and willingness-to-pay for Mobility as a Service (MaaS): A stated choice study". *Transportation Research Part A: Policy and Practice*. Volume 117, Pages 302-318.

Ho C.Q., Mulley C., Hensher D.A. (2020). "Public preferences for mobility as a service: Insights from stated preference surveys". *Transportation Research Part A: Policy and Practice*. Volume 131, Pages 70-90.

Holmberg, P.E., Collado, M., Sarasini, S., Williander, M., (2016). "MaaS framework". Final Report of MaaSterplan Project (Vinnova).

Huang, H.C., Lai, M.C., Lo, K.W. (2012). "Do founders' own resources matter? The influence of business networks on start-up innovation and performance". *Technovation*. Vol.32(5), pp.316-327.

Hwang, C. L., & Yoon, K. (1981). "Multiple Attribute Decision Making: Methods and Applications". Springer-Verlag.

Ioannou I., Serafeim G. (2019). "Corporate Sustainability: A Strategy?". Harvard Business School Accounting & Management Unit Working Paper No. 19-065, Available at SSRN: <https://ssrn.com/abstract=3312191>

Ireland, R.D., Hitt, M.A., Sirmon, D.G., (2003). "A model of strategic entrepreneurship: the construct and its dimensions". *J. Manage.* 29, 963–989.

Ishizaka, A., & Labib, A. (2011). "Review of the main developments in the analytic hierarchy process". *Expert Systems with Applications*, 38(11), 14336-14345.

ITF, (2021). "The Innovative Mobility Landscape: The Case of Mobility as a Service". *International Transport Forum Policy Papers*, No. 92, OECD Publishing, Paris.

Jacobides, M.G., Knudsen, T. and Augier, M. (2006). "Benefiting from innovation: Value creation, value appropriation and the role of industry architectures". *Research Policy*, 35(8), 1200–1221.

Jacobides, M.G., Cennamo, C. and Gawer, A. (2018). "Towards a theory of ecosystems". *Strategic Management Journal*, 39(8), 2255–2276.

Jacobides, M.G., Cennamo, C. and Gawer, A. (2024). "Externalities and complementarities in platforms and ecosystems: From structural solutions to endogenous failures". *Research Policy*, 53(1).

Johnson, M. W., Christensen, C. M. and Kagermann, H. (2008). "Reinventing your business model". *Harvard Business Review*, 86, 57–68.

Jick, T. D. (1979). "Mixing qualitative and quantitative methods: Triangulation in action". *Administrative Science Quarterly*, 24(4), 602–611.

Jittrapirom P., Caiati V., Feneri A.-M., Ebrahimi S., González M.J.A., Narayan J. (2017). "Mobility as a service: a critical review of definitions, assessments of schemes, and key challenges". *Urban Planning*, 2(2), 13-25.

Jones P. (2014). "The evolution of urban mobility: the interplay of academic and policy perspectives". *IATSS Research*, Volume 38, Issue 1, pp. 7-13.

Kamargianni M., Li W., Matyas M., Schäfer A. (2016). "A Critical Review of New Mobility Services for Urban Transport". *Transportation Research Procedia*, 14, pp.3294-3303.

Kamargianni M., Matyas M. (2017). "The business ecosystem of mobility-as-a-service". In: Paper Presented at the 96th Transportation Research Board (TRB) Annual Meeting, Washington, DC.

Kamargianni, M., Matyas, M., Li, W., Muscat, J., Yfantis, L. (2018). "The MaaS Dictionary". MaaS Lab, Energy Institute, University College London.

Kandanaarachchi, T., Nelson, J., Ho, C., (2022). "Building Trust and Collaboration Among the Stakeholders in a Mobility as a Service Ecosystem—Insights from Two MaaS Case Studies". Available at: SSRN 4253442.

Kaplan, S. (2011). "Research in cognition and strategy: Reflections on two decades of progress and a look to the future". *Journal of Management Studies*, 48(3), 665-695.

Kaplan, R.S., Norton, D.P. (1996). "The Balanced Scorecard". Harvard Business School Press.

Kapoor, R. (2018). "Ecosystems: Broadening the locus of value creation". *Journal of Organization Design*, 7(1).

Karami, M., Baber, W. W., Ojala A. (2022). "The effectual process of business model innovation for seizing opportunities in frontier markets". *Technovation*. Vol.117, 102595.

Karleuša, B., Deluka-Tibljaš, A., & Dragčević, V. (2013). "Review of multicriteria-analysis methods application in decision making about transport infrastructure". *Građevinar*, 65(7), 619–631.

Karlsson I.C.M., Sochor J., Strömberg H. (2016). "Developing the 'Service' in Mobility as a Service: experiences from a field trial of an innovative travel brokerage". *Transp. Res. Proc.*, 14 (2016), pp. 3265-3273.

Karlsson, I.C.M., Mukhtar-Landgren, D., Smith, G., Koglin, T., Kronsell, A., Lund, E., Sarasini, S., Sochor, J. (2020). "Development and implementation of Mobility-as-a- Service –A qualitative study of barriers and enabling factors". *Transport. Res. Part A* 131, 283–295.

Kirtley, J., & O'Mahony, S. (2020). "What is a pivot? Explaining when and how entrepreneurial firms decide to make strategic change and pivot". *Strategic management journal*.

Klein C., Kaefer G. (2008). "From Smart Homes to Smart Cities: Opportunities and Challenges from an Industrial Perspective". *Proc. of the 8th International Conference, NEW2AN and 1st Russian Conference on Smart Spaces, SMART 2008, St. Petersburg, Russia*.

König, D., Eckhardt, J., Aapaoja, A., Sochor, J., Karlsson, M., (2016). "Deliverable 3 –Business and Operator Models for MaaS". *MaaSIFIE Project funded by CEDR*.

König, M., Ungerer, C., Baltes, G., Terzidis, O., (2019). "Different patterns in the evolution of digital and non-digital ventures' business models". *Technol. Forecast. Soc. Chang.* 146, 844–852.

Krauss, K., Moll, C., Kohler, J., Axhausen, K.W., (2022). "Designing mobility-as-a-service business models using morphological analysis". *Transportation Business & Management* 45 (Part C), 100857.

Kriswardhana, W. and Esztergár-Kiss, D. (2023). "A systematic literature review of Mobility as a Service: Examining the socio-technical factors in MaaS adoption and bundling packages". *Transport Behaviour and Society*, 31, 232–243.

Lee, Z.W.Y., Chan, T.K.H., Balaji, M.S., Chong, A.Y.L., (2018). "Why people participate in the sharing economy: an empirical investigation of Uber". *Internet Res.* 28, 1–34.

Lepak D. P., Smith K. G., Taylor M. S. (2007). "Value Creation and Value Capture: A Multilevel Perspective". *Academy of Management Review*, Vol. 32, No. 1

Li Y., Voegelé T. (2017). "Mobility as a Service (MaaS): Challenges of Implementation and Policy Required". *International Transport Forum at OECD*, Paris, France.

Li, L. and Shalaby, A. (2024). "Navigating the transit network: Understanding how riders obtain, evaluate, and interpret transit information". *Transportation Research Part A: Policy and Practice*, Elsevier, vol. 185(C).

Liimatainen, H., Mladenović, M. N. (2018). "Understanding the complexity of mobility as a service". *Research in Transportation Business and Management*, 27, 1-2.

Lim D.S.K., Morse E.A., Yu N. (2020). "The impact of the global crisis on the growth of SMEs: A resource system perspective". *International Small Business Journal*, Volume 38 (6).

Liu, J., Baskaran, A., Li, S. (2009). "Building Technological-Innovation-Based Strategic Capabilities at Firm Level in China: A Dynamic Resource-Based-View Case Study". *Industry & Innovation*, 16(4-5), 411–434.

Lovins, A.B., Lovins, L.H., Hawken, P. (1999). "A road map for natural capitalism". *Harvard Business Review*, 77(3), 145–161.

Lusch, R. F., & Nambisan, S. (2015). "Service innovation: A service-dominant logic perspective". *MIS Quarterly*, 39(1), 155–175.

Lyons, G., Hammond, P. and Mackay, K. (2019). "The importance of user perspective in the evolution of MaaS". *Transportation Research Part A: Policy and Practice*, 121, 22–36.

Maas, G. (2022). "Literature review of Mobility as a Service (MaaS)". *Sustainability*. 14(14):8962.

MaaS Alliance (2017). "Guidelines and Recommendations to Create the Foundations for Thriving MaaS Ecosystem". White Papers.

MaaS Alliance (2018). "Data makes MaaS happen – MaaS Alliance Vision Paper on Data". White Papers.

MaaS Alliance (2019). "MaaS Alliance Study: Challenges associated with MaaS & Approaches for overcoming them". White Papers.

MaaS Alliance, (2022). "What Is MaaS?". Available at: <https://MaaS-Alliance.Eu/homepage/what-is-MaaS>

Machado, C.A.S., de Salles Hue, N.P.M., Berssaneti, F.T. and Quintanilha, J.A. (2018). "An overview of shared mobility". *Sustainability*, 10(12).

Mahadevan, B. (2000). "Business models for Internet-based e-commerce: An anatomy". *California Management Review*, 42(4), 55–69.

Mangematin, V., Lemarie, S., Boissin, J.P., Catherine, D., Corolleur, F., Coronini, R., et al. (2003). "Development of SMEs and heterogeneity of trajectories: The case of biotechnology in France". *Research Policy*, 32(4), 621–638.

Mansoori, Y., Karlsson, T., Lundqvist, M. (2019). "The influence of the lean startup methodology on entrepreneur-coach relationships in the context of a startup accelerator". *Technovation*. Vol. 84-85, pp. 37-47

Marcon, A., Ribeiro, J. L. D. (2021). "How do startups manage external resources in innovation ecosystems? A resource perspective of startups' lifecycle". *Technological Forecasting and Social Change*, 171, 120965.

Martins, L. L., Rindova, V. P., Greenbaum, B. E. (2015). "Unlocking the hidden value of concepts: a cognitive approach to business model innovation". *Strategic Entrepreneurship Journal*, 9(1), 99-117.

Massa, L., Tucci, C. L., & Afuah, A. (2017). "A critical assessment of business model research". *Academy of Management Annals*, 11(1), 73–104.

Matyas M. (2020). "Opportunities and barriers to multimodal cities: lessons learned from in-depth interviews about attitudes towards mobility as a service". *European Transport Research Review*, 12, Article 7.

McGrath, R. G. (2010). "Business models: A discovery driven approach". *Long Range Planning*, 43, 247–61.

McKinsey (2023). "The future of mobility". *McKinsey Quarterly*. Available at: <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-future-of-mobility-mobility-evolves>

McMullen, J. S., Dimov, D. (2013). "Time and the Entrepreneurial Journey: The Problems and Promise of Studying Entrepreneurship as a Process". *Journal of Management Studies*, 50(8), 1481-1512.

Meng L., Somenahalli S., Berry S. (2020). "Policy implementation of multi-modal (shared) mobility: Review of a supply-demand value proposition canvas". *Transport Reviews*, 40 (5), pp. 670-684

Merkert R., Wong Y.Z. (2020). "Workshop 3: Emerging business models and implications for the transport ecosystem". *Research in Transportation Economics*, Volume 83, 100911.

Meurs H., Sharmeen F., Marchau V., van der Heijden R. (2018). "Organizing integrated services in mobility-as-a-service systems: Principles of alliance formation applied to a MaaS-pilot in the Netherlands". *Transportation Research Part A: Policy and Practice*, Volume 131, Pages 178-195.

Meyer, A.D., Tsui, A.S. and Hinings, C.R. (1993). "Configurational approaches to organizational analysis". *Academy of Management Journal*, 36(6), 1175–1195.

Mitchell, R. K., Agle, B. R., & Wood, D. J. (1997). "Toward a theory of stakeholder identification and salience". *Academy of Management Review*, 22(4), 853–886.

Morgan T., Anokhin S., Ofstein L., Friske W. (2020). "SME response to major exogenous shocks: The bright and dark sides of business model pivoting". *International Small Business Journal*, Volume 38 (5).

Morris, M., Schindehutte, M., Allen, J. (2005). "The entrepreneur's business model: Toward a unified perspective". *Journal of Business Research*, 58(6), 726–735.

Mukhtar-Landgren, D., Karlsson, M., Konglin, T., Kronsell, A., Lund, E., Sarasini, S., Smith, G., Sochor, J., Wendle, B., (2016). "Institutional conditions for

integrated mobility services (IMS): towards a framework for analysis". K2 Working Papers 2016: 16. Available at: <https://portal.research.lu.se/en/publications/institutional-conditions-for-integrated-mobility-services-ims-tow>

Muller, M., Correia, G. H. D. A., Park, S., Fusco, B., Lee, R. (2024). "Enhancement of the impacts 2050 model to enable a whole system sustainability assessment of rideshare". *Multimodal Transportation*, 3(4), 100171.

Mulley, C. (2017). "Mobility as a Services (MaaS) – does it have critical mass?". *Transport Reviews*, 37(3), 247–251.

Mulley, C., Kronsell, A., (2018). "Workshop 7 report: the "uberisation" of public transport and mobility as a service (MaaS): implications for future mainstream public transport". *Res. Transport. Econ.* 69, 568–572.

Mulley, C., Nelson J. (2020). "How Mobility as a Service Impacts Public Transport Business Models", *International Transport Forum Discussion Papers*, No. 2020/17, OECD Publishing, Paris.

Nam T., Pardo T.A. (2011). "Conceptualizing smart city with dimensions of technology, people, and institutions". *Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times*, ACM (2011), pp. 282-291.

Narupiti S. (2019). "Exploring the possibility of MaaS service in Thailand, implications from the existing conditions and experts' opinions on "Who should be the MaaS provider in Bangkok?"". *IATSS Research*, Volume 43, Issue 4, Pages 226-234.

Newman, P. and Kenworthy, J. (1999). "Sustainability and Cities: Overcoming Automobile Dependence". Washington, DC: Island Press.

Nikolaidou, A., Papadopoulos, E., Politis, I., Basbas, S. (2023). "An Indicator-Based Methodological Framework for Assessing an eMaaS Scheme". *World Electric Vehicle Journal*, 14(7), 186.

Núñez C., Antoniou C. (2025). "The Mobility as a Service Potential Index (MaaSPI): Assessing the conditions for MaaS across countries based on public sources". *Research in Transportation Business & Management*, Volume 60, 101360.

OECD (2008). "Handbook on Constructing Composite Indicators, Methodology and user guide". Available at: https://www.oecd.org/en/publications/handbook-on-constructing-composite-indicators-methodology-and-user-guide_9789264043466-en.html

Oladimeji, D., Gupta, K., Kose, N.A., Gundogan, K., Ge, L., Liang, F. (2023). "Smart Transportation: An Overview of Technologies and Applications". *Sensors*. 23(8), 3880.

Orozco-Fontalvo, M., Soares Lopes, A., Vale, D. and Moura, F. (2024). 'IMPRESS: A comprehensive method to classify MaaS systems'. *Transport Policy*, 155, 234–241.

Ortega J., Moslem S., Tòth J., Ortega M. (2023). "A two-phase decision making based on the grey analytic hierarchy process for evaluating the issue of park-and-ride facility location". *Journal of Urban Mobility*, Volume 3, 100050.

Osterwalder, A., Pigneur, Y., Tucci, C.L., (2005). "Clarifying Business Models: Origins, Present, and Future of the Concept". *Communications of the Association for Information Systems* 16, 1e25.

Osterwalder, A. and Pigneur, Y. (2010). "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers". Hoboken, NJ: John Wiley & Sons.

Pangbourne K., Mladenović M.N., Stead D., Milakis D. (2020). "Questioning mobility as a service: Unanticipated implications for society and governance". *Transportation Research Part A: Policy and Practice*, 131, Pages 35-49.

Paschen, J., (2017). "Choose wisely: crowdfunding through the stages of the startup life cycle". *Bus. Horiz.* 60, 179–188.

Penrose E. T. (1959). "The Theory of the Growth of the Firm", John Wiley, New York.

Peralta, C.B., da, L., Echeveste, M.E., Lermen, F.H., Marcon, A., Tortorella, G., (2020). "A framework proposition to identify customer value through lean practices". *J. Manuf. Technol. Manage.* 31, 725–747.

Pérez, J. C., Carrillo, M. H., & Montoya-Torres, J. R. (2015). "Multicriteria approaches for urban passenger transport systems: A literature review". *Annals of Operations Research*, 226(1), 69–87.

Perren L., Ram M. (2004). "Case-Study Method in Small Businesszhan and Entrepreneurial Research: Mapping Boundaries and Perspectives". *International Small Business Journal*. Volume 22(1).

Peteraf, M. A. (1993) "The cornerstones of competitive advantage: a resource-based view", *Strategic Management Journal*, 14, pp. 179–191.

Picken, J.C., (2017). "From startup to scalable enterprise: laying the foundation". *Bus. Horiz.* 60, 587–595.

Polydoropoulou A., Pagoni I., Tsirimpa A., Roumboutsos A., Kamargianni M., Tsouros I. (2020). "Prototype business models for Mobility-as-a-Service". *Transportation Research Part A*, 131, pp. 149-162

Prescient & Strategic Intelligence (P&S Intelligence). (2022). "Global Mobility as a Service (MaaS) Market". Report from psmarketresearch.com

Priem, R.L., Butler, J.E., Li, S., (2013). "Toward reimagining strategy research: retrospection and on the on the 2011 AMR Decade Award Article". *Acad. Manage. Rev.* 38, 471–489.

Raff D.M.G. (2000). "Superstores and the evolution of firm capabilities in American bookselling", *Strategic Management Journal* 21(10/11), 1043e1059.

Reck, D. J., Hensher, D. A., & Ho, C. Q. (2020). "Exploring consumer preferences for Mobility-as-a-Service (MaaS) plans". *Transportation Research Part A: Policy and Practice*, 131, 282–295.

Reymen, I., Andries, P., Berends, H., Mauer, R., and Stephan, U. (2015), "Understanding dynamics of strategic decision-making in venture creation: A process study of effectuation and causation" in *Strategic Entrepreneurship Journal*, vol. 9, pp. 351–379.

Ries E. (2011). "The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses". Crown Books.

Rothaermel, F.T., Deeds, D.L., (2004). "Exploration and exploitation alliances in biotechnology: a system of new product development". *Strateg. Manag. J.* 25, 201–221.

Roumboutsos, A., Pagoni, I., Tsimipa, A., Polydoropoulou, A. (2021). "An ecosystem innovation framework: Assessing mobility as a service in Budapest". *Sustainability*, 13(7), 3753.

Rowley, J. (2014). "Designing and using research questionnaires". *Management Research Review*, 37(3), 308–330.

Saaty, T. L. (1980). "The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation". McGraw-Hill.

Sarasini, S., Sochor, J., Arby, J. (2017). "What characterises a sustainable MaaS business model?" 1st International Conference on Mobility as a Service, 28–29. Tampere, Finland.

Sarasini, S., Linder, M. (2018). "Integrating a business model perspective into transition theory: The example of new mobility services". *Environmental Innovation and Societal Transitions*, 27, 16–31.

Sharifi A. (2019). "A critical review of selected smart city assessment tools and indicator sets". *Journal of Cleaner Production*, Volume 233, pp. 1269–1283.

Shelton J., Medina M. (2010). "Integrated Multiple-Criteria Decision-Making Method to Prioritize Transportation Projects". *Transportation Research Record: Journal of the Transportation Research Board*, No. 2174, pp. 51–57.

Shih, H. S., Shyur, H. J., & Lee, E. S. (2007). "An extension of TOPSIS for group decision making". *Mathematical and Computer Modelling*, 45(7-8), 801–813.

Sirmon, D.G., Hitt, M.A., Ireland, R.D., (2007). "Managing firm resources in dynamic environments to create value: looking inside the black box". *Acad. Manag. Rev.* 32, 273–292.

Sirmon, D.G., Hitt, M.A., Ireland, R.D., Gilbert, B.A., (2011). "Resource orchestration to create competitive advantage: breadth, depth, and life cycle effects". *J. Manage.* 37, 1390–1412.

Smith G., Sochor J., Karlsson I.C.M. (2018). "Mobility as a Service: Development scenarios and implications for public transport", *Research in Transportation Economics*, Volume 69, Pages 592–599.

Smith, G., & Hensher, D. A. (2020). "Towards a framework for Mobility-as-a-Service (MaaS) policy and systems". *Transport Policy*, 89, 54–65.

Sochor J., Arby H., Karlsson I.C.M., Sarasini S. (2018). "A topological approach to mobility as a service: a proposed tool for understanding requirements and effects, and for aiding the integration of societal goals". *Res. Transp. Bus. Manag.*;27:3–14.

Sok, P., O'Cass, A., (2011). "Achieving superior innovation-based performance outcomes in SMEs through innovation resource-capability complementarity". *Ind. Mark. Manage.* 40, 1285–1293.

Sosna, M., Trevinyo-Rodriguez, R. and Velamuri, S.R. (2010), "Business model innovation through trial and-error learning", in *Long Range Planning*, vol. 43 Nos 2-3, pp. 383-407.

Srivastava, M., Wong, Y.H., (2023). "The development of mobility as a service in China and its impact on automobile manufacturers: a business model innovation". *Journal of Innovation Economics and Management* 40 (1), 225–263.

Stewart, T. J. (1992). "A critical survey on the status of multiple criteria decision making theory and practice". *Omega*, 20(5–6), 569–586.

Strauss, A., & Corbin, J. (1990). "Basics of Qualitative Research: Grounded Theory Procedures and Techniques". SAGE.

Strauss, A., & Corbin, J. (1998). "Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory (2nd ed.)". SAGE.

Teece, D.J., (2010). "Business models, business strategy and innovation". *Long Range Planning* 43 (2–3), 172–194.

Teece, D.J. (2016). "Dynamic capabilities and entrepreneurial management in large organizations: Toward a theory of the (entrepreneurial) firm". *European Economic Review*, 86, pp. 202–216.

Teece, D.J. (2017). "Towards a capability theory of (innovating) firms: Implications for management and policy". *Cambridge Journal of Economics*, 41(3), pp. 693–720, bew063

Teece, D.J. (2018). "Business models and dynamic capabilities". *Long Range Planning*, Volume 51, Issue 1, pp. 40-49.

Tracey, P., Jarvis, O. (2007). "Toward a theory of social venture franchising". *Entrepreneurship Theory and Practice*, 31(5), 667–685.

Tseng, Y.C., Chan, C.L. (2021). "When the Sharing Economy Meets Established Institutions: Uber and Airbnb in Taiwan". *IEEE Transactions on Engineering Management*, In press. <https://doi.org/10.1109/TEM.2019.2934520>

Turoń K., Kubik A. (2021). "Business Innovations in the New Mobility Market during the COVID-19 with the Possibility of Open Business Model Innovation". *Journal of Open Innovation Technology Market and Complexity*, 7(3):195.

UITP (2020). "Demystifying Ticketing and Payment in Public Transport" (update NOV 2020). International Association of Public Transport (UITP).

UITP (2022). *Ticketing in Mobility as a Service* (report). International Association of Public Transport (UITP).

Utriainen, R. and Pöllänen, M. (2018). "Review on mobility as a service in scientific publications". *Research in Transportation Business & Management*, 27, 15–23.

Voelpel, S.C., Leibold, M., Tekie, E.B., (2004). "The wheel of business model reinvention: how to reshape your business model to leapfrog competitors". *Journal of Change Management* 4 (3), 259e276.

Vogel, P. (2017). "From venture idea to venture opportunity". *Entrepreneurship theory and practice*, 41(6), 943-971.

Von Briel, F., Davidsson, P., & Recker, J. (2018). "Digital Technologies as External Enablers of New Venture Creation in the IT Hardware Sector". *Entrepreneurship theory and practice*, 42, 47-69.

Warner K.S.R., Wager M. (2019). "Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal". *Long Range Planning* Volume 52, Issue 3, Pages 326-349.

Willemstein, L., van der Valk, T., Meeus, M.T.H. (2007). "Dynamics in business models: An empirical analysis of medical biotechnology firms in the Netherlands". *Technovation*, 27, 221–232.

Wilson A., Mason M. (2019). "The coming disruption – The rise of mobility as a service and the implications for government". *Research in Transportation Economics*, 83, 100898.

Wickens C.D., Helton W.S., Hollands J.G., Banbury S. (2021). "Engineering Psychology and Human Performance". Routledge.

Wong Y.Z., Hensher D.A., Mulley C. (2018). "Stated preference design for mobility as a service (MaaS) broker/aggregator contracts". *ATRF 2018 - Australasian Transport Research Forum 2018, Proceedings*.

Wong Y.Z., Hensher D., Mulley C. (2020). "Mobility as a Service (Maas): Charting a future context". *Transportation Research Part A*, Volume 131, Pages 5-19.

Yannis G., Kopsacheili A., Dragomanovits A., Petraki V. (2020). "State-of-the-art review on multi-criteria decision-making in the transport sector". *Journal of Traffic and Transportation Engineering (English Edition)*. Volume 7 (4), Pages 413-431.

Yigitcanlar T., Kamruzzaman M., Foth M., Sabatini-Marques J., Da Costa E., Ioppolo G. (2019). "Can cities become smart without being sustainable?" *Sustainable Cities and Society*, 45, pp. 348-365.

Yin R.K. (1994). "Case Study Research: Design and Methods". SAGE Publications

Zhang Z., Zhang N. (2021). "Novel development scheme of mobility as a service: Can it provide a sustainable environment for China?". *Sustainability* (Switzerland), 13(8), 4233.

Zhao X., Vaddadi B., Sjöman M., Hesselgren M., Pernestål A. (2020). "Key barriers in MaaS development and implementation: Lessons learned from testing Corporate MaaS (CMaaS)". *Transportation Research Interdisciplinary Perspectives*, Volume 8, 100227.

Zitricky, M., et al. (2025). "Digital transformation of public transport through travel applications". *Transportation Research Procedia*, 91, 688–695.

Zott C, Amit R. (2007). "Business model design and the performance of entrepreneurial firms". *Organization Science* 18: 181–199.

Zott C., Amit R. (2010). "Business Model Design: An Activity System Perspective". *Long Range Planning*, Volume 43, Issues 2–3, pp. 216-226

Zott C., Amit R., Massa L. (2011). "The business model: Recent developments and future research". *Journal of Management*, 37, 1019–42.

Zwicky, F. (1967). "The morphological approach to discovery, invention, research and construction". In A. G. Wilson (Ed.), *New Methods of Thought and Procedure* (pp. 273–297). Springer.

CURRICULUM



Davide De Vita (Taranto, 06/06/1995) è un ingegnere gestionale e dottorando di ricerca presso il Politecnico di Bari, dove svolge attività scientifica sui temi della Mobility as a Service (MaaS), dell'evoluzione dei modelli di business digitali, e delle configurazioni organizzative degli ecosistemi di innovazione. La sua ricerca analizza come attori pubblici e privati interagiscono, cooperano e competono all'interno di piattaforme e sistemi multi-attore, osservandone implicazioni strategiche, tecnologiche e organizzative.

Formazione

- Dottorato di Ricerca (2023–2026) in *Rischio, Sviluppo Ambientale e Territoriale* – Politecnico di Bari

Tema di ricerca: Modelli di business e configurazioni organizzative per la Mobility as a Service (MaaS); ecosistemi di business e innovazione.

- Periodo di ricerca all'estero (Settembre – Dicembre 2025) - University College Dublin (UCD), Irlanda

Focus: ecosystem governance, digital platform strategy, multi-actor coordination in ecosystems.

- Laurea Magistrale in Ingegneria Gestionale (2020–2022) – Politecnico di Bari

Conseguita con votazione di 110/110 e lode, con una tesi sui modelli di business per la Mobility as a Service (MaaS), basata su una review sistematica della letteratura.

- Laurea Triennale in Ingegneria Gestionale (2016–2020) – Politecnico di Bari

Conseguita con votazione di 106/110, con una tesi sull'analisi degli effetti della pandemia Covid-19 sull'economia delle regioni italiane.

Attività scientifica e pubblicazioni

- Carbonara, N., Messeni Petruzzelli, A., Panniello, P., De Vita, D. (2024). *Embracing new disruptions: Business model innovation in the transition to Mobility as a Service (MaaS)*. Journal of Cleaner Production, 464, 142744.
- De Vita, D., Carbonara, N., Messeni Petruzzelli, A., Panniello, P. (2025). *Driving Mobility Innovations: Examining Mobility as a Service (MaaS) Start-ups Evolution from a Resource-Based View*. Submitted to: International Entrepreneurship and Management Journal (under review).
- De Vita, D., Carbonara, N., Locurcio, M., Messeni Petruzzelli, A., Ottomanelli, M. (2025). *Towards Excellence: Developing a Multidimensional Benchmarking Framework for Assessing Success in Mobility as a Service (MaaS) Systems*. Submitted to: Transportation Research Part A: Policy and Practice (under review).

- De Vita, D., Carbonara, N., Messeni Petruzzelli, A., Panniello, P. (2025). *Bridging Theory and Practice: Business Model Archetypes for Mobility as a Service (MaaS)*. Submitted to: Research in Transportation Business and Management (under review)

- De Vita, D., Carbonara, N., Messeni Petruzzelli, A., Panniello, U. (2025). *Healthcare in the Digital Age: A Systematic Literature Review on the Impact of Data-driven Technologies on Business Models and Patient Value*. Submitted to: BMC Health Services Research (under review).

Competenze linguistiche

- Italiano: madrelingua
- Inglese: livello B2+